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Impairment in Young Preschool Children with Symptoms of Attention-Deficit/Hyperactivity Disorder and Co-occurring Oppositional Defiant Disorder and Conduct Disorder

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Abstract

Background: We have limited knowledge of the impact of attention-deficit/hyperactivity disorder (ADHD) symptoms on the daily functioning of young preschool children.
Objective: This study investigated the level of impairment related to symptoms of ADHD in different functional domains. It also addressed how impairment caused by ADHD was related to ADHD subtype, symptom load, gender, and the co-occurrence of oppositional defiant disorder, conduct disorder, or both.
Method: Participating children (N = 807) who were 3.5 years old were recruited from a population-based sample included in The Norwegian Mother and Child Cohort Study. Children who scored above the 90th percentile for ADHD symptoms were included in the present sample. The assessment of the symptoms and functional impairment described in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition,* text revision, was based on parental ratings and the semi-structured psychiatric interview entitled "The Preschool Age Psychiatric Assessment."
Results: Added burden and discord within family relationships were the areas that were most severely affected. All domain scores were strongly intercorrelated, and they were added to each child's total score. Children with symptoms of ADHD, inattentive type (mean [M], 3.5; standard deviation [SD], 3.4), or ADHD, hyperactive/impulsive type (M, 2.9; SD, 2.7), were significantly less impaired than children with symptoms of ADHD, combined type (M = 6.4; SD = 3.8; $p < .001$). Furthermore, co-occurring oppositional defiant disorder was associated with higher impairment scores (M, 6.1; SD, 4.3) than ADHD alone (M, 3.2; SD, 2.9; $p < .001$. About 30% of the variance of impairment score of ADHD was explained by symptoms of ADHD and co-occurring symptoms of oppositional defiant disorder and conduct disorder. Few gender differences were observed.
Conclusion: Overall, these non-referred young children with clinical symptoms of ADHD were only modestly impaired. Impairment related to ADHD occurred mainly in the areas of family functioning, and it was associated with ADHD subtype and comorbidity. Still, it is important to assess the impact of ADHD symptoms and coexisting difficulties among preschoolers to identify children and families who are in need of early intervention efforts.

Keywords: impairment, preschool children, parent ratings, attention-deficit/hyperactivity disorder, oppositional defiant disorder, conduct disorder, subtype, gender differences

Introduction

Impairment in social, academic, or occupational functioning is a required criterion (criterion D) for the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition,* text revision (DSM-IV-TR), diagnosis of attention-deficit/hyperactivity disorder (ADHD) (1). The early identification of ADHD has been an important priority area for the last decade; however, the diagnosis of ADHD may be difficult to establish in children younger than 4 to 5 years old (1).

Clinically based preschool studies have found children who fulfill ADHD symptom criteria (criterion A) to have disturbed social relationships, impaired academic achievement, and low self-esteem (2-4). In most preschool studies, similar functional areas of impairment to those assessed in older children were applied; however, these areas may in fact not be age-appropriate with regard to context and requirements for young preschool children.

In a large clinical sample, Egger and colleagues found that children with ADHD were eight times more likely to be impaired than those without ADHD and that 58% of children who met ADHD symptom criteria were indeed impaired (2,5). Healey and colleagues found moderate to severe impairment in 54% of children with symptoms indicative of ADHD, but they did not determine which domains were the most debilitating (6).

In the study by Eggers and colleagues, according to parental report, preschoolers with ADHD, combined type (ADHD-C), were found to have twice the impairment level as compared with children with ADHD, hyperactive-impulsive type (ADHD-HI) (2). Likewise, in a community-based sample, 4-year-old preschool children with ADHD-C were found by teachers' ratings to have more deficient social skills and to more often be receiving special educational services as compared with children with symptoms of either ADHD, inattentive type (ADHD-IA), or ADHD-HI (7). In a meta-analysis, Willcutt and colleagues found that children with symptoms of either ADHD-HI or ADHD-IA were less globally and socially impaired than those with ADHD-C across all age groups (8). However, this meta-analysis included only a few preschool studies, and the existing preschool studies mainly include referred samples. Willcutt and colleagues also concluded that empirical support is stronger for a model that replaces subtypes with dimensions that reflect the number of inattentive and hyperactive-impulsive symptoms present. Thus, even if some studies indicate only modest correlations between the number of symptoms and impairment (9,10), preschool community-based studies that investigate the relationship between the number of ADHD-IA and ADHD-HI symptoms and functional impairment and that look at whether the effect of combined symptoms is additive or potentiating are indeed warranted.

For externalizing disorders in particular, both impairment and symptoms have been found to be important for both nosology and prognosis (11). Comorbid behavioral disorders - namely oppositional defiant disorder (ODD) and conduct disorder (CD) - have been found to be strongly associated with elevated levels of impairment in both school-aged children with ADHD (8;12-16) and preschoolers with ADHD (4,5,17,18). In most preschool samples, ODD and CD have been merged into one disruptive disorder construct when examining the impact of the comorbidity of ADHD (18-20). However, longitudinal studies have suggested that children with ADHD and co-occurring ODD may have a different developmental course than those with co-occurring CD (21-24). Moreover, although the long-term outcomes of ODD are linked to disturbed social relationships, ADHD and CD predict rule violation, aggression, and poorer academic attainment as compared with ODD (25). We have previously reported that, among 3-year old children with ADHD, co-occurring CD was more strongly related to ADHD-C and ADHD-IA symptoms than co-occurring ODD was (26). With this in mind, we are seeking more information about the possible differences in impact on functioning of co-occurring ODD and CD in young children with ADHD.

Both a community-based study (19) and a clinically based preschool study (27) have found minor gender differences in globally measured impairment related to ADHD. The study by Healey and colleagues found that non-referred boys were more impaired than non-referred girls according to teachers' reports but not according to parental ratings (6). However, we lack studies in this age group that address potential gender differences in impairment related to ADHD and that look at whether subtypes or concurrent ODD or CD influence gender differences.

To address these shortcomings, this study investigated impairment in 3-year-old non-referred children who presented with symptoms of ADHD, both below and above the diagnostic threshold. More specifically, we wanted to examine how scores for impairment may vary across functional domains, whether the level of impairment is differently affected by symptoms within the different ADHD subtypes, and how co-occurring symptoms of ODD, CD, or both may affect the level of impairment. Furthermore, we wanted to investigate to what degree symptoms of ADHD-IA, ADHD-HI, ODD, and CD predicted the level of impairment. Lastly, we wanted to examine whether there were gender differences in impairment related to ADHD.

Materials and methods

Participants

All participants were recruited from the Norwegian Mother and Child Cohort Study (MoBa), a popula-

tion-based prospective birth cohort study of about 107,000 children conducted by the Norwegian Institute of Public Health (28). To identify a large number of preschoolers who might be at risk for developing ADHD, 3-year-old children whose sum score was higher than the 90th percentile for 11 questions related to hyperactivity, impulsivity, and inattention for the 36-month MoBa questionnaire were invited to a clinical assessment; 6 of these 11 questions were selected from the Child Behavior Checklist (29), and 5 questions were from the symptom criteria for ADHD in DSM-IV-TR (1). Of the 2,798 invited children, 1,048 (37.5%) completed the clinical assessments, including the diagnostic evaluation. Enrollment in the present part of the preschool ADHD study was described in further detail in a previous publication (26). There were no statistically significant differences between participants and invited non-participants with regard to background factors (i.e., parental marital status, parental educational level, parental age) except for a higher maternal educational level among participants. Participants in the present study were 807 children who had one or more ADHD symptoms and available data regarding their ADHD impairment score.

The children, who were between the ages of 36 and 44 months, participated in a 1-day clinical assessment at Oslo University Hospital together with at least one parent. The clinical assessment included neuropsychological and neuromotor evaluations in addition to a clinical interview to assess psychiatric symptoms. The exclusion criteria were severe medical conditions or high scores for autistic symptoms. One of the parents had to speak the Norwegian language.

Symptom measures

One of the parents, usually the mother, was interviewed with a semi-structured interview entitled "The Preschool Age Psychiatric Assessment" (PAPA) (30). The PAPA includes questions about psychiatric symptoms as they related to preschool-aged children, including their frequency, intensity, cross-situationality, and age of onset. The PAPA interviews were performed by trained psychology students and supervised by a clinically trained psychologist or child psychiatrist, with high inter-rater reliability (26). All 18 diagnostic symptom criteria for ADHD were discussed. The eight DSM-IV-TR diagnostic symptom criteria for ODD were modified by cutpoints for the frequency level of symptoms and reflect the top 10% of frequency for preschool children (31). Eight of the 15 DSM-IV-TR diagnostic symptom criteria that had previously been found applicable for CD in preschool-aged children were used for diagnostic decision making (31,32).

Symptom threshold groups of ADHD, ODD, and CD were generated with the use of algorithms that implemented symptom criteria from criterion A of the DSM-IV-TR (1). The low ADHD symptom group consisted of children with one or more ADHD symptoms but who were below the diagnostic threshold of each subtype. On the basis of the diagnostic threshold symptom counts, ADHD only and the co-occurring groups of ODD, CD, or both were created.

Impairment measures

Each section of the PAPA was concluded with an evaluation of impairment. However, the impairment scores for the separate diagnoses were strongly correlated with comorbid conditions, co-occurring ADHD and ODD (r = 0.65), and co-occurring ADHD and CD (r = 0.90), which points toward parental ratings reflecting a more global impact than attributing disability to one specific disorder. In this article, we therefore only use impairment reported with ADHD symptoms.

Whenever a parent reported his or her child exhibiting at least one diagnostic symptom discussed in the PAPA, impairment was scored for six functional domains:

1) family (relationships with parents and siblings);
2) friends (the ability to make them and keep them);
3) learning (the child's learning capacity in structured activities like drawing, doing puzzles, and so on);
4) play and leisure activities (participation in play and showing the normal range of variation);
5) quality of life (the interference of symptoms with the child's quality of life);
6) burden to family (the interference of symptoms with family routines and daily life).

Each subscale of impairment was given a score of between 0 and 3, with 0 meaning "no," 1 meaning "yes, minor difficulties," 2 meaning "yes, definite difficulties," and 3 meaning "yes, severe difficulties." The summed score of all six coded functional domains formed a total impairment score with a range of 0 to 18. With sufficient psychometric properties (Cronbach's alpha = 0.83) and the corrected item total correlations between the different subscales and the total impairment score (r = 0.55-0.65), we used the total impairment score in most subsequent analyses. A sum score of 3 on the total impairment scale was at the 75th percentile for the whole sample and was considered to indicate a moderate level, whereas a score of 5 was at the 90th percentile and indicated a more severe level of impairment. Inter-rater reliability was 0.94 for the

impairment score of ADHD, 0.85 for ODD, and 0.99 for CD.

Covariates

Covariates included maternal and paternal educational level, which were obtained from the MoBa questionnaire at 17 weeks' gestation. We lacked information about paternal educational level for 59 children and about maternal educational level for 26 children, but the missing cases were equally distributed among the different symptom groups. Information about maternal age at delivery and marital status was obtained from the Norwegian Medical Birth Registry (33). The educational levels of the parents were moderately correlated ($r = 0.57$; $p < .001$), and we chose to use the maternal educational level as a covariate and a measure of socioeconomic status for our analysis. A measure of the child's general intellectual functioning was obtained as a part of the neuropsychological assessment with the use of a short form of the Stanford–Binet Intelligence Scale, Fifth Edition (34), which was administered by a trained psychologist.

Ethics

The study was approved by the Regional Ethics Committee, and a license was granted by the Norwegian Data Inspectorate in 2007. Assessments were carried out in accordance with ethical standards, and the principles of the Declaration of Helsinki were followed. Parents returned their written consent before the clinical assessment took place.

Statistical Analysis

We assessed the frequencies of the covariates among children with low ADHD symptoms and for groups with ADHD, ADHD+ODD, ADHD+CD, and ADHD+ODD+CD symptoms above threshold. For group comparisons, we used one-way analysis of variance for continuous measures and a chi-squared test for independence for categorical data.

One-way between-group analysis of variance with Bonferroni correction for post-hoc comparisons was conducted to investigate the impact of subtype and co-occurrence of ODD, CD, or both on the level of impairment related to ADHD.

We further examined the relationship between the number of symptoms and the impairment score with the use of the Pearson product-moment correlation and the ability of the number of ADHD-IA, ADHD-HI, ODD, and CD symptoms to predict the level of total impairment score of ADHD by multiple linear regression analyses that were controlled for covariates (i.e., maternal and paternal educational level, child's intelligence level and gender). We tested for statistical interactions between ODD and CD and between gender and ODD/CD in step 2; we looked for these between combined ADHD-HI and ADHD-IA symptoms and between gender and ADHD-HI/ADHD-IA in step 3. To avoid collinearity and to facilitate interpretation, continuous variables were centered into z-scores before interaction terms were created (35).

Lastly, we examined gender differences in the total impairment score of ADHD according to symptom subtypes and co-occurring symptom clusters of ODD, CD, or both with the use of crosstabs, chi-squared tests, and independent-sample *t*-tests.

PASW Statistics 18 was used for statistical analyses. All tests were two-tailed.

Results

Sample characteristics are presented in Table 1. Of the 807 children included, 73% (n = 593) had low ADHD symptoms; their symptom counts were between one and six for the ADHD-HI and ADHD-IA groups and between one and ten for the ADHD-C group. ADHD symptoms above the diagnostic threshold were present in 27% of the group (n = 214): 6% (n = 12) had ADHD-IA, 76% (n = 163) had ADHD-HI, and 18% (n = 39) had ADHD-C. Of the 214 children with ADHD, 63% (n = 135) had symptoms of ADHD only, whereas 37% (n = 79) had co-occurring symptoms of ODD, CD, or both.

Of children with threshold ADHD symptoms, 43% had impairment scores of less than 3, 24% had scores of 3 or 4 (i.e., between the 75th and 90th percentiles), and 33% had scores of 5 or more (i.e., at the 90th percentile or above); this was indicative of moderate to severe levels of impairment in 57% of these children.

Figure 1 shows the assessed functional areas and the percentage of children below and above the threshold for ADHD who had moderate or severe levels of impairment. Only 0% to 2% of children with symptoms below diagnostic the level was moderate or severely impaired in the areas of play, friends, and learning; this was compared with 8% to 13% of children who had a symptom load that was at or above the diagnostic threshold. Of children with threshold ADHD symptoms, 24% were reported to have disturbed family relationships, and 32% displayed behaviors that were perceived as burdens to their families; for those children whose symptoms were below threshold, these numbers were 5% and 9%, respectively.

TABLE 1. Sample characteristics of 807 preschool children

Below/above DSM-IV diagnostic symptom level			Below		Above		Above		Above		Above	
	Total		Low ADHD symptoms		ADHD only		ADHD + ODD		ADHD + CD		ADHD + ODD + CD	
N	807		593		135		43		17		19	
	N	%	N	%	N	%	N	%	N	%	N	%
Gender (boys)	436	54	313	52.8	83	61.5	23	53.5	11	64.7	6	31.6
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Age (months)	41.8	1.3	41.8	1.3	41.7	1.3	41.6	1.3	41.4	1.3	41.9	1.4
Intelligence quotient	101.6	9.2	102.2	9.3	100.3	9.1	101.9	8.2	98.1	8.4	97.3	9.6
IA symptoms*	1.8	1.9	1.2	1.3	3.3	2.2	3.7	2.3	3.8	2.6	4.2	2.9
HI symptoms*	3.7	2.3	2.6	1.5	6.5	1.3	7.1	1.1	6.5	1.8	7.2	0.9
ODD symptoms*	1.9	1.6	1.7	1.5	1.6	1.1	4.8	0.9	1.9	0.9	5.2	1.3
CD symptoms*	0.8	1.1	0.6	0.9	0.8	0.8	0.9	0.9	3.5	0.7	3.7	0.9
Mother's age (years)	30.3	4.2	30.6	4.2	29.8	4.4	30.1	4.3	30.6	3.8	28.1	3.4
Mother's education (years)	15.1	2.4	15.4	2.3	14.6	2.5	14.4	2.1	14.3	2.6	14.0	2.5
Father's education (years)	14.4	2.8	14.6	2.7	13.9	2.9	13.5	2.7	13.1	2.4	13.6	2.8
	N	%	N	%	N	%	N	%	N	%	N	%
Civil status (single parents)	31	3.6	15	2.5	10	7.4	2	4.7	1	5.9	1	5.3

*Number of symptoms.

Low ADHD symptoms, The presence of at least one symptom of attention-deficit/hyperactivity disorder (ADHD), but the number of symptoms is below the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition,* text revision, diagnostic threshold level; *ADHD only,* ADHD alone; *ADHD + ODD,* co-occurrence of ADHD and oppositional defiant disorder (ODD); *ADHD + CD,* co-occurrence of ADHD and conduct disorder (CD); *ADHD + ODD + CD,* co-occurrence of ADHD, ODD, and CD; *IA symptoms,* symptoms of ADHD, inattentive type; *HI symptoms,* symptoms of ADHD, hyperactive-impulsive type; *ODD symptoms,* symptoms of oppositional defiant disorder; *CD symptoms,* symptoms of conduct disorder.

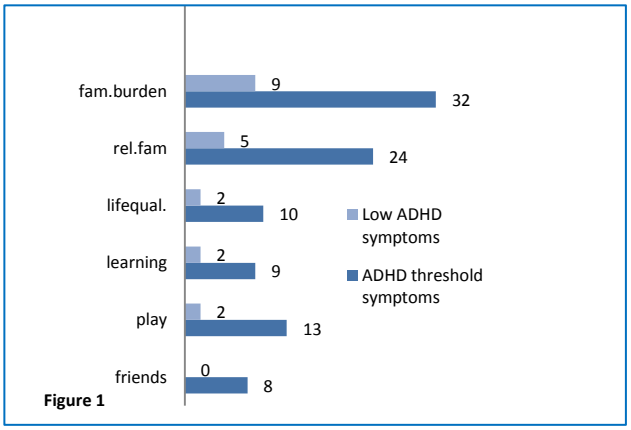

FIGURE 1. Percentage of children with attention-deficit/hyperactivity disorder symptoms below and above the diagnostic threshold for moderate to severe impairment in various functional domains.

Note: fam.burden, burden on the family; *rel.fam,* the relationship between the parent (family) and the child; *lifequal.,* quality of the child's life; *learning,* the ability to learn in various settings and through activities such as reading and doing puzzles; *play,* the ability to engage in play within a normal range of variation; *friends,* the ability to get and keep friends.

Low ADHD symptoms: the presence of at least one symptom of attention-deficit/hyperactivity disorder, but the number of symptoms is below the diagnostic threshold level.

ADHD threshold symptoms: attention-deficit/hyperactivity disorder symptom counts above the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition,* text revision, diagnostic threshold level.

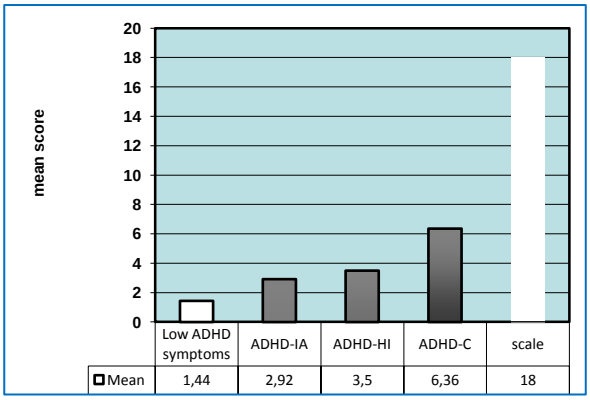

FIGURE 2. IMPAIRMENT SCORE related to attention-deficit/hyperactivity disorder ACCORDING TO attention-deficit/hyperactivity disorder SUBTYPE

Note: Low ADHD symptoms, Attention-deficit/hyperactivity disorder (ADHD) symptom counts between 1 and 6 (or of up to 10 for ADHD-C symptoms); *ADHD-IA,* ADHD, inattentive type (symptom counts of 6 or more); *ADHD-HI,* ADHD, hyperactive-impulsive type (symptom counts of 6 or more); *ADHD-C,* ADHD, combined type (symptom counts of 12 or more).

Figure 2 shows impairment scores of ADHD according to subtypes. Children with ADHD-C had significantly higher impairment scores (mean [M], 6.4; standard deviation [SD], 3.8) than children with either ADHD-HI (M, 3.5; SD, 3.4) or ADHD-IA (M, 2.9; SD, 2.7; Welch statistics [3, 41.7], 37.8; $p < .001$). Scores of more than 3 were present in 90% of children with ADHD-C symptoms.

Each child's impairment score related to ADHD was moderately correlated with the number of ADHD symptoms ($r = 0.54$; $p < .001$), ODD symptoms ($r = 0.30$; $p < .001$), and CD symptoms ($r = .26$; $p < .001$). An exploratory analysis revealed that the total impairment score gradually increased with an increasing number of ADHD symptoms both below and above threshold level and with no distinct breaking point at any level of impairment that was indicative of the diagnostic threshold.

The relationship between the total impairment score related to ADHD and the number of symptoms was further examined with hierarchical multiple regression analysis (Table 2). Background

characteristics were entered at step 1 and explained 2% of the variance in impairment related to ADHD. The numbers of ODD and CD symptoms were entered at step 2, and the explained variance was 13% (F [6, 764] = 18.2; $p < .001$; R-squared change = 0.10; F change [3, 764] = 29.3; $p < .001$). Numbers of ADHD-IA and ADHD-HI symptoms were entered at step 3, and total variance explained by the model was 32% (F [9, 761] = 39.4; $p < .001$; R-squared change = 0.19, F change [3, 761] = 71.6, $p < .001$). In the final model, there was a positive interaction between gender and the number of ODD symptoms. In addition, the interaction between the numbers of ADHD-IA and ADHD-HI symptoms added a statistically significant contribution to the explained variance of the impairment score of ADHD, which indicated a multiplicative effect of combined symptoms.

TABLE 2. The associations between the number of symptoms of attention-deficit/hyperactivity disorder, inattentive type; attention-deficit/hyperactivity disorder, hyperactive-impulsive type; oppositional defiant disorder, and conduct disorder to the impairment score related to attention-deficit/hyperactivity

	Impairment score related to attention-deficit/hyperactivity disorder											
	Step 1				Step 2				Step 3			
	B	*SE B*	*β*	*P*	*B*	*SE B*	*β*	*P*	*B*	*SE B*	*β*	*P*
	5.99	1.15		.000	3.83	1.13		.001	.41	1.03		.69
Gender (boys)	.34	.19	.06	.08	.00	.28	.00	.10	-.15	.16	-.03	.54
Intelligence quotient	-.03	.01	-.09	.01	-.02	.01	-.06	.07	-.01	.01	-.03	.35
Mother's education	-.10	.04	-.09	.01	-.06	.04	-.06	.11	.01	.03	.01	.70
ODD symptoms*					.25	.08	.15	.002	.09	.07	.05	.25
ODD/boys					.34	.18	.09	.06	.34	.16	.09	.03
CD symptoms*					.42	.09	.17	.000	.16	.08	.06	.06
IA symptoms*†									.29	.05	.21	.000
HI symptoms*†									.35	.04	.31	.000
IA/HI*†									.16	.08	.07	.05

*Adjusted for gender, intelligence quotient, and maternal education.
†Adjusted for gender, intelligence quotient, maternal education, and conduct disorder and oppositional defiant disorder symptoms.
ODD symptoms, The number of symptoms of oppositional defiant disorder (ODD); *ODD/boys,* interactions of male gender and the number of ODD symptoms; *CD symptoms,* the number of symptoms of conduct disorder; *IA symptoms,* the number of symptoms of attention-deficit/hyperactivity disorder (ADHD), inattentive type; *HI symptoms,* the number of symptoms of ADHD, hyperactive-impulsive type; *IA/HI,* interactions of the number of symptoms of ADHD, inattentive type, and ADHD, hyperactive-impulsive type.
B, the value of the unstandardized regression coefficient; SE B, the standard error; *β,* the value of the standardized regression coefficient.

Moderate or severe levels of impairment were present in 81% of children with co-occurring ODD as compared to 53% of children with co-occurring CD and 58% of children with a co-occurrence of both ODD and CD. There were some significant differences in the impairment scores between groups of children with ADHD and co-occurring ODD, CD, or both (Welch statistics [4, 54.8] = 25.9; $p < .001$) (Figure 3). Post-hoc comparisons indicated that children with ADHD and co-occurring ODD (M, 6.1; SD, 4.3) were more impaired than children with low ADHD symptoms (M, 1.4; SD, 1.9) and children with ADHD only (M, 3.2; SD, 2.9). Children with ADHD only, those with ADHD and co-occurring CD, and those with co-occurring symptoms of both ODD and CD were not significantly different from each other, but all groups were significantly more impaired than children with low ADHD symptoms.

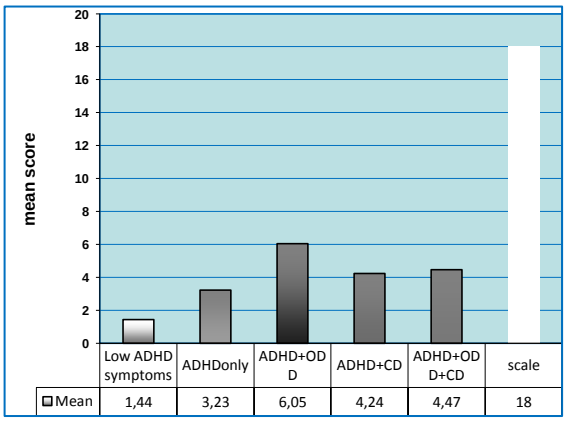

FIGURE 3. Impairment score related to attention-deficit/hyperactivity disorder in children with attention-deficit/hyperactivity disorder alone and in those with co-occurring oppositional defiant disorder, conduct disorder, or both.

More boys than girls had impairment scores of more than 5 (i.e., more than the 90th percentile): 69% of boys (n = 48) versus 31% of girls (n = 22) (χ^2 = 5.2; p = .02). Boys with co-occurring ODD

had higher impairment scores than girls ([M, 7.5; SD, 5.0] versus ([M, 4.4; SD, 2.3]; t[32.2] = 2.7; p = .01).

Discussion

In this population-based sample of non-referred preschool children with high screening scores for characteristics of ADHD, the strongest impact of ADHD symptoms was seen in the areas of family functioning, creating discord within family relationships and putting an added burden on families. Only 33% of preschoolers with clinical ADHD symptoms were rated as impaired at a conservative cutoff, and less than 60% were considered impaired when a more liberal cutoff was used. Children who fulfilled diagnostic symptom criteria were rated almost three times as impaired as children with symptom counts below the diagnostic level, and children with ADHD-C turned out to be almost twice as impaired as those with ADHD-IA or ADHD-HI. Among children within co-occurring symptoms, those with co-occurring ODD were the most debilitated. A positive linear relationship between impairment score and the number of ADHD symptoms was demonstrated, but there was no distinct breaking point at any level of impairment to indicate a diagnostic threshold. The number of ADHD symptoms explained less than 30% of the variance in the impairment score of ADHD. More boys than girls had severe level of impairment, and boys with co-occurring ODD were slightly more impaired than girls. Largely, however, there were only minor gender differences in impairment related to ADHD.

Functional areas like friendship, learning, and play - which, in school-aged children, have been found to be affected by ADHD symptoms (12;36-38) - were not considerably affected in these young preschoolers. This probably reflects the more demanding contextual environment of older children as compared with that of 3- and 4-year old children. Thus, the further evaluation of which functional domains of impairment should be assessed in preschoolers may be warranted.

In line with previous community-based and clinically based preschool studies, (2,7,39), a considerably larger proportion of children with ADHD-C were reported to be significantly impaired, and they were found to have twice the impairment levels of children with either ADHD-IA or ADHD-HI. Children with symptoms of ADHD-IA were found to be even less impaired than children with ADHD-HI symptoms, although no firm conclusions can be drawn because of the small numbers involved in these studies. Clinical levels of inattentiveness seem to represent a rare phenomenon unless they are combined with ADHD-HI symptoms, and several large preschool samples have been unable to identify children with the ADHD-IA subtype (2,18,27,40). Inattentiveness and its clinical significance seem to be hard to evaluate in these young preschool children.

We found that children with symptoms of ADHD and co-occurring ODD were more impaired than children with ADHD alone, which is also in line with the findings of previous preschool studies (5,17,20), although neither group significantly differed from the group of children with co-occurring CD. To our knowledge, no previous preschool studies have compared the impact of the comorbidity of ODD versus CD. The existing comparisons have focused less on impairment than symptom patterns, or the two diagnostic categories of ODD and CD have been collapsed into one disruptive behavior construct (7;18-20;40,41). About 80% of children with co-occurring ODD had moderate or severe levels of impairment as compared with about 50% of those with co-occurring CD. Given that temper outbursts and defiance may be considered as normative and age-appropriate in 3- and 4-year-old children, these findings were somewhat surprising. Alternatively, ODD may be highly context-specific, and it may be one of the few disorders with manifestations that are seen solely in the home environment. Thus, parents probably shoulder most of the burden of the defiance, irritability, or emotional dysregulation problems associated with ODD as compared with the symptoms of CD. The more discrete, covert, and lower base-rate symptoms of CD could be considered simply as immature and transient behaviors and thus be perceived as less impairing by the parents, especially in these very young children. However, the results cannot be generalized because of the small sample sizes in studies of co-occurring groups with ADHD and CD. These findings require replication.

Previous studies of school-aged children have found that ADHD symptoms explain about 25% to 30% of variance in impairment (9-11), which is quite similar to our findings of less than 30%. A pertinent question is of course which other factors determine impairment in children with ADHD, but studies specifically addressing these issues are largely missing. In our study, gender, intelligence, and parental educational level did not add much. We must assume that the impairment score covers several aspects of daily living that go beyond separate symptom descriptions. The score will probably also reflect factors such as attitudes toward parents and siblings, self-esteem, mood, anxiety, and others. Thus, it will be expected that

psychiatric symptoms will only explain a smaller proportion of the variance in impairment. However, it is also possible that the answer to this question will in part depend on which functional domains are being scrutinized (10).

Among children with symptoms of ADHD and concurrent ODD, boys were found to be slightly more impaired than girls. Overall, however, gender differences in impairment related to ADHD were negligible. The absence of gender differences in functional impairment related to ADHD has also previously been reported from community-based samples of both preschoolers and school-aged children (19,42). Conversely, a meta-analysis by Gaub and Carlson demonstrated more evident gender differences in community-based samples than in clinical samples (43). Although non-referred school-aged boys with ADHD were more impaired than girls, no differences were found in the clinical samples. Clinical samples may be less suited for the investigation of gender differences, because girls with ADHD are referred for treatment less frequently than boys are (44). Thus, the effects of gender on impairment related to ADHD still seem somewhat ambiguous (44), and direct comparison across studies seems to be a problem, because gender effects will partly hinge on the referral source, the rater source, the ages of the children studied, and which functional domains were examined (45).

Strengths and limitations

The present population-based sample of non-referred preschool children with high scores on ADHD traits allowed for the study of impairment related ADHD in a relatively large sample. The children were examined with the use of a validated and structured diagnostic interview that included detailed information about present psychiatric symptoms and impairment and that had high internal consistency for impairment measures. The considerable number of children with symptoms of ADHD gave us the opportunity to examine the ADHD subtypes separately and allowed for the examination of potential predictors of impairment. Population-based studies may be particularly pertinent for the detection of predictors of functional impairment at an early stage of development, because clinical samples are often subject to referral biases, with increased rates of comorbidities, a predominance of boys, and greater symptom severity (41,43).

This study also has limitations. First, the study selection was a two-step process. Participants were initially enrolled in the MoBa and then into the present study. Although the original cohort of 107,000 was large and recruited broadly from the population, the response rates for both MoBa and the ADHD study were low (39% and 37%, respectively). However, no significant differences between participants in MoBa and the general population were found for eight selected exposure/outcome associations (e.g., smoking and birth weight (47)) or between participants in the MoBa and the ADHD study, with the single exception of higher maternal education in the ADHD study as compared with MoBa. It is likely that participants with the energy to be involved in both of these studies were highly well-functioning families.

Second, we lacked information about impairment for 6% of the sample, but there were no differences in background characteristics between children lacking information and children with available impairment ratings.

Third, the impairment scale and the subscales of the different functional areas used in this version of PAPA differ from the original version of the PAPA (30) in two aspects. For example, the subscale addressing the impairment's burden to the family was derived from the Strengths and Difficulties Questionnaire (48) and added to the impairment scale in the version of the PAPA used this study. In addition, the scale used in this present study includes a rating that goes from 0 to 18, which is similar to the impairment score obtained with the Strengths and Difficulties Questionnaire; however, the original PAPA scale runs from 0 to 30. However, the sum score of impairment related to ADHD in this present study demonstrated good psychometric properties.

Fourth, we did not correct for other variables (e.g., co-occurring disorders) when presenting impairment related to ADHD in the various functional domains (see Figure 1) or according to subtypes of ADHD (see Figure 2).

Fifth, both symptoms and impairment scores were based solely on parents' ratings, and information from teachers would probably better reflect the true variance of children's behavior in structured learning and play settings. Clinical diagnostic decisions are based on the assumptions that symptoms and impairment are related but separate constructs (10,38), and impairment could be regarded as an independent external validation of a disorder and as being essential to avoid tautology in which the same measures are used to define and externally validate a disorder (8). However, when the same rater evaluates both symptoms and impairment, this does not necessarily hold true, because rater bias may be a problem. Nevertheless, the use of a validated and structured clinical

interview provided a wide scope of cross-situational information about symptoms and impairment. Parents' ratings have largely been found to be reliable independent predictors of severity and of the diagnosis of ADHD in preschoolers at follow up (49).

When using categorical diagnostic entities, children in the low ADHD symptom group may have a higher number of combined symptoms than children with threshold symptoms of ADHD-IA or ADHD-HI. This problem has been addressed by previous studies, which have demonstrated that children with subthreshold symptoms of ADHD might be as impaired as children who fulfill diagnostic symptom criteria (50, 51). However, more knowledge is required about whether functional impairment, symptom load, or symptom patterns predict further difficulties in this age group.

These children are too young to receive a formal diagnosis of ADHD, and the use of existing nosology could lead to both the overidentification and underidentification of disorders in this age group (52). In addition, the predictive validity of ADHD, ODD, and CD symptoms has been found to be only moderate for 4-year-old preschool children (8,32,53), and no studies have tested the predictive validity of CD symptoms for children less than 4.5 years old. Thus, our knowledge of the developmental trajectories of CD symptoms is still limited. There is a need for the further validation of clinical constructs and the determination of the appropriate criteria for CD in particular, and these are also needed for ADHD and ODD in younger, non-referred preschoolers. Our study requires replication and follow up to make the distinction between children who will have a persistent symptom pattern and those who will have transient symptoms.

Clinical significance

The systematic assessment of impairment related to ADHD is necessary for preschool children, and parental ratings of functional impairment provide useful information about early problems that arise within families. However, rather than being linked to specific settings, parental ratings of functional impairment probably reflect the more global impact of children's symptoms on daily functioning across several settings. Parents' perception of children's behavior as a burden to the family and as contributing to relational difficulties within the family may well indicate early emerging coercive cycles and thereby be an important target for early prevention and intervention strategies. Thus, such assessment is important when identifying children who are at risk.

Minor functional interference was reported in nearly half of children with clinical symptoms of ADHD, but a major proportion of children with symptoms of ADHD-C and those with co-occurring ODD had higher levels of impairment, and they should thus likely be monitored over time.

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