

ADHD in a representative sample of the Brazilian population: estimated prevalence and comparative adequacy of criteria between adolescents and adults according to the item response theory

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Abstract

Background: Attention deficit hyperactivity disorder (ADHD) is a clinically significant disorder in adulthood, but current diagnostic criteria and instruments do not seem to adequately capture the complexity of the disorder in this developmental phase. Accordingly, there are limited data on the proportion of adults affected by the disorder, specially in developing countries.

Method: We assessed a representative household sample of the Brazilian population for ADHD with the Adult ADHD Self-report Scale (ASRS) Screener, and evaluated the instrument according to the Rasch model of item response theory.

Results: The sample was comprised by 3007 individuals, and the overall prevalence of positive screeners for ADHD was 5.8% [95% confidence interval (CI), 4.8–7.0]. Rasch analyses revealed the misfit of the overall sample to expectations of the model. The evaluation of the sample stratified by age revealed that data for adolescents showed a significant fitness to the model expectations, while items completed by adults were not adequately.

Conclusions: The lack of fitness to the model for adult respondents challenges the possibility of a linear transformation of the ordinal data into interval measures and the utilization of parametric analyses of data. This result suggests that diagnostic criteria and instruments for adult ADHD must take into account a

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Introduction

Attention deficit hyperactivity disorder (ADHD) is a clinically significant disorder in adulthood associated to several adverse outcomes in different areas of life (Wilens *et al.*, 2004). Current diagnostic systems seem not to capture adequately the complexity of the disorder in this developmental stage (Brown, 2006; McGough and Barkley, 2004; Rohde, 2008; Wilens *et al.*, 2004; Willoughby, 2003). Accordingly, the distribution of adult ADHD in the community is poorly understood (Polanczyk and Rohde, 2007; Polanczyk *et al.*, 2007).

The current lack of agreement between experts on the definition of the most appropriate diagnostic criteria for adults, and consequently the lack of a 'gold-standard' diagnostic tool, is a pivotal limitation for the estimation of ADHD prevalence. Few studies have estimated the prevalence of the disorder in community samples of adults (de Graaf *et al.*, 2008; Faraone and Biederman, 2005; Fayyad *et al.*, 2007; Kessler *et al.*, 2006; Kooij *et al.*, 2005), and they used diverse diagnostic definitions and methodological approaches, which yielded estimates that vary from 1% (Kooij *et al.*, 2005) to 16.4% (Faraone and Biederman, 2005). Only three developing countries (Colombia, Lebanon and Mexico) have their adult population evaluated for ADHD (Fayyad *et al.*, 2007). These surveys were conducted in the context of the World Health Organization (WHO) World Mental Health surveys, and the prevalence imputation in these locations were performed after calibrating the data in accordance to a US clinical sample. In this sense, much less is known about ADHD in the developing world.

Several instruments have been constructed to evaluate ADHD in adulthood, and the WHO Adult ADHD Self-report Scale (ASRS), which was developed by a group of experts in ADHD in adulthood, is one of the most promising scales for use in clinical and research settings (Kessler *et al.*, 2005). It is composed by six items and was derived from an 18-item instrument that reflects all Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) ADHD symptoms. The abbreviated version outperformed the original scale in its diagnostic properties (Kessler *et al.*, 2005) and a superior diagnostic accuracy was achieved when the intensity of each

symptom was taken into consideration, leading the authors to propose the use of this scoring method (Kessler *et al.*, 2007). However, the psychometric properties of this instrument were neither extensively explored in samples of different cultural backgrounds nor using different methodological approaches.

It has been proposed that the ASRS Screener has the potential to be a tool for health care professionals to screen adults for ADHD (Kessler *et al.*, 2005). Integrating this scale into the routine of community health care services would be of extreme value to identify ADHD cases in adulthood, especially in countries where there are scarce resources for mental health care. In this regard, there is a strong relevance of both generating data on the prevalence of ADHD in adulthood in developing countries, and evaluating the psychometric properties of the ASRS Screener according to modern approaches.

Item response theory (IRT) is a general statistical theory about the relationship between items (questions or criterion) and subjects' ability (symptom severity), which has been increasingly used to assess the adequacy of DSM-IV diagnostic criteria and instruments for several disorders, including ADHD (Gomez, 2008; Hartman *et al.*, 2008; Ietsugu *et al.*, 2007). Rasch measurement is an IRT model that assumes that the probability that a person will endorse a symptom is a logistic function of the difference between a person's ability (intensity of symptoms) and the difficulty of the item (severity of the symptom evaluated) (Rasch, 1960). Data is compared to the expectations of the model and once it fits it, a linear transformation of the raw ordinal scale is possible. This makes possible the analysis of data using parametric tests. Moreover, Rasch analyses provides results on the internal consistency of the instrument, assess the way categories of an item works, and if items are answered in a different way according to specific characteristics of the subjects (Pallant and Tennant, 2007).

Thus, we aimed to assess the proportion of individuals in a representative sample of the Brazilian population who have a positive screening for ADHD, and to evaluate the scale according to the Rasch model of IRT, comparing the adequacy of criteria between adolescents and adults.

Methods

Setting

Brazil constitutes one of the biggest countries of the world in territorial extension. With approximately 170 million inhabitants, it is the most populous country in Latin America and ranks sixth in the world. The country is divided into five geographic regions, which are highly heterogeneous in terms of socio-economic, ethnic, and cultural characteristics.

Sample and data collection

The first Brazilian National Alcohol Survey (BNAS) is a nationally representative sample of 3007 Portuguese-speaking household residents in urban and rural areas aged 14 or older (Pechansky *et al.*, 2009). The study was conducted between November 2005 and April 2006. Institutionalized and indigenous people living in tribes were not included. Respondents were selected through a three-stage cluster sampling procedure.

The first stage involved the selection of 143 counties, the primary sampling unit (PSU), using probability proportional to size (PPS) methods. Stage 2 involved the selection of two census sectors for each county based on the PPS, with an exception of census sectors in the 14 biggest counties which were included *a priori* due to the number of inhabitants in these counties, totaling 325 census sectors. Stage 3 corresponded to the selection of eight households within each census sector by simple random sampling, followed by the selection of a household member using the 'the closest future birthday' technique. A total of 2522 interviews were conducted with respondents 18 years of age or older and 485 additional interviews were conducted with respondents 14 to 17 years of age. The survey response rate was 66.4%. The sample was weighted to correct for the probability of selection of respondents into the sample and non-response rates. Post-stratification weights were calculated to adjust the sample to known Census population distributions of socio-demographic variables. All respondents granted their informed consent. The project was approved by the Institutional Review Board (IRB) of the Federal University of São Paulo.

Instrument

The WHO ASRS Screener has been developed in the context of the WHO World Mental Health Survey Initiative and was derived from an 18-item questionnaire which mirrored all 18 DSM-IV ADHD symptoms. ASRS Screener is composed by six questions, with adequate diagnostic prop-

erties (sensitivity: 68.7%, specificity: 99.5%, total classification accuracy: 97.9%, and positive predictive value from 56.8 to 94.7, for a cut-off of four or more positive items) (Kessler *et al.*, 2005). The frequency of each symptom is evaluated in a four-point scale, from never to very often. The Portuguese version of the scale is available at <http://www.hcp.med.harvard.edu/ncs/asrs.php>

Analysis of data

Based on a previous study in a different population (Kessler *et al.*, 2007), a positive screening in the ASRS Screener was defined as a score of 14 or higher. Socio-demographic correlates were evaluated by using logistic regression analysis, conducted on data weighted for correcting to the probability of selection and non-response rates. Post-stratification weights were calculated to adjust the sample to known Census population distributions of socio-demographic variables. Analyses were conducted with Taylor linearized variance estimation using STATA 9.2 to account for the complex nature of the sample. Significance tests of sets of coefficients used Wald χ^2 tests adjusted for the design. Statistical significance was evaluated by using two-sided design-based tests with an alpha level of 0.05.

The fitness of the ASRS Screener was tested in comparison to the expectations of the Rasch model (Rasch, 1960). An estimate of the internal consistency reliability of the scale is calculated based on the Person Separation Index (PSI). Three overall fit statistics are considered: two item-person interaction statistics transformed to approximate a z score, and an item-trait interaction statistic reported as a χ^2 . A significant test indicates that the hierarchical ordering of the items varies across the trait, thus compromising the required property of invariance. In addition to these overall summary fit statistics, item-fit statistics is presented (misfit is defined by residual ≥ 2.5 or significant χ^2 test for a p value < 0.05 after Bonferroni correction) and the category ordering is evaluated (the consistency of categories with the level of the trait evaluated), and item bias, or differential item functioning (DIF). We evaluated the following characteristics as 'person factors' for DIF analysis: gender, social class according to the Brazilian Association of Market Research Institutes criteria (Rutter, 2006), Brazil's geographic region, and educational level. We used RUMM2020 software to perform these analyses.

Results

Table 1 depicts the distributions of respondents according to categories of score and age strata, weighted to represent

Table 1 Proportion of respondents stratified by age range and scores strata on the ASRS Screener, weighted to represent the Brazilian population

ASRS Screener strata	Age range (years)		
	<18	18–44	>44
0–9	66.5	77.3	82.9
10–13	25.9	17.5	11.0
14–17	6.8	4.5	5.2
18–24	0.8	0.7	0.9

the Brazilian population. According to the dichotomous scoring approach originally proposed (Kessler *et al.*, 2007), 5.8% [95% confidence interval (CI), 4.8–7.0] of subjects screened positive for ADHD. The prevalence of positive screeners stratified by age range was 7.6% (95% CI, 5.4–10.7) for respondents younger than 18 years, 5.2% (95% CI, 4.0–6.8) for respondents 18 to 44 years old and 6.1% (95% CI, 4.5–8.3) for respondents older than 44 years of age. No significant differences were detected in the rates between the three age groups ($F_{1,82,294.7} = 1.37$, $p = 0.2$).

In regard to demographic characteristics, women presented a higher prevalence of positive screening than men [odds ratio (OR) = 2.03, 95% CI, 1.3–3.2]. No significant differences on rates of positive versus negative screeners were found concerning ethnicity, occupational, educational, and marital status, social class and geographic region in Brazil (Table 2). Correlates were also analyzed within each age group (14 to 17, 18 to 44, and older than 44). Among subjects 18–44 years of age, women had a higher prevalence of screening positive than men (OR = 2.04, 95% CI, 1.0–4.1). There was a significant lower rate of positive screeners among respondents 25 to 34 (OR = 0.32, 95% CI, 0.2–0.7) and 35 to 44 (OR = 0.29, 95% CI, 0.1–0.6) years of age in comparison to those aged 18 to 24. Further analyzes on the rates of positive screeners according to ethnicity, occupational, educational, and marital status, social class and geographic region in Brazil, within the three age strata, yielded non-significant differences (available upon request).

The fitness of the ASRS Screener to the Rasch model was initially assessed in the total sample (483 cases were excluded from Rasch analysis due to extreme scores). It was detected a significant item–trait interaction ($\chi^2 = 271.700$, $df = 30$; $p < 0.001$), suggesting that there is some degree of misfit between the data and the model, which could be caused by misfit to model expectations of respondents or

Table 2 Socio-demographic distribution of individuals with positive screening for ADHD

Characteristic	Percentage (SE) ¹	Odds ratio (95% CI) ²
<i>Gender</i>		
Male	30.3 (4.0)	1
Female	69.7 (4.0)	2.03 (1.3–3.2)
<i>Ethnicity</i>		
White	50.7 (4.9)	1
Non-white	49.3 (4.9)	0.93 (0.6–1.4)
<i>Age (years)</i>		
14–17	13.8 (2.4)	1
18–44	51.9 (4.3)	0.76 (0.3–1.7)
>44	34.3 (4.4)	0.87 (0.3–2.2)
<i>Occupational status</i>		
Employed	49.8 (4.9)	1
Unemployed	3.4 (1.3)	0.58 (0.2–1.4)
Student	13.5 (2.7)	1.41 (0.5–3.7)
Homemaker	19.5 (3.1)	1.3 (0.8–2.2)
Retired	13.8 (3.0)	1.05 (0.5–2.1)
<i>Educational status (years)</i>		
0–5	35.0 (4.5)	1
6–8	27.3 (3.9)	0.88 (0.5–1.5)
9–11	30.0 (4.0)	0.98 (0.6–1.6)
>12	8.1 (3.2)	0.94 (0.4–2.4)
<i>Marital status</i>		
Single	35.3 (4.2)	1
Married	51.2 (4.4)	0.91 (0.5–1.6)
Divorced	6.0 (1.6)	0.97 (0.5–2.1)
Widow/er	7.5 (1.9)	1.07 (0.5–2.6)
<i>Social class</i>		
A	0.8 (0.6)	1
B/C	53.2 (4.7)	4.45 (0.9–20)
D/E	46.0 (4.7)	3.89 (0.8–18.6)
<i>Geographic region</i>		
North	6.2 (1.2)	1
South	7.9 (2.8)	0.77 (0.4–1.6)
Southeast	23.4 (3.9)	1.6 (0.9–2.8)
Northeast	53.3 (4.8)	1.2 (0.6–2.1)
Central-west	9.2 (2.3)	1.74 (0.7–4.2)

¹ Weighted percentages for the oversample of adolescents; SE: standard error.

² Multivariate logistic regression analysis.

items, or both. The residual mean value for items was 1.01 with a standard deviation (SD) of 3.06, much higher than the expected value of 1, given adequate fit to the model. The residual mean value for persons was –0.25 with a SD of

Table 3 Fit of the ASRS Screeners to the Rasch model

Item	Location	SE	Fit residual	df	χ^2	df	Probability
Item 1	0.471	0.023	-0.76	2099	59.437	5	<i>0.000006</i>
Item 2	0.316	0.022	-1.778	2099	76.276	5	<i>0.000001</i>
Item 3	-0.037	0.02	1.745	2099	11.451	5	0.043139
Item 4	0.107	0.021	-1.573	2099	59.55	5	<i>0.000001</i>
Item 5	-0.463	0.018	2.221	2099	6.437	5	0.266015
Item 6	-0.393	0.018	<i>6.228</i>	2099	58.549	5	<i>0.000001</i>

Note: Misfit values are in italic typeface (after Bonferroni correction).

1.17, indicating a reasonable fit among the respondents in the sample (Table 3). With respect to reliability, the PSI statistic was 0.808, which indicates that the ASRS Screener has good person separation reliability. The same pattern of results was confirmed in a random sample of 1000 subjects.

Subsequently, we stratified the sample in three categories according to age range (14 to 17, 18 to 44, and older than 44) to test the hypothesis that the misfit of the data to the model was related to age. Data from each age group were tested against the Rasch model separately. The PSI statistic varied from 0.80 to 0.82 for the three groups, indicating that ASRS Screener has good internal consistency reliability. In the group of adolescents, item–trait interaction showed borderline significance ($\chi^2 = 44.6$; $p = 0.04$) indicating a slight variability on hierarchical ordering of items across the trait. The residual mean value for items was 0.53 (SD 0.68) and the residual mean value for persons was -0.29 (SD 1.16). There were no items displaying DIF or presenting misfit. Items 1, 2, 3 and 4 showed altered thresholds. In the strata composed by individuals age 18 to 44, item–trait interaction was highly significant ($\chi^2 = 185.3$; $p < 0.001$) indicating a lack of hierarchical ordering of items across the trait. The residual mean value for items was 0.74 (SD 2.44) and the residual mean value for persons was -0.27 (SD 1.14). Items 1, 2, 4 and 6 showed misfit to model expectation and items 4 and 6 showed some degree of uniform DIF regarding social class. Moreover, item 6 showed DIF regarding demographic region in Brazil. Items 1 and 3 showed altered thresholds. In the group of subjects older than 44 years of age, item–trait interaction was also highly significant ($\chi^2 = 90.3$; $p < 0.001$) indicating an altered hierarchical ordering of items across the trait. The residual mean value for items was 0.42 (SD 1.79) and the residual mean value for persons was -0.3 (SD 1.26). Items 1, 2 and 6 showed misfit to model expectation and item 6 showed uniform DIF regarding social class and edu-

cational level. Items 1, 2, 3 and 5 showed altered thresholds. Altered thresholds were reordered in the three sets of analyses and did not result in a significant improvement of the overall performance of the scale.

Discussion

We have evaluated the prevalence of individuals with positive screening for ADHD in a representative sample of household Brazilian population. It was estimated that approximately 6% of the Brazilian population screens positive for ADHD based on the ASRS Screener. This is the first representative survey conducted in Brazil that evaluated adult ADHD and the fourth conducted in a developing country to date.

We found a significant higher prevalence of positive screeners among women, a finding also detected in the subgroup of 18 to 44 years of age. It is well established the higher prevalence of ADHD among boys, specially in clinical samples (Pliszka, 2007). However, in community samples, the difference of ADHD rates between boys and girls is less prominent (Polanczyk and Rohde, 2007). A scarcity of data had been published on this matter among adults. Kessler *et al.* (2006) and Fayyad *et al.* (2007) found a higher prevalence of ADHD among men in their sample, with modest OR (1.6 and 1.5, respectively). Kooij *et al.* (2005) explored the validity of two different cut-off points (six and four symptoms) for the diagnosis of ADHD and found no gender effect when applying the cut-off of six symptoms but a higher prevalence of females when applying the cut-off of four symptoms. The authors ruled out a confounding effect of comorbidities and hypothesized that women during adulthood may be more sensitive than men to the identification of symptoms. An alternative explanation is that the stability of ADHD symptoms during the lifetime might be higher in women. We cannot exclude that the presence of other mental disorders (e.g depression or

anxiety) have a role in the higher prevalence of ADHD among women in our sample. Our results, in conjunction with those from Kooij's investigation (Kooij *et al.*, 2005), points to this intriguing hypothesis, which deserves further study. However, the fact that a higher prevalence of women screened positive on ASRS Screener may not necessarily reflect a higher prevalence of ADHD in this group. The instrument is a screening tool and, although presented adequate sensitivity (68.7%), specificity (99.5%), and total classification accuracy (97.9%), there are uncertainties about the appropriate scoring method (Kessler *et al.*, 2005).

Aiming to assess the adequacy of the ADHD construct and ASRS Screener, we evaluated the data in relation to the Rasch model (Chachamovich *et al.*, 2008; Hartman *et al.*, 2008; Tennant *et al.*, 2004). It is important to note that previous epidemiological investigations in the adult ADHD have not assessed the psychometric properties of the instruments used in light of more recent approaches like IRT. Our results from Rasch analyses provides several interesting insights to the ADHD and to the epidemiology field in general. We showed that data pertaining the overall sample did not fit the model. Since conceptual assumptions of the Rasch model support its independence of the individuals who answer the items (i.e. sample independent) (Andrich, 1988), this finding should call attention to the necessity of the evaluation of psychometric properties of instruments in different populations with complementary methodological approaches. The absence of fitness to the model challenges the possibility of a linear transformation of the ordinal data from the ASRS into interval measures, as originally proposed (Kessler *et al.*, 2007). This has an important practical implication: since the interval between two scores may not be the same along the entire continuum, mathematical operations and parametric analysis of data may not be possible (Andrich, 1988; Pallant and Tennant, 2007). Thus, any epidemiological data based on cut-off scores derived from models assuming interval properties of the data is questionable without the appropriate testing.

A relevant finding is the superior fitness to the Rasch model for data provided by adolescents in relation to data answered by adults (18 to 44 years old and 45 years old or more). This very interesting result is in complete agreement with previous studies (Merrell and Tymms, 2005; Smith and Johnson, 2000) that evaluated the ADHD criteria with the Rasch model, indicating that the same behavioral scale for ADHD could not be used by young children and college students. ASRS Screener was constructed after the adaptation of each ADHD criterion to adulthood. Even so, data from adults misfit the model, while data from

adolescents did not. In this regard, our results, along with previous studies, may indicate the existence of problems in the construct validity of ADHD diagnostic criteria for adults, since this diagnosis was more extensively validated in children and adolescents (Pliszka, 2007; Rohde, 2008; Wilens *et al.*, 2004).

The results from the first study to assess ADHD symptoms in a representative sample of the Brazilian population indicated that these are common problems in all age ranges in this country. Furthermore, our results point to the relevance of evaluating both the validity of constructs which investigators intend to measure, and the properties of the scales used in this field. The phenomenology of ADHD in adults seem to be specific and a list of symptoms that takes into account this developmental perspective must be developed and validated in this age group before any effort to integrate adult ADHD diagnosis in future classificatory systems.

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Declaration of interest statement

Dr Polanczyk has served as a speaker for Novartis and is a recipient of a 2008 National Alliance of Research on Schizophrenia and Depression (NARSAD) Young Investigator Award. Dr Rohde was on the speakers' bureau and/or acted as consultant for Eli-Lilly, Janssen-Cilag, and Novartis in the last three years. Currently, his only industry related activity is taking part of the advisory board/speakers bureau for Eli Lilly, Novartis, and Shire (less than US\$10,000 per year and reflecting less than 5% of his gross income per year). The ADHD and Juvenile Bipolar Disorder Outpatient Programs chaired by him received unrestricted educational and research support from the following pharmaceutical companies in the last three years: Abbott, Bristol-Myers Squibb, Eli-Lilly, Janssen-Cilag, Novartis, and Shire.

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