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Please cite the final published version:

Alexandre, J. L., Lange, A-M., Bilenberg, N., Gorrissen, A. M., Søbbye, N., & Lambek, R. (2018). The ADHD rating scale-IV preschool version: Factor structure, reliability, validity, and standardisation in a Danish community sample. *Research in Developmental Disabilities, 78*, 125-135.

<https://doi.org/10.1016/j.ridd.2018.05.006>

## Publication metadata

<b>Title:</b>	The ADHD rating scale-IV preschool version: Factor structure, reliability, validity, and standardisation in a Danish community sample
<b>Author(s):</b>	Julie Lysdal Alexandre, Anne-Mette Lange, Niels Bilenberg, Anne Mette Gorrissen, Natasja Søbbye & Rikke Lambek
<b>Journal:</b>	Research in Developmental Disabilities
<b>DOI/Link:</b>	<a href="https://doi.org/10.1016/j.ridd.2018.05.006">https://doi.org/10.1016/j.ridd.2018.05.006</a>
<b>Document version:</b>	Accepted manuscript (post-print)

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# **The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample**

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**Declaration of interest**

Anne-Mette Lange has received speaker's fees from Shire Pharmaceuticals, Novartis, HB Pharma and Eli Lilly. Grants awarded by the TRYG Foundation, Rockwool Research Foundation. Author fees from Oxford University Press.

Niels Bilenberg has received speaker's fees from Shire Pharmaceuticals. Grants awarded by the TRYG Foundation, the National board of Social Science and Psychiatric Hospital in region South of Denmark

Anne Mette Gorrissen, Natasja Søbje, Julie Lysdal Alexandre, and Rikke Lambek have received grants awarded by the TRYG Foundation.

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

## Abstract

**Background:** ADHD is a debilitating disorder with symptoms often appearing in early childhood. To facilitate early identification, developmentally appropriate and validated assessment tools for the preschool-age are needed.

**Aims:** The current study aims to examine the psychometric properties of the ADHD Rating Scale (RS)-IV Preschool Version (-P) in a Danish community sample and provide national standardisation data.

**Methods and Procedures:** Parents ( $n = 916$ ) and kindergarten teachers ( $n = 275$ ) of preschool children, aged 3 to 5 years, completed the ADHD RS-IV-P.

**Outcomes and Results:** Confirmatory factor analysis indicated that a three-factor model (inattention, hyperactivity, and impulsivity) best fit the data regardless of rater. Scales generally showed acceptable internal consistency, test-retest reliability, inter-rater reliability, and criterion validity. Boys received higher ratings on the ADHD RS-IV-P than girls and younger preschool children were rated as more inattentive than older preschool children.

**Conclusions and Implications:** Our findings support the reliability and validity of the ADHD RS-IV-P and a three-factor model of ADHD. However, high factor correlations and similarity in model fit suggest that more research is needed to clarify the organisation of ADHD symptoms in preschool children. Furthermore, the external validity of separate ADHD dimensions at this age should be examined.

## Keywords

Preschool children, ADHD, ADHD Rating Scale-IV Preschool Version, psychometric properties, confirmatory factor analysis

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

## **What this paper adds?**

This is one of few studies to examine ADHD symptoms and their organisation in preschool children. It is only the second to examine the factor structure of the ADHD RS-IV-P, the first to examine the association between mothers' and fathers' ratings on the scale, and the first to provide Danish (Scandinavian) standardisation data for the ADHD RS-IV-P. It includes a large community sample and data from parents (mothers and fathers) and kindergarten teachers. Overall, the study finds support for the ADHD RS-IV-P as a psychometrically sound screening tool for ADHD in young children and for a symptom specific, three-factor model of ADHD with separate inattention, hyperactivity, and impulsivity dimensions.

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

## 1. Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common childhood mental health disorders (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). It is characterized by a persistent and age-inappropriate pattern of inattention and/or hyperactivity/impulsivity that causes significant impairment throughout the life span (American Psychiatric Association, 2013). Symptoms frequently appear in early childhood (American Psychiatric Association, 2013) and 2-4% of preschool children are estimated to fulfil diagnostic criteria (Egger & Angold, 2006; Wichstrøm et al., 2012). Preschool children with symptoms of ADHD often show marked impairments in cognitive, social, and family functioning (Daley, Jones, Hutchings, & Thompson, 2009a; Egger, Kondo, & Angold, 2006; Lahey, Pelham, Stein, et al., 1998; Posner, Melvin, Murray, et al., 2007; Sonuga-Barke, Dalen, & Remington, 2003). Preschool-onset ADHD and associated impairment appear to be stable across time and to constitute a risk factor for continued problems in school-age (Lahey, Pelham, Loney, et al., 2004; Lee, Lahey, Owens, & Hinshaw, 2008). This knowledge has resulted in an increased interest in the early identification of ADHD. Early identification is expected to enable early intervention that may help change negative developmental trajectories before symptoms become manifest and secondary problems such as academic failure or conduct problems develop (Daley, Jones, Hutchings, & Thompson, 2009b). However, rapid developmental changes take place during the preschool years as children gain increasing control over their attention and behaviour. Consequently, defining the boundaries between typical and atypical behaviour is challenging (Egger et al., 2006). To facilitate the early identification of ADHD, and to avoid labelling typical child development as problematic, developmentally appropriate and well validated assessment tools are needed.

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

The ADHD RS-IV (DuPaul, Power, Anastopoulos, & Reid, 1998) is a behavior rating scale with well-established psychometric properties widely applied to measure ADHD symptoms in school-age children. A preschool version, the ADHD RS-IV-P, has also been published and its validity and reliability examined in an American preschool sample (McGoey, DuPaul, Haley, & Shelton, 2007). In the American sample, Cronbach's  $\alpha$  values ranged between 0.85 and 0.95 for the home and the school versions, indicating good to excellent internal consistency. Likewise, test-retest reliability was good, with values ranging from 0.80 to 0.96. Finally, correlation coefficients in the range of 0.54 and 0.96 between the ADHD RS-IV-P and the Conners Rating Scales – revised (Conners, 1997) supported the criterion validity of the scale (McGoey et al., 2007). In a Spanish study, Marín-Méndez, Borra-Ruiz, Álvarez-Gomez, McGoey, and Soutullo (2016) also found the ADHD RS-IV-P to have good to excellent internal consistency ( $.86 \geq \alpha \leq .95$ ). While these results support the scale's psychometric properties, it is unclear if the ADHD-RS-IV-P is a psychometrically sound screening tool in samples outside America.

More recently, the factor structure of the ADHD RS-IV-P was examined by the scale developers (McGoey, Schreiber, Venesky, et al., 2015). Three alternative models - a unidimensional model, a two- factor model (inattention and hyperactivity/impulsivity), and a three-factor model (inattention, hyperactivity, and impulsivity) - were compared using confirmatory factor analysis (CFA). Results indicated that the three-factor model best fitted both parent and teacher data, which suggests that ADHD is best characterised by separate symptom dimensions of inattention, hyperactivity and impulsivity in the preschool-age. However, the factors were highly correlated ( $.86 \leq r \leq .92$ ) questioning the discriminant validity among the three subscales. Furthermore, studies examining the organisation of ADHD symptoms in preschool children based on data from other questionnaires do not

## The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

necessarily support a “three-dimensional” view of ADHD. For instance, an exploratory factor analysis by Hardy et al. (2007) indicated two- and three-factor models to be adequate for a population of symptomatic preschool children, but as models were characterised by substantial item cross-loadings and some items loaded relatively weakly, the authors concluded that inattention, hyperactivity, and impulsivity should be considered mixed symptoms rather than separate dimensions in preschool-age. Using CFA, Willoughby et al. (2012) found that one-, two-, and three-factor models all represented their data well. The two-factor solution did not result in improved model fit relative to the one-factor model, and the three-factor model was characterised by very large correlations between latent factors. This led Willoughby et al. (2012) to conclude that a one-factor model provided the best representation of ADHD symptoms in preschool children. Therefore, despite the findings by McGoey et al. (2015), the organisation of ADHD symptoms in younger children remains poorly understood and the dimensional structure of items on the ADHD-RS-IV-P requires replication. Essentially, the factor-structure will help determine how results from the scale should be interpreted (e.g., whether subscale or total scores should be interpreted) and ultimately whether or not the use of ADHD subtype presentations to specify impairment have any merit at this age (i.e., if symptoms are a unidimensional construct, then the use of presentations may have little clinical utility).

Finally, differences between parent and teacher ratings on the ADHD-RS-IV-P have previously been identified. Marín-Méndez et al. (2016) found significantly higher parent than teacher ratings on scales of the ADHD RS-IV-P. However, the consistency between parent and teacher ratings and between parent ratings (i.e., mothers and fathers) has not yet been examined. A certain degree of consistency between different raters (i.e., inter-rater reliability) is desirable if a behaviour rating scale is to be considered appropriate for measuring a construct of interest.

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

The aim of the current study is to evaluate the ADHD RS-IV-P in a Danish community sample in order to (1) examine the scale's factor structure, (2) examine aspects of the scale's reliability (internal consistency, retest-, and inter-rater reliability) and criterion validity, (3) present standardisation data (means, SDs, and raw-score percentiles), and (4) analyse gender and age differences on scales of the ADHD RS-IV-P.

## 2. Materials and methods

### 2.1. Participants

For the present study, parents of 2340 children attending one of 31 selected, state funded mainstream day care kindergartens in the province of Jutland, Denmark, were invited to participate<sup>i</sup> (kindergarten selection procedures are described in section 2.2). Parents of 916 children (51.2% boys) aged 3 years, 0 months - 5 years, 11 months of age ( $M = 4.40$ ;  $SD = 0.84$ ) were included in the final sample. Children at or above the age of 6 years were not included, as school is mandatory from the age of 6 in Denmark. The sample includes data collected in the Lambek, Lange, Petersen, & Gorrissen study (in preparation), referred to as "subsample two" in the procedures section. Respondents included biological mothers (86.8%), biological fathers (11.6%), and other relatives (1.6%; e.g., adoptive, foster, or step parents). The majority of respondents were ethnic Danes (96.1%), and their socio-economic status (defined as the highest obtained education level) was generally high, with most respondents (70%) having completed high school and at least three years of further education (i.e., vocational or university degree). Comparison with data from Statistics Denmark, a state institution under the Ministry of Economic Affairs and the Interior, suggested that parents of other ethnic background than Danish and with low socioeconomic status were under-represented in the sample.

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

Kindergarten teacher ratings were collected on a subsample of 275 children (52% boys) aged 3 years, 0 months -5 years, 11 months of age ( $M = 4.37$   $SD = 0.85$ ) from the parent sample. The kindergarten teachers had known the children between 1 month and 4.58 years ( $M = 1.41$   $SD = 0.93$ ).

To examine parent inter-rater reliability, mother and father ratings for the same child were collected on a subsample of 235 children from the parent sample. To examine the scale's criterion validity, a subsample of 224 parents completed the Child Behavior Checklist preschool checklist 1½-5 years (CBCL; 1½-5; Achenbach & Rescorla, 2000) in addition to the ADHD RS-IV-P. Finally, to examine test-retest reliability, the ADHD RS-IV-P was re-administered to a subsample of 206 parents and 58 kindergarten teachers after one month (+/- one week).

## 2.2. Procedures

Kindergartens were selected according to three demographic criteria; 1) inner city, 2) suburban-, and 3) rural areas, to ensure data representativeness. Kindergartens with a minimum of 40-50 children were selected. The kindergarten management was contacted by telephone, presented with the study, and invited to participate. Written information was also sent by e-mail. Invitation letters were distributed to families through the participating kindergartens. The letters included a description of the study and an individual password for an online survey. Data collection took place in two subsamples in order to fulfil the study aims. In subsample one, parents (i.e., either the mother *or* the father) from 15 kindergartens completed a brief background questionnaire and the ADHD RS-IV-P. A subgroup of these parents also completed the CBCL; 1½-5. Parents in subsample one were additionally asked permission to have their child's kindergarten teacher complete the scale. Parents were encouraged to participate regardless of whether they consented to having their child's kindergarten teacher participate

## The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

or not. In subsample two, the mothers *and* the fathers from 16 kindergartens completed the background questionnaire and the ADHD RS-IV-P. Mothers and fathers in subsample two received separate letters with personal passwords which were matched by ID. In both subsamples it was emphasised that participation was voluntary and anonymous.

To ensure a high response rate, a monetary reward was offered to the kindergarten with the highest parent response rate, and kindergarten teachers received a small appreciation at the end of the data collection.

In Denmark, questionnaire-based studies do not require ethics committee approval. Instead, the study was approved by the Danish Data Protection Agency (16<sup>th</sup> October 2012; reference no.: 2012-41-1088).

### 2.3. Measures

*The ADHD RS-IV-P* (McGoey et al., 2007) is a modified version of the ADHD RS-IV School Age Version (DuPaul et al., 1998) with developmentally appropriate examples of preschool activities and play. The scale consists of 18 ADHD symptoms as defined in the DSM-IV-TR/-5, to be rated on a four-point Likert scale ranging from 0 (the symptom is “never/rarely” present) to 3 (the symptom is “very often” present). The scale is designed to generate an Inattentive Score (0-27 points on odd numbered items), a Hyperactive/Impulsive Score (0-27 points on even numbered items), and a Total Score (0-54 points on all items). The present study included the home and the kindergarten versions of the Danish ADHD RS-IV-P (Lange, Bilenberg, & Lambek, 2012). The ADHD-RS-IV-P was translated into Danish in accordance with international guidelines (Beaton, Bombardier, Guillemin, & Ferraz, 2000), and with permission from the original developers (i.e., Kara E. McGoey and George J. DuPaul). In the

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

Danish version, minor cultural adaptations have been made (e.g., item 11; “learning ABC’s” was changed to “learning numbers”) to reflect the Danish preschool curriculum (i.e., the kindergartens).

*CBCL; 1½-5* (Achenbach & Rescorla, 2000) is a well-established, psychometrically sound checklist for preschool children. It consists of 100 items assessing broadband behavioural and emotional problems as well as social competencies. The present study employed the Danish parent version of the *CBCL; 1½-5* (Kristensen, Henriksen, & Bilenberg, 2010). In a previous Danish study, Cronbach’s alpha for the total problem scale of the *CBCL; 1½-5* was 0.94, indicating excellent internal consistency (Kristensen et al., 2010).

*Background questionnaire.* A short background questionnaire was applied to collect descriptive data including child age and gender, parent education and ethnicity, as well as kindergarten teacher familiarity with child.

## 2.4. Statistical analyses

The construct validity of scores on the ADHD RS-IV-P was examined using CFA. Following McGoey et al. (2015) three models were tested. Model 1 specified a single latent variable, ADHD, on which all items from the ADHD RS-IV-P were set to load and reflected a one-dimensional view of ADHD.

Model 2 specified two latent variables, Inattention, on which all nine inattention items were set to load, and Hyperactivity/impulsivity, on which all nine hyperactivity/impulsivity items were set to load. This model represented the two-dimensional model of ADHD included in the DSM-5 (American Psychological Association, 2013). In model 3, the latent variable, Inattention, was retained, but the

## The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

latent variable, Hyperactivity/impulsivity, was separated into two latent variables (i.e., Hyperactivity *and* Impulsivity) with the six hyperactivity items set to load on the first variable and the three impulsivity items set to load on the latter one. Consequently, the three-factor model represented a symptom-specific model. The latent variables were specified to be correlated and all error variances were uncorrelated. As items were measured on a four-point Likert scale, data were treated as ordinal and model parameters estimated using robust weighted least squares (WLSMV). The models were evaluated based on the following fit indices and cut-offs:  $\chi^2$  ( $p > .05$  suggests adequate fit), the comparative fit index (CFI  $> .90$  suggests adequate fit), the Tucker-Lewis index (TLI  $> .90$  suggests adequate fit), and RMSEA ( $< .08$  suggests reasonable approximate fit). Finally, the DIFFTEST option in MPLUS was used to compare the relative fit of the models ( $p < .05$  suggests that the least restrictive model should be retained).

Internal consistency of scales on the ADHD RS-IV-P was measured using Cronbach's alpha. Pearson product-moment correlations were applied to investigate test-retest reliability, inter-rater reliability, and criterion validity.

To obtain standardisation data on the ADHD RS-IV-P; means, SDs, and raw score cut offs of 80<sup>th</sup>, 90<sup>th</sup>, 93<sup>rd</sup>, and 98<sup>th</sup> percentiles were calculated separately for boys and girls on total scales and subscales. These percentiles and the provision of gender stratified standardisation data are in line with McGoey et al. (2007).

Age and gender differences were analysed using two-way between-groups analyses of variance (two-way ANOVAs) with subsequent Tukey Honestly Significant Difference (HSD) tests. Effect sizes were assessed using partial eta squared with .01, .06 and .14 considered small, medium, and large effect sizes respectively (Cohen, 1988).

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

All analyses were performed for the home and kindergarten versions separately (i.e., ratings obtained by parent and kindergarten teachers respectively) and all statistical tests were two-tailed. CFA was carried out using Mplus 7.4 (Muthén & Muthén, 1998–2016). Remaining analyses were conducted using the Statistical Package for the Social Sciences Version 21 for Windows.

## 3. Results

The response rate for parent reports was 46%. Prior to further analysis, 165 cases from the parent sample and 82 cases from the kindergarten teacher sample were excluded. Reasons for exclusion included child age (i.e., children were younger than three- or older than five years), missing data (e.g., on child age or gender), and duplicates from subsample one and two, as one kindergarten participated in both subsamples.

### 3.1. Factor structure

The fit statistics from the CFA based on parent ratings are provided in Table 1. All models had a significant  $\chi^2$ -value, but as this value is highly sensitive to sample size, more weight was given to the remaining fit indices (Tanaka, 1987). Only models 2 and 3 obtained CFI and TLI values above .90 as well as a RMSEA value below .08 (although the upper limits of the 90% confidence interval were at or above .08). When models 2 and 3 were contrasted, the difference was found to be significant ( $\chi^2 = 41.282$ ,  $df = 2$ ,  $p < .000$ ), indicating that the less restrictive model (i.e., the three-factor model) should be retained.

The fit statistics from the CFA based on kindergarten teacher ratings are also provided in Table 1. All models had CFI and TLI values well above .90, but only model 3 had a RMSEA value below .08 (the

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

upper limit of the 90% confidence interval was above .08). Due to similarity in model fit, models 2 and 3 were contrasted. Again, results suggested that the less restrictive model (i.e., the three-factor model) should be retained ( $\chi^2 = 27.278$ ,  $df = 2$ ,  $p < .000$ ).

**Table 1.** Fit Statistics for the Confirmatory Factor Analysis

Model <sup>a</sup>	$\chi^2$ (df) <i>p</i>	CFI	TLI	RMSEA (90% CI)
Home version				
1 (one-factor)	1010.375 (135) .000	.909	.897	.084 (.079-.089)
2 (two-factor)	854.190 (134) .000	.925	.915	.077 (.072-.082)
3 (three-factor)	805.472 (132) .000	.930	.919	.075 (.070-.080)
Kindergarten version				
1 (one-factor)	493.113 (135) .000	.968	.964	.098 (.089-.108)
2 (two-factor)	386.151 (134) .000	.978	.975	.083 (.073-.092)
3 (three-factor)	349.032 (132) .000	.981	.978	.077 (.068-.087)

*Note.*  $\chi^2$  = Chi-square; CFI = comparative fit index; CI = confidence interval; RMSEA = root mean square error of approximation; TLI = Tucker Lewis index.

<sup>a</sup>Model 1 = ADHD; Model 2 = Inattention and Hyperactivity/Impulsivity; Model 3 = Inattention, Hyperactivity, and Impulsivity.

The factor loadings and correlations for model 3 are included in Table 2. The loadings were all statistically significant ( $p < .001$ ) and ranged from .47 to .84 (home version) and from .70 to .95 (kindergarten version). All factors were strongly correlated ( $.76 \leq r \leq .92$ ).

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

**Table 2.** Factor Loadings (SDs) and Factor Correlations (SDs) for the Three-Factor Model

Item	ADHD symptom	<u>Home version</u>			<u>Kindergarten version</u>		
		IN	HYP	IMP	IN	HYP	IMP
1	Fails to give attention	.684 (.027)			.812 (.030)		
3	Difficulty sustaining attention	.769 (.021)			.861 (.022)		
5	Does not listen	.682 (.024)			.888 (.022)		
7	Does not follow instructions	.688 (.022)			.833 (.025)		
9	Difficulty organising tasks	.684 (.028)			.870 (.022)		
11	Avoids tasks	.670 (.029)			.769 (.033)		
13	Loses things	.509 (.032)			.811 (.029)		
15	Easily distracted	.755 (.020)			.914 (.018)		
17	Forgetful	.561 (.030)			.846 (.028)		
2	Fidgets or squirms		.707 (.023)			.894 (.019)	
4	Leaves seat		.646 (.024)			.948 (.016)	
6	Runs or climbs		.837 (.018)			.926 (.016)	
8	Difficulty playing quietly		.810 (.020)			.878 (.023)	
10	“On the go”		.647 (.025)			.858 (.022)	
12	Talks excessively		.470 (.030)			.702 (.040)	
14	Blurts out answers			.552 (.037)			.818 (.033)
16	Difficulty awaiting turn			.739 (.025)			.918 (.019)

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

18	Interrupts or intrudes			.767 (.023)		.953 (.014)
IN		-			-	
HYP		.856 (.017)	-		.916 (.014)	-
IMP		.761 (.027)	.814 (.027)	-	.838 (.028)	.910 (.018)

HI = Hyperactivity; IMP = Impulsivity; IN = Inattention.

As model 3 fitted the data the best, the remaining analyses were based on this tripartite model.

However, to be able to compare with previous research and due to the high correlation between the hyperactivity and impulsivity factors in the three-factor model analyses were also carried out with the combined hyperactivity/impulsivity scale (factor loadings and factor correlations for the two-factor model are provided in Appendix).

### 3.2. Internal consistency

The Cronbach's  $\alpha$  coefficients for the ADHD RS-IV-P home version were 0.89 for the Total scale, 0.82 for the Inattention scale, 0.78 for the Hyperactivity scale, 0.62 for the Impulsivity scale, and 0.82 for the combined Hyperactivity/impulsivity scale. The following mean inter-item correlations were obtained: Total scale: 0.31 (range 0.10-0.54), Inattention scale: 0.33 (range 0.19-0.51), Hyperactivity scale: 0.39 (range 0.20-0.54), Impulsivity scale: 0.35 (range 0.26-0.51), and Hyperactivity/impulsivity scale 0.35 (range 0.20-0.54). This indicates varying degrees of internal consistency for scales on the ADHD RS-IV-P home version, ranging from questionable to good.

The  $\alpha$  coefficients for the ADHD RS-IV-P kindergarten version were 0.96 for the Total scale, 0.92 for the Inattention scale, 0.90 for the Hyperactivity scale, 0.86 for the Impulsivity scale and 0.93 for the combined Hyperactivity/impulsivity scale. The following mean inter-item correlations were

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

obtained: Total scale 0.55 (range 0.28-0.77), Inattention scale: 0.57 (range 0.46-0.71), Hyperactivity scale: 0.61 (range 0.37-0.76), Impulsivity scale: 0.67 (range 0.60-0.77) and Hyperactivity/impulsivity scale: 0.60 (range 0.37-0.77). This indicates good to excellent internal consistency for all scales on the ADHD RS-IV-P kindergarten version.

### 3.3. Test-retest reliability

There was a strong, positive correlation between assessments at time one and time two for the home version: Total scale:  $r = 0.84$ ,  $n = 206$ ,  $p < .001$ , Inattention scale:  $r = 0.76$ ,  $n = 206$ ,  $p < .001$ , Hyperactivity scale:  $r = 0.82$ ,  $n = 206$ ,  $p < .001$ , Impulsivity scale:  $r = 0.67$ ,  $n = 206$ ,  $p < .001$ , and Hyperactivity/impulsivity scale:  $r = 0.83$ ,  $n = 206$ ,  $p < .001$ .

The correlation between assessments was also strong (and positive) for the kindergarten version: Total scale:  $r = 0.83$ ,  $n = 58$ ,  $p < .001$ , Inattention scale:  $r = 0.84$ ,  $n = 58$ ,  $p < .001$ , Hyperactivity scale:  $r = 0.71$ ,  $n = 58$ ,  $p < .001$ , Impulsivity scale:  $r = 0.76$ ,  $n = 58$ ,  $p < .001$ , and Hyperactivity/impulsivity scale:  $r = 0.77$ ,  $n = 58$ ,  $p < .001$ . Overall, this suggests acceptable degree of retest reliability for parent- and kindergarten teacher ratings on the ADHD RS-IV-P after one month.

### 3.4. Inter-rater reliability

On the home version of the ADHD RS-IV-P, the correlations between mother and father ratings were positive and moderate to strong: Total scale:  $r = 0.58$ ,  $n = 235$ ,  $p < .001$ , Inattention scale:  $r = 0.46$ ,  $n = 235$ ,  $p < .001$ , Hyperactivity scale:  $r = 0.63$ ,  $n = 235$ ,  $p < .001$ , Impulsivity scale:  $r = 0.44$ ,  $n = 235$ ,  $p < .001$ , and Hyperactivity/impulsivity scale:  $r = 0.63$ ,  $n = 235$ ,  $p < .001$ .

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

There was a moderate, positive correlation between parent and kindergarten teacher ratings on the ADHD RS-IV-P Total scale ( $r = 0.35, n = 275, p < .001$ ), Inattention scale ( $r = 0.33, n = 275, p < .001$ ), Hyperactivity scale ( $r = 0.31, n = 275, p < .001$ ), and Hyperactivity/impulsivity scale ( $r = 0.32, n = 275, p < .001$ .) On the Impulsivity scale the correlation between parent and kindergarten teacher ratings was weak:  $r = 0.26, n = 275, p < .001$ .

This suggests moderate to high consistency between parent (mother and father) ratings, and weak to moderate consistency between parent and kindergarten teacher ratings on scales of the ADHD RS-IV-P.

### 3.5. Criterion validity

The correlations between scales of the ADHD RS-IV-P and the ADHD subscale from the CBCL; 1½-5 were strong and positive: Total scale:  $r = 0.62, n = 224, p < .001$ , Inattention scale:  $r = 0.50, n = 224, p < .001$ , Hyperactivity scale:  $r = 0.58, n = 224, p < .001$ , Impulsivity scale:  $r = 0.55, n = 224, p < .001$ , and Hyperactivity/impulsivity scale:  $r = 0.62, n = 224, p < .001$ . Given the moderate to high correlations between the scales, the validity of the ADHD RS-IV-P is supported.

### 3.6. Standardisation data

Standardisation data on the home and kindergarten versions of the ADHD RS-IV-P are presented in Tables 3 and 4.

**Table 3.** Standardisation Data for Preschool Boys ( $n = 469$ ) and Girls ( $n = 447$ ) on the ADHD RS-IV-P  
*Home Version*

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

Scale	<i>M (SD)</i>	80 Percentile	90 Percentile	93 Percentile	98 Percentile
<b>Boys</b>					
Total score	13.67 (7.45)	20	24	25	34
Inattention	5.92 (3.83)	9	11	12	16
Hyperactivity	5.46 (3.12)	8	10	11	14
Impulsivity	2.29 (1.51)	3	4	5	6
Hyperactivity/ impulsivity	7.75 (4.21)	11	13	15	19
<b>Girls</b>					
Total score	11.69 (7.16)	16	21	23	30
Inattention	4.60 (3.43)	7	9	10	14
Hyperactivity	4.87 (3.25)	7	9	11	14
Impulsivity	2.23 (1.52)	3	4	5	6
Hyperactivity/ impulsivity	7.09 (4.37)	10	13	14	18

**Table 4.** Standardisation Data for Preschool Boys ( $n = 143$ ) and Girls ( $n = 132$ ) on the ADHD RS-IV-P  
*Kindergarten Version*

Scale	<i>M (SD)</i>	80 Percentile	90 Percentile	93 Percentile	98 Percentile
<b>Boys</b>					
Total score	11.61 (10.07)	19	27	29	38
Inattention	5.73 (5.10)	10	14	14	19
Hyperactivity	3.75 (3.71)	7	9	11	14
Impulsivity	2.13 (1.96)	4	5	5	7
Hyperactivity/ impulsivity	5.87 (5.42)	10	15	15	19

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

impulsivity					
<hr/>					
Girls					
Total score	7.81 (8.84)	14	20	24	35
Inattention	3.54 (4.23)	7	10	11	15
Hyperactivity	2.65 (3.36)	5	8	9	14
Impulsivity	1.62 (1.90)	3	4	5	7
Hyperactivity/ impulsivity	4.27 (5.02)	8	12	13	21
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### 3.7. Age and gender differences

Table 5 summarises the results of the two-way ANOVAs with child gender and age as independent variables and scales from the ADHD RS-IV-P as dependent variables. On the home and kindergarten versions statistically significant main effects of gender were found, with boys being rated as more inattentive, hyperactive and hyperactive/impulsive than girls. With respect to impulsivity the gender effect was only significant on the kindergarten version. Effect sizes were generally small. The mean (SD) scores from the inattention, hyperactivity, impulsivity and hyperactivity/impulsivity scales for boys and girls, stratified by age and respondent are presented in Table 6.

There were statistically significant main effects of child age on the inattention scales. This was found for both versions, with small effect sizes (revisit table 5). Post-hoc comparisons using the Tukey HSD test indicated that three-year olds were rated as significantly more inattentive than five-year olds on both versions (revisit table 6). The remaining age groups did not differ significantly with respect to inattention.

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

No statistically significant interaction effects were found between age and gender for scales on the two versions of the ADHD RS-IV-P.

**Table 5.** Age and Gender Differences (ANOVAs) on Scales of the ADHD RS-IV-P

Scale	Gender			Age		
	<i>F</i> (1, 910)	<i>p</i>	$\eta^2_p$	<i>F</i> (2, 910)	<i>p</i>	$\eta^2_p$
Home Version						
Inattention	27.89	0.000	0.030	3.13	0.044	0.007
Hyperactivity	9.47	0.002	0.010	1.07	0.345	0.002
Impulsivity	0.15	0.697	0.000	0.05	0.946	0.000
Hyperactivity/ impulsivity	5.91	0.015	0.006	0.84	0.434	0.002
Scale	Gender			Age		
	<i>F</i> (1, 269)	<i>p</i>	$\eta^2_p$	<i>F</i> (2, 269)	<i>p</i>	$\eta^2_p$
Kindergarten Version						
Inattention	16.05	0.000	0.056	5.39	0.005	0.039
Hyperactivity	7.42	0.007	0.027	0.25	0.782	0.002
Impulsivity	6.12	0.014	0.022	0.86	0.425	0.006
Hyperactivity/impulsivity	7.99	0.005	0.029	0.27	0.762	0.002

**Table 6.** Mean Scores (SD) on Scales of the ADHD RS-IV-P for Boys and Girls Stratified by Age

Scale	Boys			Girls		
	3-year	4-year	5-year	3-year	4-year	5-year
	<i>M</i> ( <i>SD</i> )					
Home version						

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

Inattention	6.20 (3.69)	5.99 (3.79)	5.51 (4.02)	4.81 (3.14)	4.54 (3.51)	4.42 (3.67)
Hyperactivity	5.88 (3.17)	5.22 (3.07)	5.20 (3.08)	4.74 (2.81)	4.99 (3.53)	4.88 (3.43)
Impulsivity	2.48 (1.57)	2.15 (1.48)	2.19 (1.47)	2.04 (1.32)	2.33 (1.58)	2.33 (1.66)
Hyperactivity/ impulsivity	8.35 (4.27)	7.38 (4.16)	7.39 (4.12)	6.78 (3.62)	7.31 (4.73)	7.21 (4.75)
<hr/>						
Kindergarten version						
Inattention	6.25 (5.09)	6.45 (5.38)	4.33 (4.59)	4.63 (4.44)	3.23 (4.21)	2.58 (3.78)
Hyperactivity	3.77 (3.48)	4.02 (3.89)	3.42 (3.83)	2.94 (3.55)	2.32 (3.39)	2.67 (3.15)
Impulsivity	1.75 (1.86)	2.68 (2.10)	1.98 (1.82)	1.90 (1.82)	1.48 (1.96)	1.45 (1.92)
Hyperactivity/ impulsivity	5.53 (5.13)	6.70 (5.75)	5.40 (5.41)	4.83 (5.13)	3.80 (5.13)	4.13 (4.83)

#### 4. Discussion

The aim of the present study was to evaluate the ADHD RS-IV-P in a Danish community sample.

Parents and kindergarten teachers of preschool children who attended state funded mainstream day care kindergartens in Denmark completed the ADHD-RS-IV-P. A three-factor model with separate, albeit highly correlated factors (inattention, hyperactivity, and impulsivity) best fitted the data. Scales showed somewhat varying, but for the most part, good internal consistency. The inter-rater reliability was good, although somewhat weaker consistency between raters was found on the impulsivity scale. The test-retest reliability and criterion validity were also supported. Preschool boys generally received higher ratings (indicating more symptomatology) than girls, and younger preschool children were rated as significantly more inattentive than older preschool children. The results will be discussed below.

##### 4.1. ADHD symptom organisation in preschool-age

## The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

The first purpose of the current study was to examine the factor structure of the ADHD RS-IV-P using CFA. The results indicated that a three-factor model with separate inattention, hyperactivity, and impulsivity dimensions best fitted the data. Similar results were found for parent and for kindergarten teacher data which points to a consistent behavioral profile for preschool children across settings. The current study has thereby replicated recent findings by McGoey et al. (2015) who found support for a three-factor structure for the ADHD RS-IV-P in an American community sample. A three-factor structure reflects a symptom-specific model of ADHD and indicates that the presentation of symptoms in preschool children may include a distinction between hyperactivity and impulsivity. Such a distinction is inconsistent with the two-dimensional presentation of ADHD (with inattention and combined hyperactivity/impulsivity), widely accepted and reflected in the current DSM-5 (American Psychiatric Association, 2013), but is consistent with the presentation of the disorder in the Tenth Revision of the International Classification of Diseases and Related Health Problems (ICD-10; World Health Organisation, 1993) commonly used in Europe. However, in the current study, the fit values of the two- and the three-factor models were very similar, and although statistical comparison between the models supported the three-factor model, the two-factor model also fitted the data and was in fact more parsimonious (having fewer parameters) than the three factor-model. In addition, the correlations between the latent factors of the three-factor model were extremely high ( $.76 \leq r \leq .92$ ), which suggests little discriminant validity among the subscales. Results may of course have been constrained by the relatively few ( $n = 3$ ) impulsivity items on the ADHD RS-IV-P (and in the DSM symptom list). Adding more (age-appropriate) impulsivity symptoms to the scale could possibly result in better models, as has also been suggested in reviews of results with older children (e.g. Wolraich, Lambert, Baumgaertel, Garcia-Tornel, Feurer, Bickman, & Doffing, 2003). In general, however, the literature on

## The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

the organisation of ADHD symptoms in preschool-age appears to be characterized by mixed findings with factor solutions characterised by substantial item cross-loadings (e.g., see Hardy et al., 2007) and highly intercorrelated factors (e.g., see Willoughby et al., 2012, and McGoey et al., 2015).

Consequently, there is currently little consensus about which structure best represents ADHD symptoms at this age and it may be too early to propose an alternative model of ADHD in young children at least until the external validity of separate factors has been examined and their clinical utility established.

### 4.2. Internal consistency, test-retest reliability, inter-rater reliability, and criterion validity

With the exception of the short hyperactivity and impulsivity scales on the home version, scales on the ADHD RS-IV-P displayed good internal consistency, with Cronbach's  $\alpha$  coefficients consistent with those reported for the original (McGoey et al., 2007) and a recent Spanish version (Marín-Méndez et al., 2016). The results found for the separate hyperactivity and impulsivity scales (reflecting the three-factor model of ADHD) on the home version may be a consequence of the relatively few items on these scales (i.e., six and three items respectively) - a common problem with short scales.

Both versions of the ADHD RS-IV-P were found to have acceptable degree of temporal stability after one month, indicating good test-retest reliability (at least short term), again consistent with the original version.

Inter-rater reliability between parents and kindergarten teachers was found to be good with mostly moderate associations between ratings. Parents and kindergarten teachers experience the child in different contexts (home vs. day-care). The fact that ratings are moderately but not perfectly correlated suggests that the home and kindergarten versions of the ADHD RS-IV-P measure similar

## The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

aspects of child behaviour, but differ sufficiently to merit the collection of ratings in different contexts. Marín-Méndez et al. (2016) also identified differences between parent and teacher ratings on the ADHD RS-IV-P although the study did not examine the scale's inter-rater reliability. Nor was the inter-rater reliability assessed in the original study (McGoey et al., 2007) but the associations between parent and kindergarten teacher ratings found in the present study are consistent with the inter-rater reliability between parents and teachers reported for the ADHD RS-IV School Version (DuPaul et al., 1998; DuPaul, Power, McGoey, Ikeda, & Anastopoulos, 1998).

Mother and father ratings on scales of the ADHD RS-IV-P were moderately to highly related. This is the first time the association between mother and father ratings on the ADHD RS-IV-P has been investigated. In addition to supporting the inter-rater reliability of the scale, these results also suggest consistency between parents' views of their child's behaviour, indicating they should be considered equally valuable informants in the assessment of child behaviour.

The association between the home version of the ADHD RS-IV-P and the ADHD subscale of the CBCL; 1½-5 (Achenbach & Rescorla, 2000) was moderate to strong ( $r = 0.50-0.62$ ); though lower than the association ( $r = 0.80-0.94$ ) reported between the original ADHD RS-IV-P (McGoey et al., 2007) and the ADHD index of the Conners parent and teacher rating scales (Conners, 1997) - another well-validated ADHD rating scale. This finding could reflect differences between the scales (i.e., the Conners scales and the CBCL; 1½-5) against which the validity of the ADHD RS-IV-P was examined. That is, the ADHD index of the Conners scales is (like the ADHD RS-IV) derived from items based on the 18 ADHD symptoms in the DSM-IV, whereas the ADHD subscale of the CBCL is based on only six items worded quite differently than the DSM-IV symptoms. Consequently, the ADHD RS-IV-P and

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

the Conners scale may be more similar, leading to the somewhat stronger association found in previous studies.

## 4.3. Standardisation data

Following the results from the CFA, Danish standardisation data, stratified by gender and rater (parents and kindergarten teachers), were presented for separate and combined hyperactivity and impulsivity scales. We consider this to be a strength, as the debate concerning the ADHD symptom organisation in young children is currently unresolved.

## 4.4. Age and gender differences

In terms of gender differences, there were statistically significant, albeit small main effects on both home and kindergarten versions of the ADHD RS-IV-P, with boys being rated as more inattentive, hyperactive, impulsive (only according to kindergarten teachers) and hyperactive/impulsive than girls. This finding is consistent with previous studies of both clinical and non-clinical samples of preschool children and indicates that boys as a group display a higher baseline level of ADHD symptoms (Gimpel & Kuhn, 2000; Hartung et al., 2002; Kadesjö, Kadesjö, Hägglöf, & Gillberg, 2001; Smidts & Oosterlaan, 2007). Although the effects of child gender were small in the present study, the findings support the need for gender-stratified standardisation data. In terms of age, there were statistically significant effects on the inattention scales of the home and kindergarten versions, with three-year-olds rated as significantly more inattentive compared to five-year-olds by parents and by kindergarten teachers. This is consistent with findings from longitudinal studies where preschool children, generally, are found to show a decline in ADHD symptoms during the preschool years, with improved attention

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

and less hyperactivity with age (Galéra et al., 2011; Romano, Tremblay, Farhat, & Côté, 2006; Willoughby et al., 2012).

## 4.5. Limitations

Potential limitations are important to consider when interpreting the results from the current study.

The response rate for parent reports in the current study was 46%. Ideally, we would have liked it to be even higher. However, several efforts were made to obtain a sample representative of the Danish population and to ensure a high response rate (e.g., parents from 31 different kindergartens participated in the study; parents received several reminders to participate via the kindergartens during the data collection phase etc.). Furthermore, the response rate is almost identical to those generally obtained in other recent large-scale Danish validation studies of this kind, (e.g., 47% in Lambek & Trillingsgaard, 2015, and 49% in Kristensen, Henriksen, & Bilenberg, 2010) and is comparable to the response rate (50%) obtained in the original study by McGoey et al. (2007).

Fewer kindergarten teachers ( $n = 275$ ) than parents ( $n = 916$ ) participated in the study. This was a consequence of the study design, where kindergarten teachers were recruited via parents in subsample one. Results from the kindergarten teacher sample largely replicated the findings from the parent sample, thereby supporting the validity of these data. However, future studies should endeavour to include larger teacher samples.

In order to obtain a representative sample of Danish preschool children, no a priori exclusion criteria were applied. Consequently, although we did not include special needs kindergartens in the sample, it is possible that some children may have had one or more psychiatric diagnoses such as

# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

ADHD. However, given the large sample size this is unlikely to have substantially increased ADHD scores.

On a related note, parents of other ethnic background than Danish and with low socioeconomic status were under-represented in the sample. This may have introduced a bias since studies have found negative associations between socio economic position and ADHD. For instance a recent register based study concluded that children exposed to lower income levels were at increased risk of ADHD (Larsson, Sariaslan, Långström, D’Onofrio, and Lichtenstein, 2014). It is possible that the relatively high SES sample included in the current study could have artificially lowered the scores on the ADHD RS-IV-P. This limitation should be kept in mind when interpreting the results, and generalisation of the normative data to lower socio economic groups should be made with caution.

## **5. Conclusion**

In conclusion, the current study supports a three-factor model of ADHD in the preschool-age. However, high factor correlations and similarity in model fit suggest that more research is needed to clarify how ADHD symptoms are organised in young children. Specifically, the external validity of distinct factors should be determined to establish their clinical utility with this age-group. The results relating to the scale’s reliability and validity indicate that the Danish version of the ADHD RS-IV-P has acceptable psychometric properties, largely comparable to previous investigations of the ADHD RS-IV-P (McGoey et al., 2007; Marín-Méndez et al., 2016) and the ADHD RS-IV School Version (DuPaul et al., 1997; DuPaul et al., 1998). The validated scale and standardisation data may be useful in Denmark (and Scandinavia) for screening purpose within research and clinical practice.

The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

### **Funding**

This study was supported by a grant awarded by the TRYG Foundation [grant number: 7-12-1006]. The funding source had no involvement in the study design, or in the collection, analysis, and interpretation of data, neither in the writing of the report or in the decision to submit the article for publication.

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Standardisation in a Danish Community Sample

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The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
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The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
Standardisation in a Danish Community Sample

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The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and  
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# The ADHD Rating Scale-IV Preschool Version: Factor Structure, Reliability, Validity, and Standardisation in a Danish Community Sample

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<sup>i</sup> In Denmark, 92% of children between the ages of 3 and 5 years attend kindergartens prior to entering elementary school at the age of 6 or 7, with the majority (71%) of kindergartens being state funded (Møller, 2014).