Criterion validity and clinical usefulness of Attention Deficit Hyperactivity Disorder Rating Scale IV in attention deficit hyperactivity disorder (ADHD) as a function of method and age

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Abstract

Background: The aim of this research is to analyze Attention Deficit Hyperactivity Disorder Rating Scales IV (ADHD RS-IV) criteria validity and its clinical usefulness for the assessment of Attention Deficit Hyperactivity Disorder (ADHD) as a function of assessment method and age. **Methodology:** A sample was obtained from an epidemiological study (n = 1095, 6-16 years). Clinical cases of ADHD (ADHD-CL) were selected by dimensional ADHD RS-IV and later by clinical interview (DSM-IV). ADHD-CL cases were compared with four categorical results of ADHD RS-IV provided by parents (CATPA), teachers (CATPR), either parents or teachers (CATPAOPR) and both parents and teachers (CATPA&PR). Criterion validity and clinical usefulness of the answer modalities to ADHD RS-IV were studied. **Results:** ADHD-CL rate was 6.9% in childhood, 6.2% in preadolescence and 6.9% in adolescence. Alternative methods to the clinical interview led to increased numbers of ADHD cases in all age groups analyzed, in the following sequence: CATPAOPR> CATPRO> CATPA> CATPA&PR> ADHD-CL. CATPA&PR was the procedure with the greatest validity, specificity and clinical usefulness in all three age groups, particularly in the childhood. **Conclusions:** Isolated use of ADHD RS-IV leads to an increase in ADHD cases compared to clinical interview, and varies depending on the procedure used.

Keywords: Attention Deficit Hyperactivity Disorder, ADHD Rating Scale -IV, prevalence, criterion validity, clinical usefulness.

Resumen

Validez de criterio y utilidad clínica del Attention Deficit Hiperactivity Disorder Rating Scales IV en el Trastorno por Déficit de Atención con Hiperactividad en función del método y la edad. **Antecedentes:** se estudia la validez de criterio y utilidad clínica del Attention Deficit Hiperactivity Disorder Rating Scales IV (ADHD RS-IV) en el Trastorno por Déficit de Atención con Hiperactividad (TDAH) en función del método y edad. **Método:** muestra extraída de un estudio epidemiológico (n = 1095, 6-16 años). Los casos de TDAH clínico (TDAH-CL) fueron seleccionados mediante ADHD RS-IV dimensional y entrevista clínica (DSM-IV) y fueron comparados con cuatro modalidades categoriales de respuesta al ADHD RS-IV implementado por padres (CATPA), profesores (CATPR), padres o profesores indistintamente (CATPAOPR) y/o conjuntamente (CATPAYPR). Se estudió la validez de criterio y utilidad clínica de las modalidades de respuesta. **Resultados:** la tasa de TDAH-CL es 6,9% en infancia, 6,2% en preadolescencia y 6,9% en adolescencia. Los procedimientos alternativos a la entrevista clínica aumentan los casos de TDAH en los tres grupos de edad, siguiendo la sucesión CATPAOPR > CATPRO > CATPA > CATPAYPR > TDAH-CL. El procedimiento con mayor índice de validez, especifidad, utilidad clínica y capacidad predictiva de TDAH fue CATPAYPR. **Conclusiones:** la utilización de una versión categorial del ADHD RS-IV produce un incremento de casos de TDAH respecto a la entrevista clínica que varía en función del método utilizado.

Palabras clave: Trastorno por Déficit de Atención con Hiperactividad, ADHD Rating Scale -IV, prevalencia, validez de criterio, utilidad clínica.

The main purpose of our study is to analyze the criterion validity and clinical usefulness of Attention Deficit Hyperactivity Disorder Rating Scales IV (ADHD RS-IV) in the Attention Deficit Hyperactivity Disorder (ADHD) as a function of the method used and age.

ADHD is a frequent cause of referral of children and adolescents to clinical psychologists, pediatricians and child psychiatrists (López-Villalobos, 2002; Paiva, Saona, & Ramos, 2009), and it is considered one of the most important clinical and public health problems in terms of morbidity and dysfunction. ADHD makes increasing demands on mental health services and gives rise to higher clinical, family, social and academic impairment compared to the general population or clinical controls (Erskine et al., 2016; López-Villalobos et al., 2004).

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According to the criteria of the Diagnostic and Statistical Manual of Mental Disorders in its fourth edition (DSM-IV, American Psychiatric Association [APA], 2000), Attention deficit hyperactivity is characterized by a persistent pattern of inattentive, restless and impulsive behavior which is more frequent and severe than that typically observed in subjects at a similar stage of development. ADHD symptoms should have an onset before the age of 7, persist for at least six months to a degree which is maladaptive and inconsistent with the developmental level, and give rise to a clinically significant impairment in social, academic or occupational functioning and some of the alterations caused by these symptoms should be present in at least two of these settings.

The new classification of the DSM in its fifth edition ([DSM-5] APA, 2013) has recently emerged: ADHD has been included in neurodevelopmental disorders, the age of onset has been modified (symptoms should appear before age 12), subtypes have been replaced by presentations, comorbidity with autism spectrum disorders is allowed and the symptom threshold for adults has been modified.

A recent prevalence study has found that the extension of the criterion on the age of onset of 7 to 12 years led to an increase in the prevalence rate of ADHD from 7.4% (DSM-IV) to 10.8% (DSM-5). However, young people with a later onset age did not differ from those with earlier onset in terms of severity and comorbidity patterns, although they were more likely to belong to low-income families and ethnic minorities (Voort, He, Jameson, & Merikangas, 2014).

A global systematic review of prevalence studies in childhood and youth ADHD observed an average of 5.29% (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007).

Recent meta-analysis studies on the prevalence of ADHD, following DSM-IV criteria, show rates between 5.9 and 7.1% (Willcutt, 2012), and following DSM third edition ([DSM-III] APA, 1980), (DSM-III-R] APA, 1987 and DSM-IV criteria inclusively it rises to 7.2% (95% CI = 6.7 - 7.8) (Thomas, Sanders, Doust, Beller, & Glasziou, 2015). The most recent meta-analysis on the prevalence of ADHD in Spain finds rates of 6.8% (IC95% = 4.8 - 8.8) (Catalá-López et al., 2012).

The prevalence of ADHD may vary depending on the informant (parent or teacher) and on the criteria used to define the disorder (i.e., to exceed the cut-off point in either one or both scales). In turn, there may also be variation if we consider either the symptoms of ADHD in two or more settings or the complete diagnosis according to DSM (Thomas et al., 2015).

Through meta-analysis, several studies show that the prevalence of ADHD is lower when parents, rather than teachers, are the informants, and they show a lower prevalence than in previous cases when the diagnosis is clinical (Polanczyk et al., 2007; Willcutt, 2012).

Regarding only the number of symptoms required to meet DSM-IV criteria, a well-known meta-analysis (Willcutt, 2012) found that prevalence numbers varied according to whether the respondents were parents (8.8%), teachers (13.3%), parents-teachers agreement (5.7%) or parents-teachers indistinctly (12.9%). When the criterion was full compliance with all DSM-IV criteria, the figures decreased for both parent (6.1%) and teacher responses (7.1%). Overall, these results revealed the sensitivity of prevalence estimates based on the specific method used to define the symptoms of ADHD.

These prevalence numbers are also equivalent to the possibility of a diagnosis, if the clinician only paid attention to the response to these questionnaires. At present the diagnosis of the disorder is considered basically clinical (NICE, 2009) and is usually accompanied by questionnaires to parents and teachers, such as those previously mentioned. These questionnaires usually have a cut-off point that allows people to be deemed within or outside the clinical range and can lead to different estimates depending on their use. The authors think that the validity of the criteria and clinical usefulness of these questionnaires may vary according to the method used and the age range.

Our study will provide new figures on the prevalence of ADHD in Spain by age and will show its variability depending on the method used. These numbers can be compared with the international data previously mentioned. In addition, our study focuses on the problem of the variability of the diagnosis of ADHD and its consequences according to the procedure used by the clinician. This circumstance has obvious implications in clinical practice.

Therefore, the main objective of our research is to study the criterion validity and clinical usefulness of ADHD RS-IV depending on the procedure used to define ADHD (parent response, teacher response, parent-teacher responses and their use in childhood (6-9 years), preadolescence (10-13 years) or adolescence (14-16 years).

Method

Participants

Our research is posed as a population study to evaluate the prevalence of ADHD in Castile and Leon (Spain). The target population includes all students in primary and secondary education from 6 to 16 years old in the region. The sample design was multi-stage, stratified and proportional by clusters, as stated in the original research (Rodríguez et al., 2009). For a total population of 212,657 and a sample error of 0.05 for an expected prevalence of 5% and precision ± 1.4 (CI = 95%), a minimum sample size of 932 students was required, with an increase to 1200 in anticipation of losses.

1,095 cases were analyzed. The total sample had a mean age of 10.9 (SD = 3.0) and included 51.9% male (mean age = 10.7, SD = 3.0) and 48.1% female (mean age = 11.0; SD = 3.1). The sample included 661 cases of primary education and 434 cases of secondary education from 21 schools. 361 cases came from a rural environment and 734 from an urban environment. 670 cases came from state schools and 425 from private schools.

According to the original study, 73 cases of ADHD were detected. The clinical prevalence rate of ADHD obtained through clinical interview was 6.6% (95% CI = 5.1 to 8.1%). The cases had a mean age of 10.8 (SD = 3) and included 69.9% males (mean age = 11.2; SD = 2.8) and 30.1% females (mean age = 9.8; SD = 3.1). There were no significant differences between cases of ADHD and the rest of the population in age, public / private school or rural / urban area (Rodríguez et al., 2009).

Procedure and instruments

Parents and teachers completed the RS-IV ADHD questionnaire (DuPaul, Power, Anastopoulos, & Reid, 1998). The questionnaire

corresponds to the DSM-IV items / criteria for ADHD and is one of the most commonly used instruments to evaluate it (Döpfner et al., 2006). Each item can be scored between 0 and 3, depending on the response given to a frequency scale between never or rarely, sometimes, often, and frequently. As in the DSM-IV, an assessment of each question is requested according to its frequency in the previous six months. The sum of direct scores can be transformed into percentiles depending on teachers or parents responses, age and gender of the subject.

The diagnosis of ADHD can also be made considering the number of categorical symptoms that DSM-IV requires for the disorder. The symptom is considered to be present when the response includes "often" or "very often" and absent when the response was "never" or "sometimes." This categorization is recommended to conform to DSM-IV and it is one of the most frequently used in research (Döpfner et al., 2006).

The internal consistency of ADHD RS-IV (school version), assessed by Cronbach's Alpha, was 0.94 and the test-retest reliability, assessed by the Pearson correlation coefficient, was 0.90. The same values in ADHD RS-IV (parent version) were 0.92 and 0.85 respectively (DuPaul, Power et al., 1998).

The questionnaire has convergent validity and correlates adequately with other scales commonly used in the evaluation of ADHD such as the Conners Teacher Rating Scale-39 (r = 0.88) and the Conners Parent Rating Scale-48 (r = 0.80) (DuPaul, Power et al., 1998).

Regarding the criterion validity, good results are observed. The test handbook reports values of sensitivity, specificity and predictive value as well as corresponding percentiles that are presented in multiple tables (DuPaul, Anastopoulos et al., 1998).

A study conducted in 10 European countries with 1478 patients with symptoms of hyperactivity, inattention and impulsivity, showed internal consistency and convergent / discriminant validity, concluding that, due to transcultural stability of results, ADHD RS-IV can assess ADHD in Europe in a valid and reliable way (Döpfner et al., 2006).

Many studies support the bifactorial structure of ADHD RS-IV in ADHD (Döpfner et al., 2006), although the results of the original research provide similar support to the conceptualization of DSM-IV ADHD as a construct with one or two factors (inattention / hyperactivity - impulsivity). There is a high correlation between both factors and some items of the model load on both factors (DuPaul, Anastopoulos et al., 1998). Factor analysis performed by other authors support both a bifactorial and unifactorial view of DSM-IV items in ADHD RS-IV (López-Villalobos et al., 2014).

In the first screening phase of our epidemiological study, dimensional criteria of ADHD RS-IV were used. Those questionnaires with scores equal to or above the 90th percentile according to age and sex, for both parents and teachers, were selected.

Students who passed the first screening phase were deemed potentially to have ADHD and were evaluated in the second phase (clinical).

In the second phase of our study, the clinical consistency of ADHD cases extracted using the psychometric criteria of ADHD RS-IV was analyzed through an interview.

ADHD cases were defined according to the model of ADHD in the structured interview of the National Institute of Mental Health, called the Diagnostic Interview Schedule for Children in its parent version (DISCIV). The DISCIV in the ADHD dimension offers adequate values of test - retest reliability (k = .79) and validity according to the clinical diagnosis (k = .72) (Shaffer, Fisher, Lucas, Dulcan, & Schwab, 2000). The existence of all the DSM-IV criteria (A, B, C, D and E) was recorded for the cases being finally defined as ADHD in our prevalence study. These cases are referred to in this study as ADHD Clinical (ADHD-CL).

The results obtained through a clinical interview were subsequently adjusted for this study by prevalence rates in infancy (IN), preadolescence (PR) and adolescence (AD) and were compared to four possible answer options to the ADHD RS-IV. In all of these options the diagnosis of ADHD was made considering the number of categorical symptoms that the DSM-IV defines as necessary for the disorder. The categorization of ADHD RS-IV was performed according to the previously mentioned criteria.

Possible comparison options are as follows:

– ADHD RS-IV questionnaire answered by parents. ADHD is considered if the response exceeds the categorical cutoff point for diagnosis in the parent questionnaire (CATPA).
– ADHD RS-IV questionnaire answered by teachers. ADHD is considered if the response exceeds the categorical cutoff point for diagnosis in the teacher questionnaire (CATPRO).
– ADHD RS-IV questionnaire answered by parents or teachers. ADHD is considered if the response exceeds the categorical cutoff point for diagnosis in the parent or teacher questionnaire (CATPAOPR).
– ADHD RS-IV questionnaire answered by parents and teachers: ADHD is considered if the response exceeds the categorical cutoff point for diagnosis in the parents and teachers questionnaire (CATPA&PR).

At this point, we record the validity of the criteria and clinical usefulness of ADHD RS-IV in CATPA, CATPRO, CATPAOPR and CATPA&PR, comparing their results with clinical ADHD (ADHD-CL) in different age groups (IN, PR and AD).

In summary, CATPA, CATPRO, CATPAOPR and CATPA&PR are constructed by an ADHD RS-IV categorization adjusted to DSM-IV criteria, checking each of them for their criterion validity and clinical usefulness, taking as reference the clinical ADHD that has been constructed following a double dimensional psychometric phase and clinical interview.

In accordance with our objectives, the statistical procedures described below were used.

Data analysis

Descriptive and exploratory statistics were used. A significance level α <0.05 was considered for comparisons between variables and 95% confidence intervals were used.

Prevalence was expressed in percentages. Proportions/percentages with their 95% CI were calculated according to the score method by Wilson (Newcombe & Merino, 2006).

Sensitivity and specificity values were used to estimate the criterion validity of each of the diagnostic methods used with respect to the reference standard (clinical ADHD).

The likelihood ratio was also used.

We carried out a logistic regression analysis in which the predictive variables were each of the four possible response options to the ADHD RS-IV and the dependent variable, clinical ADHD (ADHD-CL), using gender and age as covariates.

The parameters have been estimated by the maximum likelihood method. The significance of the model parameters was obtained through the Wald test. The coefficients were estimated for each factor of the model, obtaining the corresponding odds ratio with their 95% confidence intervals.

Results

Prevalence rates of ADHD based on response options to ADHD RS-IV and age

The overall figure of ADHD cases assessed by clinical interview is 6.9% in childhood, 6.2% in preadolescence and 6.9% in adolescence (Table 1), with no statistically significant differences between the different age groups, assessed by the Chi-square test (p <0.05).

The use of alternative procedures to the clinical interview leads to an increase in the cases of ADHD in the three age groups analyzed as follows: CATPAOPR> CATPRO> CATPA> CATPA&PR> ADHD-CL (table 1). In all cases, there were significant differences in the distribution of proportions between CLD-ADHD and each of the response options to ADHD RS-IV (p <0.001).

Criterion validity for methods used in ADHD RS-IV as a function of age

As we can see in the overall validity index (table 2), the best procedure is CATPA&PR, with values within the interval (93.85%, 95.27%) with very slight decreasing differences as a function of age. The second best procedure would be CATPA, with the interval (89.05%, 92.31%) and with very slight differences increasing as a function of age.

Similarly for specificity (Table 2), the best procedure is CATPA&PR, with figures between 96.3% and 97.1% (on children without ADHD), with very slight decreasing differences as a function of age. The second best procedure is also CATPA (values

between 90.4% and 93%) with very slight differences that increase as a function of age.

Table 1
Prevalence of ADHD based on ADHD RS-IV and age options

Factor	[a]ADHD Diagnosis	[b] 95% CI		age
	n / N	(%)		
ADHD Clinical	28/402	(6.9)	4.9 - 9.9	
CATPA [d]	56/402	(13.9)	10.9 - 17.7	6-9
CATPRO [e]	66/402	(16.4)	13.1 - 20.4	
CATPAOPR [f]	91/402	(22.6)	19 - 27	
CATPA&PR [g]	31/402	(7.7)	5.5 - 10.7	
Factor	[a]ADHD Diagnosis	[b] 95% CI		age
	n / N	(%)		
ADHD Clinical	27/433	(6.2)	4.3 - 8.9	
CATPA [d]	54/433	(12.5)	9.7 - 15.9	10-13
CATPRO [e]	61/433	(14.1)	11.1 - 17.7	
CATPAOPR [f]	82/433	(18.9)	15.5 - 22.9	
CATPA&PR [g]	33/433	(7.6)	5.5 - 10.9	
Factor	[a]ADHD Diagnosis	[b] 95% CI		age
	n / N	(%)		
ADHD Clinical	18/260	(6.9)	4.4 - 10.7	
CATPA [d]	32/260	(12.3)	8.9 - 16.9	14-16
CATPRO [e]	34/260	(13.1)	9.5 - 17.7	
CATPAOPR [f]	46/260	(17.7)	12.2 - 21.1	
CATPA&PR [g]	20/260	(7.7)	5.0 - 11.6	

Note: [a]ADHD = Attention deficit hyperactivity disorder; [b]95% CI = 95% confidence interval; [d]CATPA = ADHD RS-IV questionnaire answered by parents; [e]CATPRO = ADHD RS-IV questionnaire answered by teachers; [f] CATPAOPR = ADHD RS-IV questionnaire answered by parents or teachers; [g]CATPA&PR = ADHD RS-IV questionnaire answered by parents and teachers

Table 2
Validity of criteria for the different methods used in ADHD RS-IV, taking as clinical reference the clinical ADHD according to age

Methods	Sensitivity (IC 95%)	Specificity (95% CI	Validity Index	age
CATPA [a]	71.43 (69.54-73.32)	90.37 (90.22- 90.53)	89.05 (88.91- 89.20)	
CATPRO [b]	85.71 (83.85-87.58)	88.77 (88.62 - 88.92)	88.56 (88.41- 88.70)	6-9
CATPAOPR [c]	85.71 (83.85-87.58)	82.09 (81.93-82.24)	82.34 (82.19- 82.49)	
CATPA&PR [d]	71.43 (69.54- 73.32)	97.06 (96.91- 97.20)	95.27 (95.14- 95.41)	
Methods	Sensitivity (95% CI)	Specificity (95% CI	Validity Index	age
CATPA [a]	77.78 (75.83-79.72)	91.87 (91.73- 92.01)	90.99 (90.86-91.12)	
CATPRO [b]	74.07 (72.12-76.03)	89.90 (89.76-90.04)	88.91 (88.78- 89.05)	10-13
CATPAOPR [c]	81.48 (79.54- 83.42)	85.22 (85.08- 85.37)	84.99 (84.85-85.12)	
CATPA&PR [d]	70.37(68.41- 72.33)	96.46 (96.33- 96.60)	94.80 (94.67-94.93)	
Methods	Sensitivity (95% CI)	Specificity (95% CI	Validity Index	age
CATPA [a]	83.33 (80.45- 86.22)	92.98 (92.75- 93.20)	92.31 (92.10- 92.52)	
CATPRO [b]	61.11 (58.20-64.03)	90.50 (90.27-90.72)	88.46 (88.25- 88.68)	14-16
CATPAOPR [c]	83.33 (80.45- 86.22)	87.19 (86.96- 87.42)	86.92 (86.71- 87.14)	
CATPA&PR [d]	61.11 (58.20- 64.03)	96.28 (96.06- 96.50)	93.85 (93.64- 94.06)	

Note: [a]CATPA = ADHD RS-IV questionnaire answered by parents; [b]CATPRO = ADHD RS-IV questionnaire answered by teachers; [c]CATPAOPR = ADHD RS-IV questionnaire answered by parents or teachers; [d]CATPA&PR = ADHD RS-IV questionnaire answered by parents and teachers

Regarding sensitivity, the best procedure is CATPAOPR (Table 2), with figures between 81.5% and 85.7% (on ADHD cases), showing the best classification rate in childhood.

Clinical utility of methods used in ADHD RS-IV as a function of age

The highest positive likelihood ratio is obtained with the CATPA&PR procedure (Table 3), in which a positive ADHD test increases between 16.4 and 24.3 times the probability of clinical ADHD compared to not having that diagnosis, with a decreasing trend as a function of age. According to the classification defined in the section of data analysis it is an excellent test that strongly supports the diagnosis of clinical ADHD at any age.

The negative likelihood ratio (LR-) (Table 3) is more easily interpretable by calculating its inverse (inverse LR- = 1 / LR-). The CATPAOPR procedure has an LR - stably low in all three age groups, finding that it is 5.9 (infancy), 4.5 (preadolescence) or 5.3 (adolescence) times more likely a negative result in people without the disease than in people with the disease. Similar results are observed in CATPRO in childhood (inverse LR- = 6.3) and CATPA in adolescence (inverse LR- = 5.6).

Association between variables and predictive capacity of methods used in ADHD RS-IV

Table 4 shows each of the four logistic regression models implemented as reported in the data analysis section. The interaction between variables is not reflected in the table because it never had significant results.

As seen CATPA, CATPRO, CATPAOPR and CATPA&PR significantly increase the probability of clinical ADHD, when the set of variables are present. Specifically a positive ADHD result

in CATPA&PR shows an odds ratio for clinical ADHD 62.8 times higher than a negative result. The same happens with different odds ratio in CATPA (odds ratio = 34.4), CATPRO (odds ratio = 25.7) and CATPAOPR (odds ratio = 27.1).

When all variables are present in the model, neither gender nor age nor their interactions increase the probability of clinical ADHD, due to the logical presence of CATPA, CATPRO, CATPAOPR or CATPA&PR.

Table 3
Clinical utility measures of the different methods used in ADHD RS-IV using clinical ADHD, as a reference test, according to age

Methods	LR +[e] (IC 95%)	LR -[f] (IC 95%)	age
CATPA [a]	7.42 (7.40-7.44)	0.32 (0.32- 0.32)	
CATPRO [b]	7.63 (7.62-7.65)	0.16 (0.16 - 0.16)	6-9
CATPAOPR [c]	4.78 (4.78 - 4.79)	0.17 (0.17 - 0.17)	
CATPA&PR [d]	24.29 (24.19 - 24.38)	0.29 (0.29 - 0.30)	

Methods	LR +[e] (IC 95%)	LR -[f] (IC 95%)	age
CATPA [a]	9.57 (9.55- 9.59)	0.24 (0.24- 0.24)	
CATPRO [b]	7.34 (7.32-7.35)	0.29 (0.29 - 0.29)	10-13
CATPAOPR [c]	5.51 (5.50 - 5.52)	0.22 (0.22 - 0.22)	
CATPA&PR [d]	19.90 (19.84 - 19.97)	0.31 (0.31 - 0.31)	

Methods	LR +[e] (IC 95%)	LR -[f] (IC 95%)	age
CATPA [a]	11.86 (11.83-11.90)	0.18 (0.18- 0.18)	
CATPRO [b]	6.43 (6.41-6.45)	0.43 (0.43 - 0.43)	14-16
CATPAOPR [c]	6.51 (6.49 - 6.52)	0.19 (0.19 - 0.19)	
CATPA&PR [d]	16.43 (16.36 - 16.51)	0.40 (0.40 - 0.41)	

Note: [a]CATPA = ADHD RS-IV questionnaire answered by parents; [b]CATPRO = ADHD RS-IV questionnaire answered by teachers; [c]CATPAOPR = ADHD RS-IV questionnaire answered by parents or teachers; [d]CATPA&PR = ADHD RS-IV questionnaire answered by parents and teachers; [e]LR + = Positive Likelihood ratio; [f]LR - = Negative likelihood ratio

Table 4
Logistic regression of each of the different methods used in ADHD RS-IV on clinical ADHD, controlling gender and age

Method	Variables	B	ET	Wald	df	Sign.	Exp(B)	CI 95% EXP(B) Inferior	CI 95% EXP(B) Superior
CATPA [a]	CATPA [a]	3.538	0.305	134.205	1	.000	34.407	18.909	62.607
	gender	-0.191	0.304	0.395	1	.529	0.825	0.454	1.500
	age	-0.003	0.045	0.007	1	.932	0.996	0.911	1.088
	constant	0.609	0.555	1.203	1	.272	1.839		
CATPRO [b]	CATPRO [b]	3.245	0.300	116.956	1	.000	25.681	14.261	46.247
	gender	-0.118	0.300	0.156	1	.692	0.888	0.493	1.599
	age	-0.008	0.045	0.037	1	.846	0.991	0.906	1.084
	constant	0.839	0.551	2.318	1	.127	2.315		
CATPAOPR [c]	CATPAOPR [c]	3.300	0.335	96.943	1	.000	27.113	14.056	52.296
	gender	-0.132	0.293	0.202	1	.652	0.875	0.492	1.558
	age	-0.016	0.043	0.151	1	.697	0.983	0.902	1.071
	constant	1.227	0.522	5.512	1	.018	3.413		
CATPA&PR [d]	CATPA&PR [d]	4.139	0.320	166.776	1	.000	62.751	33.481	117.610
	gender	-0.032	0.332	0.009	1	.922	0.967	0.504	1.858
	age	0.0207	0.051	0.165	1	.683	1.020	0.923	1.128
	constant	-0.586	0.654	0.803	1	.369	0.556		

Note: [a]CATPA = ADHD RS-IV questionnaire answered by parents; [b]CATPRO = ADHD RS-IV questionnaire answered by teachers; [c]CATPAOPR = ADHD RS-IV questionnaire answered by parents or teachers; [d]CATPA&PR = ADHD RS-IV questionnaire answered by parents and teachers; B = logistic coefficient; Wald = Wald test; df = degrees of freedom; ET = Typical error; Sign = Significance; Exp (B) = Odds ratio; CI = confidence interval

Discussion

The overall number of ADHD cases assessed by clinical interview shows a prevalence rate of 6.9% in childhood, 6.2% in preadolescence and 6.9% in adolescence. There were no significant differences in the distribution of proportions in the three groups of age.

These data are in line with a global systematic review of prevalence studies in childhood and youth ADHD that observed an average of 5.3% (Polanczyk et al., 2007) and are in the confidence interval for the mean of several more recent studies of Meta-analyses (Catalá-López et al., 2012; Thomas et al., 2015; Willcutt, 2012).

In turn, our results show a certain stability of the disorder in the different age groups analyzed and contrast with studies where the prevalence figures decrease slightly between childhood and adolescence (Willcutt, 2012).

As underlined below, after our study we can state that the procedure used for the diagnosis of ADHD is influential and the use of any of the alternative procedures to the clinical interview leads to an increase of the cases of ADHD in the three age groups analyzed. Significant differences in the distribution of proportions in all cases were observed.

The use of CATPAOPR, as observed in Table 1, would lead to an alarming and notable increase in cases compared to ADHD-CL in infancy, preadolescence and adolescence. The same holds for CATPA and CATPR, although to a lesser extent.

Clinical interview, the gold standard in the diagnosis of ADHD, approaches the criterion of ADHD through the CATPA&PR procedure (7.7% in childhood, 7.6% in preadolescence and 7.7% in adolescence). Although the figure is close to the CL-ADHD, we noted CATPA&PR would only identify 68.4% of the cases assessed by clinical interview, with an increase in false positives and negatives.

Our results may be contrasted with those observed in a recent meta-analysis by Willcutt (2012). When the informants were the parents, the authors obtained mean prevalence figures within the 95% CI 7.7 to 9.9%, which were lower than our results. When the informant was the teacher the figures were between 11.6 and 15.2%, compatible with our results. In both studies the prevalence figures are higher when the answer to the questionnaires is carried out by teachers than when answered by parents.

When analogous procedures to our CATPAOPR were used in the meta-analysis, average ADHD values were between 8.5 and 19.2%, comparable with our figures, except in childhood where our study had higher numbers. When analogous procedures to our CATPA&PR were used, average ADHD values were between 2.4 and 12.6%, similar to our results.

In summary, our results emphasize that the method used for the diagnosis of ADHD is influential and the use of any alternative procedures to the clinical interview leads to an erroneous increase in ADHD cases mainly in childhood, but also in preadolescence and adolescence.

We found similar results in studies that compared categorical ADHD assessments using DSM-IV questionnaires and were contrasted with clinical interview (López-Villalobos, Andrés-De Llano, Sánchez-Azón, & López-Sánchez, 2013).

Questionnaires used to assess ADHD can be classified as categorical and / or dimensional. The categorical questionnaires present a dichotomous assessment of the items and consider a certain number of symptoms to define the presence or absence of the disorder under study, considering it as a discrete entity. On the other hand, the dimensional questionnaires present an ordinal scale evaluation of each symptom, quantifying the pathological behavior and assessing its intensity. Normal and abnormal behavior is considered as part of a continuum, not as two distinct phenomena (López-Villalobos et al., 2014).

Although they are different concepts, in both cases there is usually a cut-off point that allows the practitioner to locate patients inside or outside the clinical range and that can lead to different estimates depending on their use.

A study by Lora and Muñoz (2010) found that using a list of ADHD symptoms based on DSM-IV (categorical criteria) produced a prevalence of 23.8%, while using a dimensional psychometric criterion (98th percentile on the ADHD RS scale -IV) the prevalence was 4.8%.

The use of dimensional criteria reduced the prevalence. In our study we also observed that the prevalence in CATPA&PR, CATPA, CATPR or CATPAOPR is higher in each age group than the prevalence of clinical ADHD. Certainly, the method and the categorical / dimensional criterion can influence the results.

Regarding the criterion validity and clinical usefulness of ADHD RS-IV, the best results are observed in the CATPA&PR procedure, with respect to CATPA, CATPR and CATPAOPR since it classifies both healthy and ADHD subjects in the three age groups better than the other procedures ,it is the best diagnostic procedure because of its high specificity, it shows greater clinical usefulness and a positive result of disorder in CATPA&PR presents an odds ratio for clinical ADHD higher than the rest of the alternatives. The studies cited in the ADHD RS-IV manual reflect, through a different procedure, that the combination of the parent and teacher responses classifies 83% of the cases (DuPaul, Power et al., 1998), a significantly lower number than that observed in our study in the three age groups.

The second option with better psychometric characteristics is CATPA because of its ability to classify ADHD, high specificity in the three age groups and its clinical utility indicators.

The studies cited in the ADHD RS-IV manual reflect, through a different procedure, that the parent response classifies 82% of the cases (DuPaul, Power et al., 1998), a significantly lower number than that observed in our case in all three age groups.

If our interest was focused on a screening test, the option would be CATPAOPR because of its greater sensitivity.

In this regard, several studies have been reported which, making use of the ADHD RS-IV and searching for a reduction of items through an adjusted logistic regression model, found good criterion validity and clinical utility in the combination of questionnaires of parents and teachers (López-Villalobos et al., 2014), as well as with the parent-only (López-Villalobos et al., 2011) and teacher-only questionnaire (López-Villalobos et al., 2010). Regarding our best procedure (CATPA&PR), these studies found lower rates of specificity and clinical utility, as well as greater sensitivity.

An interesting reflection in this section is that expressed by Willcutt (2012), suggesting that the correct algorithm regarding the use of CATPA&PR, CATPA, CATPR or CATPAOPR would be purpose-specific, considering the greater or lesser need for sensitivity, specificity or clinical usefulness of the test.

At this point in the discussion we can ask ourselves how the appearance of the new DSM-5 could influence our results. The evolution from DSM-III to DSM-IV led to an increase in

prevalence figures (Thomas et al., 2015) and with the new DSM-5 the numbers seem to continue increasing (Voort et al., 2014).

From this we can deduce that the prevalence figures in our study would increase in clinical ADHD, but would not be modified in CATPA&PR, CATPA, CATPR or CATPAOPR because of the similarity of symptoms between DSM-IV and DSM-5 in the age range studied. Regarding the criterion validity, we recall that sensitivity and specificity are intrinsic characteristics of the test and do not depend on the prevalence.

Through our research, we can state that the isolated use of categorical questionnaires does not permit the accurate assessment of the diagnosis of ADHD because it does not consider the duration of symptoms, the presence of symptoms in two or more settings, the age of onset, the family, social or school repercussion and the confusion with other clinical entities or with the absence of psychopathology.

We cannot forget that even though there is frequent comorbidity of ADHD with other disorders such as emotional disturbances, behavior disorders or learning disorders (Erskine et al., 2016; López-Villalobos, Serrano, & Delgado, 2004; Rodríguez et al., 2009), the disorder can also be confused with them. Finally, we note that recent research has shown that the incomplete use of the DSM-IV criteria for ADHD affects overdiagnosis (Bruchmüller, Margraf, & Schneider, 2012), in agreement with our study.

The implications of our study are important in clinical practice and make us think about the importance of the diagnosis of ADHD by clinical interview and not exclusively on the basis of categorical questionnaires. The isolated use of such questionnaires would fictitiously increase the number of children affected by the disorder and would be detrimental to those with a misdiagnosis because of the stigma of incorrect labeling, potential harm from pharmacological interventions' side effects, and deprivation of adequate intervention for problems that could be present.

Previous statements should not suggest that the use of questionnaires is inappropriate, but should be complementary to the clinical interview. CATPA&PR is the best procedure for its better psychometric properties.

We encourage other researchers to replicate or refute our results with the same procedure or alternative procedures as the consideration of CATPA&PR, CATPA, CATPR or CATPAOPR from a dimensional perspective.

Acknowledgments

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