Relationship between ADHD, Oppositional Defiant, Conduct, and Disruptive Mood Dysregulation Disorder Symptoms and Age in Children with ADHD and Autism

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Abstract: No study has simultaneously analyzed externalizing symptoms in children with autism, ADHD-Combined, and ADHD-Inattentive to (1) determine the relationship between oppositional behavior, irritability/anger/tantrums, aggression, conduct problems, inattention, impulsivity, and hyperactivity, (2) compare symptom frequencies between diagnostic groups, and (3) examine symptom frequencies relative to age. Mothers rated 1,436 children with autism and 1,056 with ADHD without autism, 2-17 years, on Pediatric Behavior Scale externalizing symptoms. Results yielded three factors: (1) inattentive, impulsive, and hyperactive, (2) disobedient/defiant, irritable/angry/tantrums, aggressive, and bully, and (3) lies/cheats and steals. Children with autism and children with ADHD-Combined were similar in symptom profiles and more impaired in all areas (except inattention) than children with ADHD-Inattentive. Hyperactivity and aggression decreased with age in ADHD-Combined and autism. Age was not related to any symptoms in ADHD-I. Results support the ICD-11 decision to make irritability/anger an ODD specifier and argue against disruptive mood dysregulation disorder as a stand-alone DSM-5 diagnosis. Results also support including aggression as an ODD specifier. Findings show that most children with autism have ADHD symptoms that should be targeted for evaluation and treatment. Conversely, autism needs to be ruled in or out in children presenting with ADHD symptoms. Inattention, impulsivity, hyperactivity, oppositional behavior, and irritability/tantrums were significant problems for the majority of children with ADHD-Combined and children with autism in all age groups. Because these symptoms are present and measurable during the preschool years and continue to be reported in adolescence, early identification and treatment are critical and may positively affect outcome.

Keywords: Autism, ADHD, oppositional defiant disorder, externalizing problems, age, factor analysis.

EXTERNALIZING SYMPTOMS IN ADHD AND AUTISM

Most children with autism have ADHD, with rates of 59% to 83% across 13 studies [1]. Relatedly, ADHD rating scale and continuous performance attention test scores did not differ significantly between children with ADHD and children with autism [2]. Oppositional behavior, aggression, and irritability are common in children with ADHD-Combined presentation (ADHD-C) and in children with autism. Data from five studies revealed that 51% to 68% of children with autism and children with ADHD-C met criteria for oppositional defiant disorder/ODD [3-7]. Further, maternal ODD ratings were similar for 59 boys with ADHD only and 74 boys with ADHD and autism [8]. Conduct disorder (CD) is less common than ODD in youth with ADHD but still considerably higher than the norm, with rates of 20% to 22% [3, 6]. In another study [7], disruptive mood dysregulation disorder (DMDD) symptoms (i.e., irritability/anger and tantrums) were significantly more prevalent in children with autism (45%) than in children with ADHD-C (39%) who significantly exceeded children with ADHD-Inattentive presentation (ADHD-I) (12%). Children with ADHD-I also have far lower levels of oppositional behavior and conduct problems than children with ADHD-C and children with autism [5, 7, 9-13] and do not differ significantly from typical controls in maternal ratings of oppositional, aggressive, and explosive behavior [10]

AGE AND EXTERNALIZING SYMPTOMS

ADHD Symptoms

Longitudinal studies of children with ADHD show a reduction in ADHD symptoms with age [14-16], characterized by a decrease in hyperactivity and impulsivity more so than inattention [17, 18]. Hart *et al*. (1995) [18] reported that hyperactive-impulsive symptoms declined with age independent of the type and amount of treatment received and conduct symptoms at year 1 of the study predicted the persistence of an ADHD diagnosis. A cross-sectional age analysis of Conners-3 normative data for children 6-18 years also showed a significant decrease with age in parent ratings of inattention and hyperactivity/impulsivity [19]. Similarly, a review of studies indicated decreasing rates of ADHD diagnoses from childhood through adolescence [20]. In contrast, for children with autism 3-21 years of age, a composite parent rating of hyperactivity and inattention was stable across age groups [21].

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ODD/CD Symptoms

Oppositional behavior decreased with age in a cross-sectional analysis of community children ages 9-17 years [22]. In the same study, aggression peaked at 11-13 years and property offenses (e.g., vandalism and fire setting) and status offenses (e.g., truancy, running away, and underage drinking) increased with age [22]. These findings are consistent with a study showing the mean age of onset in boys for oppositional behavior was 6.0 years, aggression 6.8 years, property offenses 7.2 years, and status offenses 9.0 years [23]. Likewise, Conners-3 norms indicated an increase in parent CD symptom ratings with age [19], and a review of studies reported an increase in the prevalence of CD diagnoses with age [24].

Although studies generally show a decrease in oppositional behavior and an increase in CD symptoms with age, the diagnostic picture is complicated somewhat by previous DSM criteria which did not allow a diagnosis of ODD in the presence of CD. A cross-sectional age analysis of over 10,000 children 5-15 years of age indicated that diagnoses of CD increased with age and ODD decreased with age but when the DSM-IV constraint of not diagnosing ODD in the presence of CD was not applied, ODD persisted at similar levels from childhood to adolescence [25].

In a study of children with autism 3-21 years of age, a composite ODD/CD symptom score was not related to age [21]. Similarly, aggression was not associated with age in a study of children with autism 3-14 years [26]. ODD declined with age in a longitudinal study of boys with ADHD, and 11% of those with ODD and no CD at baseline (mean age 11 years) had an ODD diagnosis between 4 and 10 years follow-up, as did 32% of those who had ODD plus CD at baseline [27].

DMDD Symptoms

DSM-5 DMDD symptoms are irritability/anger and tantrums. DMDD symptom scores were not significantly correlated with age in children with ADHD-C, ADHD-I, or autism 6 to 16 years of age, whereas preschool children with ADHD-C and ADHD-I had significantly higher DMDD maternal ratings than school age children, which was not the case for children with autism [28]. Similarly, in community samples, negative mood (sadness, irritability, anger, or low frustration tolerance) was greater in preschool than in school age children [29], but age was not significantly related to over-sensitivity in 3- to 21-year-olds with autism [21].

In a longitudinal study of psychiatric referrals, 53% of those with DMDD symptoms at baseline (6-12 years of age) continued to have DMDD symptoms at 12 months follow-up and 19% had DMDD symptoms at both 12 and 24 months follow-up [30]. In this same study, the stability of DMDD was much less than the stability for ADHD, for which 61% of children with ADHD at baseline had ADHD at both 12 and 24 months follow-up [30]. In a general population longitudinal study, DMDD scores were significantly higher at baseline (mean age 9 years) than follow-up 8 years later, and 29% with DMDD symptoms at baseline continued to have DMDD symptoms at follow-up and 3% had symptoms at both baseline and follow-up [31].

RELATIONSHIP BETWEEN ADHD, ODD, CD, AND DMDD SYMPTOMS

Research suggests that the ODD symptom cluster can be divided into affective symptoms (irritability, anger, and tantrums) and oppositional behavior (disobedient and defiant) representing two independent constructs [32-34]. By definition, ODD and DMDD are related because of overlapping symptoms. DMDD symptoms are irritable/angry mood and temper tantrums, which comprise three of the eight ODD symptoms and are the ODD affective symptoms. In a general population sample, 92% of children with DMDD symptoms had ODD, and 66% of children with ODD had DMDD symptoms, indicating that it is very unlikely to have DMDD without ODD, but that ODD can occur without DMDD [35]. In the same study, ADHD and CD symptoms did not increase the risk of having DMDD beyond that for ODD alone [35].

Correlations between parent reported oppositional behavior, aggression, property offenses, and status offenses in a household survey of 9- to 17-year-olds were all significant for boys and most were for girls, with small to medium correlations of .11 - .37 [22]. A meta-analysis of factor analytic data on 28,401 children [23] supported dividing conduct problems into oppositional behavior, aggression, property violations, and status violations, as well as conceptualizing conduct problems as overt (direct confrontation with the victim) and covert (no confrontation with the victim). Results showed that physical aggression covaried with oppositional behaviors on the overt pole.

Many studies show that children with ADHD are at heightened risk for ODD and CD and vice versa [36]. In boys with ADHD, the presence of ODD at baseline (mean age 11 years) increased the risk of a diagnosis

of CD between 4 and 10 years follow-up [27]. Among children with ADHD 6-17 years of age, 65% had ODD and 22% had CD and 32% of those with ODD had CD [3]. In children with CD, 92% had ODD and 88% had ADHD, consistent with other studies showing that ADHD and ODD are the most common comorbid psychiatric disorders in CD [13]. In a referred sample, children with ADHD-C and children with autism were more likely to be bullies compared to typical controls, children with ADHD-I did not differ from controls in bullying, and the frequency of bullying in ADHD-C (43%) was significantly higher than the 29% prevalence in autism [11].

PURPOSE

No study has yet simultaneously conducted analyses at the symptom level in large samples of children with autism, ADHD-C, and ADHD-I to (1) determine the relationship between symptoms of oppositional behavior, irritability/anger/tantrums, aggression, conduct problems, and ADHD, (2) compare symptom frequencies between diagnostic groups (autism, ADHD-C, and ADHD-I), and (3) examine symptom frequencies relative to age in each diagnostic group. Results will have implications for classifying externalizing disorders in children, understanding comorbid problems associated with established disorders, and generating age-appropriate treatment goals. Diagnoses were based on comprehensive clinical evaluations considering all possible child psychiatric diagnoses. This is important because many children with autism are initially diagnosed with only ADHD without ruling in or out autism [37, 38]. Most prior studies also failed to analyze ADHD-C and ADHD-I separately, which is critical because of significant differences in symptom profiles and comorbidity between the two subtypes.

METHODS

Sample

The study was approved by the Institutional Review Board, which waived informed consent because analyses were conducted retrospectively on existing clinical data. The sample comprised 2,492 children referred to a psychiatry diagnostic clinic, including 1,436 with autism (with or without ADHD) and 1,056 with ADHD without autism. The children were 2-17 years of age (*M* = 7.4, *SD* = 3.2), and IQs ranged from 9 to 149 (*M* = 96.6, *SD* = 22.5). In all, 90.7% were white, 74.1% were male, 36.6% had a parent with a professional or managerial occupation, and 33.8% were treated with a psychotropic medication. Demographic data for each diagnostic group are reported in Table **1**.

All children underwent a diagnostic evaluation by a licensed PhD psychologist. The evaluation included a diagnostic interview with the parents, parent and teacher questionnaires and rating scales (Pediatric Behavior Scale, PBS) [39], review of educational records, administration of psychological tests (IQ, achievement, and neuropsychological), and clinical observations of the child during the evaluation. All children in the ADHD group had a DSM-IV or DSM-5 (whichever version was current when the child was evaluated) diagnosis of ADHD and fulfilled the following criteria: (1) symptoms of ADHD observed during psychological testing and (2) ratings of short attention span or distractible as often or very often a problem on the PBS by at least two raters (mother, father, teacher). Children were classified with ADHD-C if the median mother, father, and teacher rating on the PBS impulsive and hyperactive items was often or very often a problem. Children were classified with ADHD-I if the median impulsive and hyperactive rating was less than often a problem.

Table 1: Demographic Data for Children with Autism, ADHD-C, and ADHD-I

	Autism *n* **= 1,436**	**ADHD-C** *n* **= 747**	**ADHD-I** *n* **= 309**	F/χ^2	*p*	*ϕ/M d*
Age *M (SD)*	6.6 (3.3)	8.2 (2.7)	9.2 (2.8)	128.6	<.0001	0.54
IQ *M (SD)*	92.1 (24.9)	102.7 (17.0)	103.0 (16.8)	72.6	<.0001	0.32
Male	79.0%	72.0%	56.3%	70.9	<.0001	0.17
Parent occupation[1]	34.1%	36.7%	48.5%	23.0	<.0001	0.10
White	90.6%	90.1%	92.9%	2.1	1.0	0.03
On psychotropic medication	34.1%	38.9%	20.4%	33.5	<.0001	0.12

[1]One or both parents have a professional or managerial position.

Children in the autism sample had a DSM-IV or DSM-5 diagnosis of autism (i.e., autistic disorder, Asperger's disorder, or autism spectrum disorder) and a score in the autism range on the Checklist for Autism Spectrum Disorder (CASD) [40]. The CASD is a 30-item diagnostic measure normed and standardized on 2,469 children (1-18 years, IQs 9-146) with autism, other clinical disorders, and typical development [40]. In the national standardization study, the CASD identified children with and without autism with 99.5% accuracy. The CASD differentiates children with autism from children with intellectual disability, learning disability, traumatic brain injury, language disorder, ADHD, ODD, anxiety disorder, apraxia of speech, and reactive attachment disorder [40-42]. Concurrent validity is strong with high diagnostic agreement (93%-98%) between the CASD and the Childhood Autism Rating Scale, the Gilliam Asperger's Disorder Scale, and the Autism Diagnostic Interview-R [43, 44]. Children with autism who also had ADHD symptoms were only included in the autism sample. These children were not given an additional clinical diagnosis of ADHD because the DSM-IV did not permit an ADHD diagnosis with autism. In the autism sample, 79.5% had elevated (often or very often a problem) maternal ratings on the PBS total ADHD subscale (ADHD-C) and 9.1% had elevated ratings on attention deficit but not on impulsivity/hyperactivity (ADHD-I).

Instrument and Variables

The 165 items on the PBS were rated by mothers on a 4-point scale (0 = almost never or not at all, 1 = sometimes, 2 = often, and 3 = very often a problem). The PBS assesses multiple areas of psychopathology including ODD, CD, irritability/anger, ADHD, anxiety, and depression. The PBS corresponds well with established measures of psychopathology [45, 46] and has been used to diagnose and differentiate psychological problems in several published studies [2, 10, 47-50]. The nine PBS symptom scores analyzed in this study were inattentive (short attention span/distractible), impulsive, hyperactive, disobedient/defiant, irritable/angry/tantrums, physically aggressive (e.g., hits, bites, or throws things at people), bully/mean/cruel/starts fights, lies/cheats, and steals.

Data Analyses

Inter-relationships between symptom raw scores were determined with Pearson correlations and factor analysis (principal axis factoring with an oblique rotation). Differences in symptom scores between the three diagnostic groups (autism, ADHD-C, and ADHD-I) were investigated with ANCOVA, post hoc *t*-tests, and Cohen's *d*. Linear relationships between age and symptom scores were explored using partial correlations and explained variance. Because of significant differences between diagnostic groups on most demographic variables (Table **1**), the significant variables were covaried in ANCOVA when comparing differences in symptom scores between diagnostic groups. Within the autism, ADHD-C, and ADHD-I samples, children prescribed psychotropic medication were older than children not treated with medication (t = 3.37 - 17.8, $p < .01$). Therefore, psychotropic medication status was controlled using partial correlations when correlating age and symptom scores. Age was not significantly ($p > .01$) related to demographic variables in the autism, ADHD-C, and ADHD-I samples, including IQ (r = .00 - .08), sex (t = 0.46 - 1.59), race (t = 0.5 - 2.7), and parent occupation (t = 0.3 - 2.5). Symptom raw scores did not differ significantly between girls and boys within each diagnostic group (t = 0.2 - 2.5, $p > .05$), so data for girls and boys were combined in the analyses. All reported *p*-values are 2-tailed and were interpreted using a Bonferroni correction for the number of comparisons made.

RESULTS

Relationships between Symptom Scores

Factor analysis using the nine symptom scores in the total sample (Table **2**) yielded three discrete factors without symptom cross loading. The factors were (1) oppositional defiant disorder (disobedient/defiant and irritable/angry/tantrums) plus aggression (physically aggressive and bully/mean/cruel/starts fights), (2) ADHD (inattentive, impulsive, and hyperactive), and (3) covert conduct disorder symptoms (lies/cheats and steals). Correlations between the three factors were significant and moderate (.37 - .45), and correlations between the nine symptom scores were all significant ($p < .0001$). Correlations were the lowest between inattentive and all other scores (.10 - .27), except for medium to large correlations between inattentive and impulsive (r = .44) and hyperactive (r = .41). Correlations between lying and stealing were large (r = .52), but were small to medium (median .26) between all other symptom scores.

Symptom Frequencies by Diagnosis and Age

Symptom frequencies (almost never or not at all vs. sometimes vs. often or very often a problem) for

Table 2: Factor Loadings for the Total Sample (*N* = 2,492)

	Factor		
	ADHD	**ODD/Aggressive**	**Lies/Steals**
Inattentive	.67	-.13	.05
Impulsive	.63	.13	.10
Hyperactive	.61	.19	-.11
Disobedient/defiant	.22	.52	.19
Irritable/angry/tantrums	.14	.65	.03
Aggressive	-.04	.80	-.09
Bully/mean/cruel/fights	-.05	.72	.20
Lies/cheats	.03	-.06	.95
Steals	.00	.10	.51

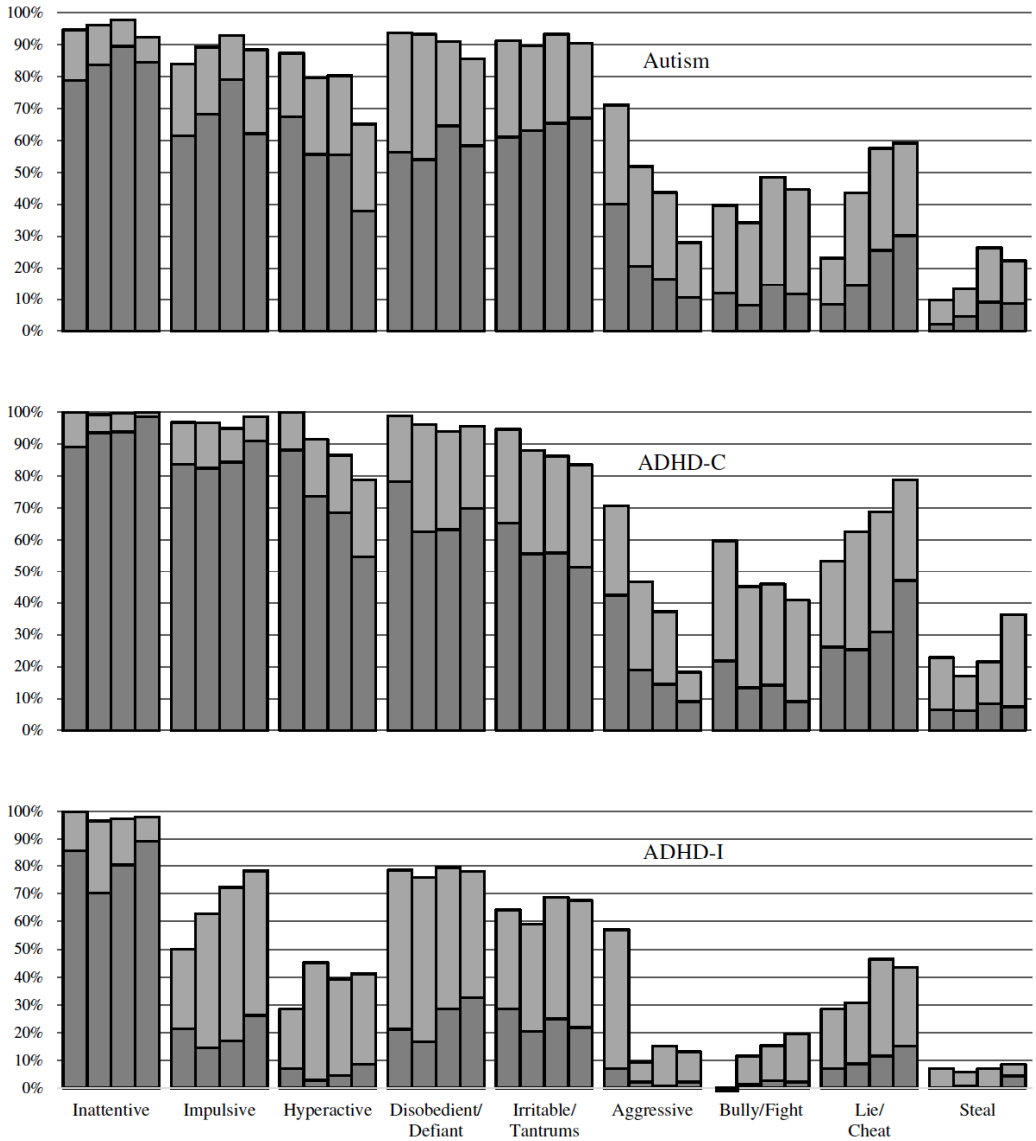

Figure 1: Key: For each problem, the first column depicts 2-5 years, followed by 6-8 years, 9-12 years, and 13-17 years. For each bar, the darker portion represents often or very often a problem and the lighter part represents sometimes a problem. Note: For ADHD-I, 0% were rated as sometimes or more a bully in the 2-5 year group.

Table 3: Mean Symptom Scores[1] for Children with Autism, ADHD-C, and ADHD-I

	Autism *M (SD)*	ADHD-C *M (SD)*	ADHD-I *M (SD)*	*F*[3]	post hoc[2]
Inattentive	2.14 (0.87)	2.42 (0.67)	1.96 (0.81)	41.1	C>A, I
Impulsive	1.91 (1.04)	2.26 (0.82)	0.91 (0.82)	194.7	C>A>I
Hyperactive	1.77 (1.12)	2.02 (0.99)	0.48 (0.63)	191.1	C>A>I
Disobedient/defiant	1.51 (0.87)	1.67 (0.84)	0.90 (0.72)	73.8	C>A> I
Irritable/angry/tantrums	1.64 (0.94)	1.49 (0.96)	0.74 (0.76)	93.4	A>C> I
Aggressive	0.94 (0.99)	0.70 (0.93)	0.16 (0.42)	28.3	A, C> I
Bully/mean/cruel/fights	0.57 (0.70)	0.65 (0.72)	0.19 (0.40)	34.6	A, C> I
Lies/cheats	0.58 (0.87)	1.03 (0.96)	0.51 (0.75)	49.3	C>A> I
Steals	0.21 (0.55)	0.30 (0.66)	0.08 (0.30)	12.8	A, C> I

[1]0 = almost never or not at all, 1 = sometimes, 2 = often, 4 = very often a problem.
[2]Bonferroni *t*-test comparisons $p < .05$, A = autism, C = ADHD-C, I = ADHD-I.
[3]All *F*-values $p < .0001$ with a Bonferroni correction.

children with autism, ADHD-C, and ADHD-I are presented in Figure **1**.

Differences in Symptom Scores between Diagnostic Groups

As shown in Table **3**, children with ADHD-I had significantly lower symptom scores than children with ADHD-C and children with autism in all nine areas except for a nonsignificant difference between ADHD-I and autism on inattention. The majority of effect sizes for the significant differences were large (median d = 0.85). Children with ADHD-C scored significantly higher than children with autism on inattentive, impulsive, hyperactive, disobedient/defiant, and lies/cheats. Effect sizes were generally small (d = 0.19 - 0.49, median = 0.36). Children with autism were significantly higher on irritable/tantrums than children with ADHD-C, but the effect size was small (d = 0.16). Children with ADHD-C and autism did not differ significantly on aggression, bully, and steals.

Symptom Scores and Age

The linear relationship between age and symptom scores for children with autism was statistically significant for four symptoms, indicating a decrease in hyperactivity and aggression and an increase in lying/cheating and stealing with increasing age (Table **4**). For children with ADHD-C, the linear relationship between age and symptom scores was significant for four symptoms, indicating a decrease in hyperactivity, aggression, and irritability/tantrums and an increase in lying/cheating with increasing age. Significant correlations in children with autism and children with ADHD-C were small to medium (.08-.32), explaining 0.6% to 10.2% of the variance. None of the correlations between age and symptom scores were significant in children with ADHD-I.

Table 4: Correlations between Age and Symptom Scores

	Autism	ADHD-C	ADHD-I
Inattentive	-.01	.06	.12
Impulsive	.00	-.02	.11
Hyperactive	-.27[1]	-.24[1]	.00
Disobedient/defiant	-.05	-.03	.08
Irritable/angry/tantrums	-.05	-.12[1]	.03
Aggressive	-.32[1]	-.29[1]	-.12
Bully/mean/cruel/fights	-.04	-.09	.07
Lies/cheats	.23[1]	.16[1]	.14
Steals	.08[1]	.06	.05

[1]$p < .05$ with a Bonferroni correction.

DISCUSSION

Relationship between Symptoms

Factor analysis revealed several important findings. Three distinct factors emerged without symptom cross loading: (1) ADHD symptoms (inattentive, impulsive, and hyperactive), (2) ODD symptoms plus aggression (disobedient/defiant, irritable/angry/tantrums, aggressive, and bully/mean/cruel/starts fights), and (3) lies/cheats and steals. These results provide support for the separate DSM diagnostic categories of ADHD, ODD, and CD, except that bully/mean/cruel/starts fights

and physical aggression loaded with the ODD symptoms and not with the other CD symptoms (lies and steals). These findings are consistent with the position that conduct problems can be separated and characterized as overt (e.g., aggression and bullying) and covert (e.g., lying and stealing). Our findings are overall compatible with a meta-analysis of factor analytic studies involving 28,401 children conducted more than 25 years ago indicating that aggression loads with ODD symptoms and that overt and covert CD symptoms are distinct from each other. [23]

Physical aggression and bully/mean/cruel/starts fights covaried strongly with the ODD symptoms and weakly with the ADHD and covert CD symptoms in our study, which was also found by Frick *et al*. [23]. Further, Turgay [13] reported that 77% of children with ODD displayed physical aggression and 93% of children referred with serious aggressive behavior had ODD. This raises the question of whether aggression should be an ODD specifier in the DSM and International Classification of Diseases (ICD). Our findings showed that the ODD behavioral symptoms (disobedient/defiant) and affective symptoms (irritable/angry and tantrums) occurred at similarly high rates, whereas aggression (which is not an ODD symptom) was much less frequent. Therefore, if aggression is included with ODD in future versions of the DSM and ICD, it might more aptly be considered an ODD specifier rather than an ODD symptom.

DMDD symptoms (i.e., irritable/angry and tantrums) covaried strongly on the ODD plus aggression factor. This argues against DMDD as a stand-alone DSM-5 diagnosis and supports the decision of the ICD-11 to make irritability/anger an ODD specifier and not include DMDD as a separate diagnosis. The ICD-11 decision was based on the results of several studies reviewed by an international panel of experts [33, 51]. Studies show that almost all children who have DMDD symptoms have ODD [7, 30, 35], but approximately one-third of children with ODD do not have DMDD symptoms [31, 35, 52]. These findings also argue against the DSM-5 rule prohibiting a diagnosis of ODD and allowing only a diagnosis of DMDD when a child meets criteria for both ODD and DMDD. Strict adherence to this rule may result in failure to identify and provide intervention for clinically significant oppositional behavior. This is problematic because these children are left with a diagnosis of DMDD that has not yet been proven valid or reliable and for which interventions are not empirically established, in contrast to ODD (which includes DMDD symptoms) which has evidence-based interventions [53, 54].

Factor analysis demonstrated that the three ADHD symptoms (inattention, impulsivity, and hyperactivity) loaded highly together separate from other externalizing problems, despite the fact that ADHD-C and ADHD-I are distinct subtypes. Inattention had the lowest correlations with all symptoms other than impulsivity and hyperactivity, suggesting that inattention itself is not an externalizing symptom, even though it occurs in conjunction with impulsivity and hyperactivity.

Differences in Externalizing Symptoms between Diagnostic Groups

Children with autism and children with ADHD-C were markedly similar to each other and distinct from ADHD-I in symptom profiles and comorbidity. Children with ADHD-I had significantly lower symptom scores than children with ADHD-C and children with autism on all symptom scores with large effect sizes. The only exception was a nonsignificant difference between ADHD-I and autism on inattention. These findings are consistent with other studies showing that children with ADHD-I (in comparison to ADHD-C and/or autism) had fewer ODD symptoms and conduct problems [5, 9, 10-13, 49, 55-57] and fewer DMDD symptoms [7]. Further, children with ADHD-I did not differ from typical controls on maternal ratings of oppositional, aggressive, and explosive behavior [10]. Studies also indicated that children with ADHD-I (vs. ADHD-C) were less severely impaired [56, 58], had fewer sleep problems [59, 60], had greater daytime sleepiness [59, 61], had slower processing speed on cognitive tests [62], and were less likely than children with ADHD-C and children with autism to be treated with a psychotropic medication [63]. These significant differences in comorbidity between ADHD-C and ADHD-I underscore the importance of analyzing the two ADHD subtypes separately in future research, which typically is not done.

Notably, children with ADHD-C and autism in our study did not differ from each other on physical aggression, bullying, and stealing. Some differences were found, including more irritability/tantrums in autism and more inattention, impulsivity, hyperactivity, disobedience/defiance, and lying/cheating in ADHD-C. However, effect sizes were small, suggesting minimal clinically significant differences in externalizing symptoms between ADHD-C and autism. Although

ADHD symptoms were more severe in children with ADHD-C than in autism, 89% of children with autism had significantly elevated maternal ADHD ratings. Therefore, it is important to recognize that most children with autism have ADHD symptoms that should be targeted for evaluation and treatment. Conversely, autism needs to be assessed and ruled in or out in children presenting with symptoms of ADHD so, if present, evidence-based autism intervention can be provided.

Relationship between Age and Externalizing Symptoms

For children with ADHD-I, inattention was high in all age groups but all other ADHD and externalizing symptoms were infrequent (occurring in one-third or fewer of children in all age groups) and correlations between age and the ADHD and externalizing symptoms were all nonsignificant. In contrast, in both ADHD-C and autism, increasing age was moderately associated with decreasing hyperactivity, but age was not related to impulsivity and inattention. Our findings present new information because previous studies investigating the relationship between age and ADHD symptoms did not consider the three core symptoms and the ADHD subtypes separately. A review by Willcutt *et al*. [64] indicated that the subtypes of ADHD-C and ADHD-I were not stable over time because children initially diagnosed with ADHD-C were equally likely to have ADHD-C and ADHD-I at follow-up 5-9 years later, whereas most children initially diagnosed with ADHD-I had ADHD-I at follow-up or no longer met criteria for ADHD. This is consistent with our finding of decreasing hyperactivity with age.

For children with ADHD-C and children with autism, aggression decreased with age, ODD symptoms (disobedience/defiance and irritability/tantrums) were relatively stable across age groups, and lying/cheating in autism and ADHD-C and stealing in autism increased with age. Symptoms associated with DSM conduct disorder (physical aggression, bullying/fighting, lying/cheating, and stealing) were infrequent compared with the ADHD and ODD symptoms and were rated as often or very often a problem for only a minority of children in all age groups. These findings are consistent with the lower prevalence of CD than ODD found in children with ADHD [3, 6].

LIMITATIONS

Our study has several limitations. Symptom scores were based exclusively on maternal report, age analyses were cross-sectional and not longitudinal, and the samples were from a single clinical site. Therefore, study findings need to be replicated with other samples and should include longitudinal data and additional measures of externalizing problems reported by multiple informants. Our participants were from a psychiatry diagnostic clinic, so the sample is likely to have more severe behavior problems than nonreferred children with autism and/or ADHD. Although psychotropic medication status was controlled in our statistical analyses, medication is a potentially confounding factor that needs to be investigated in future studies, particularly the influence of specific medications on externalizing symptoms.

CONCLUSIONS

Children with ADHD-C and children with autism were markedly similar in their symptom profiles, and almost all children with autism had ADHD. Core ADHD diagnostic features and associated comorbid ODD symptoms were apparent in 2- to 5-year-olds with ADHD-C and with autism, and inattention, impulsivity, oppositional behavior, irritability/anger, and tantrums were reported as often or very often a problem for the majority of children with ADHD-C and with autism in all age groups from 2 to 17 years. Because these prominent and impairing symptoms are present and measurable during the preschool years and continue to be problematic in adolescence, early identification and treatment are critical with the goal of improving long-term outcome.

COMPLIANCE WITH ETHICAL STANDARDS

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

The study was approved by the Institutional Review Board which waived informed consent because the study is a retrospective review of existing clinical data.

Conflicts of interest

The authors declare they have no conflicts of interest.

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