# Clinical Significance of Tics and Attention-Deficit Hyperactivity Disorder (ADHD) in Children With Pervasive Developmental Disorder

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*Original Article*

# Clinical Significance of Tics and Attention-Deficit Hyperactivity Disorder (ADHD) in Children With Pervasive Developmental Disorder

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**ABSTRACT**

The goal of this study was to examine the clinical significance of co-occurring tics and attention-deficit hyperactivity disorder (ADHD) as indicators of a more complex symptomatology in children with and without pervasive developmental disorder. Parents and teachers completed a *Diagnostic and Statistical Manual of Mental Disorders-IV*–referenced rating scale for 3- to 5- ($n$ = 182/135) and 6- to 12- ($n$ = 301/191) year-old children with pervasive developmental disorder and clinic controls, respectively. The percentage of children with tic behaviors varied with age: preschoolers (25%, 44%) versus elementary schoolchildren (60%, 66%) (parent and teacher ratings, respectively). For many psychiatric symptoms, screening prevalence rates were highest for the ADHD + tics group and lowest for the group with symptoms of neither, but the pattern of group differences varied by age group and informant. In general, there were few differences between the ADHD only and tics only groups. The pattern of ADHD/tic group differences was similar for both children with and without pervasive developmental disorder. We concluded that these findings support the notion that the co-occurrence of ADHD and tics is an indicator of a more complex psychiatric symptomatology in children with pervasive developmental disorder. (*J Child Neurol* 2005;20:481–488).

For at least two decades, investigators have commented on a possible relationship between pervasive developmental disorders and tic disorders.[1–6] Researchers suggest that the co-occurrence of these two disorders might constitute a unique clinical entity and that the two disorders possibly share causal mechanisms, but it is also possible that there is a tic disorder phenocopy in pervasive developmental disorder.[5,7–11] There is only one large-scale study of the prevalence of Tourette syndrome in pervasive developmental disorder, which involved 447 children from nine schools for children with autism.[12] Family interviews indicated that 6.5% met the criteria (definite or probable) for a diagnosis of Tourette syndrome.

Although there is a voluminous literature supporting a relationship between tic disorder and co-occurring psychiatric symptoms in other groups, this topic has received scant attention in children with pervasive developmental disorder.[13–22] This is due in part to the controversy surrounding the existence of psychiatric disorders in this clinical population.[23–26] Nevertheless, the findings of recent large-scale studies of 3- to 5- and 6- to 12-year-old children evaluated in a developmental disabilities clinic demonstrate high rates of *Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV)* symptomatology.[27,28] In fact, the percentage of children with pervasive developmental disorder receiving screening cutoff scores for specific disorders was similar to or higher than rates for children without pervasive developmental disorder evaluated in a child psychiatry outpatient service. A comparable number of pervasive developmental disorder (56%) and non–pervasive developmental disorder (62%) clinic–referred 6- to 12-year-old boys, for example, met symptom count criteria for attention-deficit hyperactivity disorder (ADHD) according to their teachers. Furthermore, teachers rated the severity of motor and vocal tics higher in children with pervasive developmental disorder. Additional studies have also provided evidence supporting the existence of an ADHD syndrome and, more importantly, ADHD subtypes in children with pervasive developmental disorder.[29]

The co-occurrence of ADHD and tic disorder and their relationship to other psychiatric symptoms is well documented in non–pervasive developmental disorder samples.[19,20,30–32] For example, Gadow et al studied 3006 public schoolchildren (ages 3 to 18 years) with a teacher-completed, *DSM-IV*–referenced rating scale that contained two items pertaining to motor and vocal tics.[31] Children were divided into four groups: ADHD ± tics, tics only, and symptoms of neither. Findings indicated that oppositional defiant disorder, conduct disorder, and dysthymia symptoms were mostly associated with ADHD behaviors, whereas obsessive-compulsive and specific phobia symptoms were more associated with tics. In general, impairment from most to least was as follows: ADHD + tics > ADHD only > tics only > symptoms of neither. Specific findings were consistent with prior studies of clinic-referred patients.[5,13–18,20,22]

Given the growing literature on the importance of ADHD in understanding differences between subgroups of individuals with tic disorder, the present study compared four groups of children with pervasive developmental disorder: ADHD ± tics, tics only, and symptoms of neither.[20,30] It was modeled on our previous investigations of these disorders in community- and non–pervasive developmental disorder clinic–based samples.[19,31] We predicted that the general pattern of obtained relationships between ADHD, tics, and co-occurring symptomatology would share many similarities with findings for children without pervasive developmental disorder. We also expected to show important informant-related variation in the pattern of group differences, which supports the value of examining source-specific syndromes.[27–29,33,34]

## METHOD

### Participants

Children were consecutive referrals (1994–2002) to a university hospital developmental disabilities specialty clinic (pervasive developmental disorder sample) and a child psychiatry outpatient service (non–pervasive developmental disorder sample) located on Long Island, New York. Children were separated into two age groups: 3 to 5 years and 6 to 12 years. Their demographic and background characteristics are presented in Table 1. Both samples are also described in other publications.[27,28,35] A university Institutional Review Board approved this retrospective chart review study, and appropriate measures were taken to protect patient (and rater) confidentiality.

Pervasive developmental disorder diagnoses were made according to *DSM-IV* criteria (see Table 1) and were based on a comprehensive developmental history of language and social development and inflexible or repetitive behaviors that was obtained from a structured questionnaire completed prior to intake and clinician interview, direct observations of the child in the clinic, and a review of parent- and teacher-completed rating scales and previous records (see Procedure). Expert pervasive developmental disorder diagnoses were made by a child psychiatrist (or his supervisee) who had more than 20 years of clinical and research experience with pervasive developmental disorder. In the *DSM-IV* Autism Field Trial, Klin et al reported that agreement for expert diagnosticians was excellent: autism versus non–pervasive developmental disorder (kappa = 1.00), autism versus other (kappa = .94), and autism versus nonautistic pervasive developmental disorder (kappa = .85).[36] We assessed the interrater reliability of our expert pervasive developmental disorder diagnoses in a subsample of 45 randomly selected 3- to 5-year-old children with and without pervasive developmental disorder.[35] Charts were "edited" to exclude mention of initial diagnoses, and a second clinician classified the children according to *DSM-IV* criteria. Interrater agreement for pervasive developmental disorder was excellent (kappa = .90).

In the pervasive developmental disorder sample, comparisons between age groups indicated no significant differences in gender, IQ, ethnicity, socioeconomic status, income level, or single-parent household. Only medication use was higher in 6 to 12 versus 3 to 5 year olds.

### Procedure

Prior to scheduling the clinic evaluation, the parents of potential patients were mailed a packet of materials including behavior rating scales for both parents and teachers to complete, a background information questionnaire, and permission for release of school records. Parents were required to complete and return their forms and distribute school materials prior to

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**Table 1. Group Characteristics**

| | *PDD Sample* | | *Non-PDD Sample* | |
|---|---|---|---|---|
| *Variable* | *3–5 yr (n = 182)* | *6–12 yr (n = 301)* | *3–5 yr (n = 135)* | *6–12 yr (n = 191)* |
| Age, mean (SD) | 4.2 (0.8) | 8.3 (1.9) | 4.6 (0.6) | 8.7 (2.0) |
| Gender (males: frequency/%) | 144 (79) | 254 (84) | 99 (73) | 136 (71) |
| IQ, mean (SD) | 79 (22.7) (*n* = 122) | 87 (25.4) (*n* = 244) | 92 (14.4) (*n* = 58) | 98 (15.8) (*n* = 82) |
| Ethnic status (frequency/%) | | | | |
| Caucasian | 171 (96) | 279 (94) | 111 (82) | 159 (86) |
| African-American | 2 (1) | 8 (3) | 13 (10) | 17 (9) |
| Hispanic-American | 4 (2) | 5 (1.5) | 10 (7) | 6 (3) |
| Other | 2 (1) | 5 (1.5) | 1 (1) | 3 (2) |
| Special education (frequency/%) | 167 (91) | 249 (83) | 70 (52) | 63 (33) |
| Medication (frequency/%) | 12 (7) | 112 (38) | 13 (10) | 27 (14) |
| SES (frequency/%) | *n* = 171 | *n* = 299 | *n* = 100 | *n* = 176 |
| Lower (1–3) | 14 (8) | 28 (9) | 18 (18) | 42 (24) |
| Middle (4–6) | 88 (49) | 142 (48) | 47 (47) | 94 (53) |
| Upper (7–9) | 79 (43) | 129 (43) | 35 (35) | 40 (23) |
| Income level,* mean (SD) | 4.3 (1.0) | 4.2 (0.9) | 3.1 (1.5) | 3.4 (1.2) |
| Single parent (frequency/%) | 15 (8) | 40 (13) | NA | 42 (24) |
| PDD subtype | | | | |
| Autistic disorder | 67 (37) | 103 (34) | NA | NA |
| Asperger's syndrome | 24 (13) | 80 (27) | NA | NA |
| PDD-NOS | 91 (50) | 118 (39) | NA | NA |

NA = not applicable; PDD = pervasive developmental disorder; PDD-NOS = pervasive developmental disorder not otherwise specified; SES = socioeconomic status assessed with Hollingshead's (1975) 9-point index of occupational status.[47]
*Income level (low =1, high =5).

the first appointment. In most cases (94%), the child's mother completed the ratings. Clinical evaluations included interviews with the children and their caregivers; informal observation of parent-child interaction; school reports, psychoeducational and special education evaluations; a questionnaire of developmental, educational, medical, and family histories; and scores from several parent- and teacher-completed behavior rating scales. These included the *DSM-IV*–referenced Early Childhood Inventory-4 (ECI-4) and the Child Symptom Inventory-4 (CSI-4).[37–39]

## Measures

Early Childhood Inventory-4/Child Symptom Inventory-4 items represent *DSM-IV* symptoms, and they are scored in two different ways: screening cutoff (categorical) and symptom severity (dimensional) scores. If the number of symptoms rated as being of concern for a specific disorder is equal to or greater than the minimum number of symptoms necessary for a *DSM-IV* diagnosis, then the child receives a screening cutoff score for that symptom category. The symptom severity score is the sum of items scored from 0 to 3 (0 = never, 3 = very often). Although these measures contain the behavioral symptoms of specific disorders, they do not include additional diagnostic criteria such as age at onset of symptoms or impairment of functioning. For this and other reasons, screening cutoff scores do not signify a clinical diagnosis.

In addition to ADHD, symptom categories include oppositional defiant disorder, conduct disorder, generalized anxiety disorder, separation anxiety disorder (parent only), social phobia, major depressive disorder, dysthymic disorder, mania (6 to 12 year olds), and the triad of pervasive developmental disorder symptoms: social deficits, language deficits, and perseverative behaviors (ie, restricted, repetitive, stereotyped behaviors), which are scored for autistic disorder and Asperger's syndrome. There are also individual screening items for simple phobia, obsessions, compulsions, and motor and vocal tics.

Research indicates that the Early Childhood Inventory-4/Child Symptom Inventory-4 demonstrate satisfactory internal consistency (Cronbach's alpha), reliability, and convergent and discriminant validity in community-based normative, clinic-referred non–pervasive developmental disorder and pervasive developmental disorder samples.[27,28,33,35,37–41] Early Childhood Inventory-4/Child Symptom Inventory-4 screening cutoff scores exhibit moderate to high sensitivity for screening disruptive behavior disorders and pervasive developmental disorder and relatively high specificity for most disorders when compared with data-based clinical diagnoses. Early Childhood Inventory-4/Child Symptom Inventory-4 scores show little relation to age, IQ, or socioeconomic status.

## Subgrouping

Children were sorted into one of four groups based on their Early Childhood Inventory-4/Child Screening Inventory-4 screening cutoff scores: ADHD + tics, ADHD only, tics only, and neither disorder (comparison group). ADHD symptom categories consist of three subtypes: inattentive, hyperactive-impulsive, and combined type; the screening cutoff scores for these categories are ADHD inattentive, ≥ 6; ADHD hyperactive-impulsive, ≥ 6; and ADHD combined ≥ 6 for both inattentive and hyperactive-impulsive subtypes. These cutoff scores were derived from *DSM-IV* diagnostic criteria, and comparisons with chart diagnoses support their clinical utility as a screening procedure.[33,35,39,41] Children who met the criterion for any ADHD symptom category were placed into one of the ADHD groups.

The cutoff score for the motor and vocal tic items is a frequency of occurrence rating of at least "sometimes," which is based on comparisons between symptom inventory ratings and chart diagnoses of chronic tic disorder.[39] In other words, a cutoff score of "often" was too restrictive because it missed diagnosed cases. Because a screening instrument needs to maximize sensitivity, it was better to err on the side of identifying as many true-positives as possible.[42] Children who met the criterion for motor or vocal tics or both were placed into one of the tic groups.

Group classifications were conducted separately for parent and teacher ratings for each age group. There was little overlap in parent- and teacher-defined symptom groupings of children with pervasive developmental disorder. For 3 to 5 year olds, of the total number of children classified as parent defined versus teacher defined, the percentage of children in common was as follows: ADHD + tics, 9% (*n* = 12, kappa = .27); ADHD only, 10% (*n* = 14, kappa = .22); tics only, 3% (*n* = 4, kappa = .12); and symptoms of

**Table 2. Means (SD) and Comparison Statistics for Parent Ratings of Parent-Defined Symptom Groups**

| *Variable* | *ADHD + T* | *ADHD Only* | *Tics Only* | *NONE* | *F Ratio* | *Post hoc Comparisons* |
|---|---|---|---|---|---|---|
| 3–5 year olds | *n* = 21 | *n* = 46 | *n* = 20 | *n* = 76 | | |
| ODD | 8.5 (6.5) | 7.4 (4.5) | 5.7 (3.6) | 3.7 (3.3) | 11.32*** | ADHD +T, ADHD > NONE |
| CD | 1.8 (2.9) | 1.5 (2.2) | 1.0 (1.3) | 0.3 (1.0) | 6.5*** | ADHD > NONE |
| GAD | 6.0 (2.6) | 6.0 (3.4) | 5.4 (2.7) | 3.3 (3.9) | 3.4* | ADHD > NONE |
| MDD | 6.1 (3.9) | 5.0 (3.3) | 4.2 (1.6) | 3.5 (1.4) | 7.4*** | ADHD +T, ADHD > NONE |
| Dysthymia | 4.5 (2.9) | 3.8 (2.6) | 2.8 (1.6) | 2.6 (1.1) | 7.8*** | ADHD +T, ADHD > NONE |
| Social deficits | 8.8 (3.2) | 6.4 (3.5) | 6.6 (2.9) | 4.8 (3.0) | 9.4*** | ADHD +T > ADHD > NONE |
| Perseverative behaviors | 6.8 (3.3) | 4.4 (2.7) | 4.9 (2.8) | 3.6 (2.3) | 8.3*** | ADHD +T > ADHD, NONE |
| 6–12 year olds | *n* = 114 | *n* = 53 | *n* = 48 | *n* = 58 | | |
| ODD | 10.4 (6.5) | 8.9 (6.2) | 6.8 (5.5) | 5.1 (3.9) | 12.0*** | ADHD +T >T, NONE; ADHD > NONE |
| CD | 2.0 (3.2) | 1.1 (2.0) | 0.7 (1.3) | 0.4 (0.8) | 7.5*** | ADHD +T >T, NONE |
| GAD | 5.6 (4.2) | 4.7 (3.2) | 4.6 (3.6) | 2.8 (2.9) | 7.4*** | ADHD +T, ADHD, T > NONE |
| SAD | 3.3 (4.2) | 2.5 (2.9) | 2.8 (3.9) | 1.1 (1.7) | 5.1** | ADHD +T, ADHD, T > NONE |
| Specific phobia | 0.6 (0.5) | 0.5 (0.5) | 0.8 (0.4) | 0.5 (0.5) | 4.1** | T > ADHD, NONE |
| OCD | 1.5 (1.5) | 1.0 (1.2) | 1.6 (1.5) | 0.4 (0.7) | 10.6*** | ADHD +T, ADHD, T > NONE |
| MDD | 6.1 (4.3) | 5.2 (2.8) | 4.9 (4.2) | 3.5 (2.6) | 6.3*** | ADHD +T, ADHD > NONE |
| Dysthymia | 5.9 (4.1) | 5.0 (3.4) | 4.4 (4.1) | 3.3 (2.8) | 6.3*** | ADHD +T, ADHD > NONE |
| Manic episode | 8.0 (6.2) | 5.4 (5.5) | 4.8 (4.5) | 2.1 (2.6) | 9.6*** | ADHD +T >T > NONE; ADHD > NONE |
| Social deficits | 6.8 (3.3) | 6.2 (3.1) | 6.3 (3.3) | 4.4 (3.2) | 7.2*** | ADHD +T, ADHD, T > NONE |
| Perseverative behaviors | 5.9 (3.0) | 5.1 (2.7) | 6.4 (3.4) | 3.9 (2.6) | 7.8*** | ADHD +T, T > NONE |

ADHD = attention-deficit hyperactivity disorder; CD = conduct disorder; GAD = generalized anxiety disorder; MDD = major depressive disorder; NONE = symptoms of neither disorder; OCD = obsessive-compulsive disorder; ODD = oppositional defiant disorder; SAD = separation anxiety disorder; T = tics.
*$P < .05$; **$P < .01$; ***$P < .001$.

neither, 23% ($n$ = 32, kappa = .22). For 6 to 12 year olds, of the total number of children classified as parent defined versus teacher defined, the percentage of children in common was as follows: ADHD + tics, 20% ($n$ = 52, kappa = .18); ADHD only, 7% ($n$ = 18, kappa = .26); tics only, 7% ($n$ = 18, kappa = .12) and symptoms of neither, 6% ($n$ = 15, kappa = .11).

### Statistical Analyses

Student $t$-tests were used to compare children with pervasive developmental disorder with and without tic disorder on parent and teacher ratings of symptom severity. Chi-square tests (categorical variables) and analysis of variance (ANOVA) (continuous variables) were used for ADHD/tic group comparisons. Tukey HSD tests (equal variances) and Dunnett's C tests (unequal variances) were performed to localize differences between groups. To identify the source of significant interaction effects, subsequent simple effects tests were conducted. Age, IQ, and socioeconomic status were only minimally correlated with the severity of all symptom categories and therefore were not treated as covariates. Because we believe that more is lost than gained by correcting the significance level for the number of group comparisons, we report here all group differences that are significant at the $P < .05$ level. However, this means that some "significant" findings might be a chance occurrence. Therefore, it should be noted that the Bonferroni-corrected alpha for the ANOVA analyses of parent and teacher ratings is $P < .004$.

For the children with pervasive developmental disorder, the four ADHD/tic groups were initially compared with regard to the severity of their tic and ADHD symptoms. For 3 to 5 year olds, the ADHD + tics group was comparable in tic, ADHD inattentive, and ADHD hyperactive-impulsive symptom severity to the other relevant groups. This was true for both parent- and teacher-defined ADHD/tic group comparisons. However, for 6 to 12 year olds, the teacher-defined ADHD + tics group received higher tic severity ratings than the tics only group. In addition, both parent- and teacher-defined ADHD + tics groups of 6 to 12 year olds received higher ratings of ADHD hyperactive-impulsive symptoms than the ADHD only groups. Given these findings, the severity of tic and ADHD hyperactive-impulsive symptoms was controlled in relevant group comparisons.

A two-step process was used to test if the magnitude of differences between ADHD/tic groups in the pervasive developmental disorder sample varied as a function of informant.[33] Initially, we created one set of three variables denoting whether the child was classified as ADHD + tics (A1), ADHD only (A2), or tics only (A3) according to neither, one, or both raters. A second set of three variables indicated the difference between group assignments (D1–D3): classified by teacher rating only (1), teacher and parent agreed (0), or parent rating only (−1). In the first step of this analysis, we estimated a model in which differences among ADHD/tic groups for a given validator were assumed to be identical for parent- and teacher-defined groups. This was done by regressing each validator on variables A1 to A3. In the second step, D1 to D3 were added as predictors to the equation (thereby allowing for differences in rater classifications). When the addition of D1 to D3 resulted in a statistically significant increase in $R^2$ ($\Delta R^2$), it was concluded that the magnitude of ADHD/tic group differences for this validator varied for parent- and teacher-defined groups.

For this study, comparisons between pervasive developmental disorder and non–pervasive developmental disorder samples are limited to the following analyses: To determine if observed symptom severity differences between ADHD/tic groups in children with pervasive developmental disorder were comparable to non–pervasive developmental disorder clinic children, we compared these two samples of children using a clinic (pervasive developmental disorder vs non–pervasive developmental disorder) × ADHD/tic group ANOVA for each age group and for each informant. Significant interactions would indicate a varied pattern of ADHD/tic group differences for pervasive developmental disorder versus non–pervasive developmental disorder samples.

## RESULTS

### Are tics associated with psychopathology in children with pervasive developmental disorder?

We compared Early Childhood Inventory-4/Child Sympton Inventory-4 symptom severity scores for children with pervasive developmental disorder with and without tic-like behaviors. Separate

analyses were conducted for each age group and each informant. The results demonstrated that children with tic symptoms scored higher than children without tics for most symptom categories. In no instance did children without tics receive higher scores.

**Are tics related to pervasive developmental disorder subtype?**

We compared the screening prevalence rate of tics (yes/no) between pervasive developmental disorder subtypes (autistic disorder, Asperger's syndrome, pervasive developmental disorder not otherwise specified) for each age group and each informant separately. There were no pervasive developmental disorder subtype differences, with the exception of teacher ratings of 3 to 5 year olds: tic rates for children with autistic disorder (61%) were higher than those for children with Asperger's syndrome (36%) and pervasive developmental disorder not otherwise specified (33%).

**Are demographic, family, and treatment variables external validators of ADHD/tic group differences?**

Groups were compared for age, gender, IQ, socioeconomic status, ethnicity, income, single-parent household, and medication use. For 3 to 5 year olds, the only significant group difference was in socioeconomic status for teacher-defined groups (symptoms of neither disorder > ADHD + tics). For 6 to 12 year olds, age (ADHD + tics > neither disorder), medication use (ADHD + tics > ADHD only), and single-parent household (ADHD + tics > neither disorder) differentiated parent-defined groups. For teacher-defined groups, the only difference was in socioeconomic status (neither disorder > ADHD + tics).

**Do ADHD/tic groups differ in the severity of their psychiatric symptoms?**

***Parent-Defined Groups***

Among 6 to 12 year olds, there was a main effect of group for 11 symptom categories (Table 2). The most consistent finding was the relatively greater severity of symptoms in the ADHD ± tics and tics only groups versus the group with neither disorder (ie, anxiety and manic symptoms and social withdrawal). Note that for these same symptom categories, the three ADHD/tic groups did not differ from each other, except in the case of manic episode symptom score. In other words, ADHD and tics were both indicators of a more complex psychopathology. There were three exceptions to this general pattern of findings. First, the tics only group did not differ from the group with neither disorder with regard to depression symptoms, suggesting that tics per se might not be indicators of more severe depression symptoms. Second, although the ADHD + tics group received more severe oppositional defiant disorder, conduct disorder, and manic episode symptom scores than the tics only group and the group with neither disorder, the ADHD only group merely differed from the group with neither disorder. This finding supports the notion that the ADHD + tics group might constitute a unique clinical entity. Third, the tics only group had higher specific phobia symptom scores than the ADHD only group and group with neither disorder but did not differ from the ADHD + tics group.

The findings for 3 to 5 year olds showed both similarities and differences when compared with those for older children (see Table 2). First, there were fewer main effects of group (seven categories), indicating that for preschoolers, ADHD and tic symptoms are somewhat less indicative of a complex symptomatology (ie, specific phobia, obsessive-compulsive, and separation anxiety symptoms). Second, the dominant pattern was greater impairment in the two ADHD groups (but not tics only group) compared with the group with neither disorder, which suggests that ADHD symptoms were indicators of oppositional behavior and depression symptoms. For these categories, this pattern was similar to that for 6 to 12 year olds. However, in preschoolers, tics were not an indicator of more severe anxiety or aggression symptoms, which was the case for older children. Lastly, only preschoolers in the ADHD ± tics groups had more severe social deficits scores than the group with neither disorder, whereas in older children, the tics only group was also more impaired than the group with neither disorder.

***Teacher-Defined Groups***

In general, findings for 6 to 12 year olds in the teacher-defined ADHD/tic groups were fairly consistent with the results for the parent-defined groups (Table 3), with one notable exception: teacher-defined groups resulted in less differentiation with the group with neither disorder (ie, oppositional defiant disorder, generalized anxiety disorder, specific phobia, manic episode, obsessive-compulsive, and social deficits scores). Specifically, ADHD only (oppositional defiant disorder, generalized anxiety disorder, obsessive-compulsive disorder scores) and tics only (generalized anxiety disorder, specific phobia, manic episode, and social deficits scores) groups were not differentiated from the group with neither disorder with teacher classifications, whereas they were with parent-defined groups. In short, ADHD and tics were more clear-cut indicators of complex symptomatology with parent versus teacher group classification schemes.

The findings for teacher-defined preschool groups can be summarized as follows (see Table 3): first, for several symptom categories (ie, oppositional defiant disorder, major depressive disorder, dysthymia, social deficits, and perseverative behaviors), the teacher-defined ADHD + tics group was more impaired than the group with neither disorder, a finding that is consistent with parent-defined groups. However, for these same symptom categories, differentiation between teacher-defined ADHD only and tics only groups and the group with neither disorder was highly variable. In addition, the teacher-defined ADHD only group and the group with neither disorder were not differentiated on anxiety or aggression symptoms, whereas parent-defined groups were.

**Does the magnitude of ADHD/tic group differences vary by informant?**

In preschoolers, there were six variables for which the magnitude of group differences varied depending on the informant who served as the basis for classifying the children. Significant ($P < .05$) differences for classification systems were found for parent Early Childhood Inventory-4 social phobia scores ($\Delta R^2 = .12$) and teacher social phobia ($\Delta R^2 = .06$), obsessive-compulsive ($\Delta R^2 = .08$), social deficits ($\Delta R^2 = .09$), language deficits ($\Delta R^2 = .06$), and perseverative behaviors ($\Delta R^2 = .15$) scores. For all but two of these six variables, the parent-defined ADHD/tic group classifications better discriminated the groups (ie, the eta squared was higher) than teacher classifications, including teacher social phobia, social deficits, and language deficits scores (ie, external validation). For teacher obsessive-compulsive and perseverative behaviors

**Table 3. Means (SD) and Comparison Statistics for Teacher Ratings of Teacher-Defined Symptom Groups**

| *Variable* | *ADHD +T* | *ADHD Only* | *Tics Only* | *NONE* | *F Ratio* | *Post hoc Comparisons* |
|---|---|---|---|---|---|---|
| 3–5 year olds | *n* = 45 | *n* = 32 | *n* = 25 | *n* = 57 | | |
| ODD | 9.6 (6.3) | 8.1 (6.4) | 5.8 (5.1) | 4.2 (4.0) | 9.1*** | ADHD +T, ADHD > NONE |
| OCD | 2.0 (1.7) | 1.4 (1.7) | 1.9 (1.7) | 1.0 (1.2) | 4.0* | ADHD +T > NONE |
| MDD | 5.1 (2.3) | 4.3 (2.2) | 4.7 (2.4) | 3.0 (1.8) | 9.6*** | ADHD +T, ADHD,T > NONE |
| Dysthymia | 3.2 (1.8) | 2.6 (1.8) | 2.4 (1.7) | 1.9 (1.4) | 5.5** | ADHD +T > NONE |
| Social deficits | 10.1 (2.2) | 8.5 (3.7) | 8.7 (3.3) | 5.7 (3.6) | 16.4*** | ADHD +T, ADHD,T > NONE |
| Language deficits | 9.3 (2.6) | 7.5 (4.0) | 7.2 (3.7) | 6.5 (3.7) | 5.6** | ADHD +T > NONE |
| Perseverative behaviors | 8.4 (2.7) | 5.2 (3.1) | 6.8 (2.6) | 3.8 (3.0) | 23.2*** | ADHD +T > ADHD, NONE;T > NONE |
| 6–12 year olds | *n* = 110 | *n* = 45 | *n* = 77 | *n* = 50 | | |
| ODD | 8.7 (5.8) | 7.9 (7.1) | 5.6 (5.7) | 4.9 (4.5) | 7.2*** | ADHD +T >T, NONE |
| CD | 2.0 (3.5) | 0.9 (1.6) | 1.0 (2.0) | 0.5 (1.2) | 4.8** | ADHD +T > NONE |
| GAD | 4.9 (3.1) | 3.7 (3.1) | 4.0 (3.3) | 3.3 (2.8) | 3.6* | ADHD +T > NONE |
| Specific phobia | 0.6 (0.9) | 0.2 (0.7) | 0.7 (0.9) | 0.3 (0.8) | 4.0** | T > ADHD |
| OCD | 1.5 (1.5) | 1.0 (1.7) | 1.4 (1.5) | 0.7 (1.2) | 3.5* | ADHD +T,T > NONE |
| MDD | 5.3 (3.4) | 5.2 (3.9) | 3.8 (3.6) | 3.1 (2.2) | 6.5*** | ADHD +T >T, NONE; ADHD > NONE |
| Dysthymia | 4.5 (3.1) | 4.3 (3.8) | 3.4 (3.3) | 2.6 (2.2) | 4.7** | ADHD +T, ADHD > NONE |
| Manic episode | 4.6 (5.1) | 3.5 (3.3) | 2.7 (3.0) | 1.8 (2.5) | 6.5*** | ADHD +T >T, NONE; ADHD > NONE |
| Social deficits | 8.4 (2.9) | 8.0 (3.7) | 5.9 (3.3) | 4.8 (3.4) | 18.7*** | ADHD +T, ADHD >T, NONE |
| Language deficits | 6.7 (3.8) | 6.1 (3.6) | 4.8 (3.4) | 3.8 (4.0) | 9.0*** | ADHD +T >T, NONE; ADHD > NONE |
| Perseverative behaviors | 6.9 (3.3) | 4.2 (3.0) | 4.7 (2.4) | 3.2 (2.6) | 22.6*** | ADHD +T > ADHD,T, NONE;T > NONE |

ADHD = attention-deficit hyperactivity disorder; CD = conduct disorder; GAD = generalized anxiety disorder; OCD = obsessive-compulsive disorder; MDD = major depressive disorder; NONE = symptoms of neither disorder; ODD = oppositional defiant disorder;T = tics.
*$P < .05$; **$P < .01$; ***$P < .001$.

scores, however, teacher-defined groups resulted in better group differentiation.

For the 6 to 12 year olds, there were 14 variables for which the magnitude of group differences varied depending on the informant who served as the basis for classifying the children. Significant ($P < .05$) differences for classification systems were found for parent Child Symptom Inventory-4 oppositional defiant disorder ($\Delta R^2 = .08$), conduct disorder ($\Delta R^2 = .04$), generalized anxiety disorder ($\Delta R^2 = .06$), major depressive disorder ($\Delta R^2 = .06$), dysthymia ($\Delta R^2 = .05$), separation anxiety disorder ($\Delta R^2 = .05$), obsessive-compulsive ($\Delta R^2 = .08$), manic episode ($\Delta R^2 = .07$), social deficits, ($\Delta R^2 = .09$), and perseverative behaviors ($\Delta R^2 = .06$) scores and teacher ratings of manic episode ($\Delta R^2 = .04$), social deficits ($\Delta R^2 = .09$), language deficits ($\Delta R^2 = .10$), and perseverative behaviors ($\Delta R^2 = .12$) scores. For 9 of these 14 variables, parent-defined groups resulted in better group differentiation than teacher-defined groups. For teacher Child Symptom Inventory-4 manic episode, social deficits, language deficits, and perseverative behaviors scores, teacher-defined groups were better differentiated (than parent-defined groups), including parent Child Symptom Inventory-4 social deficits scores (ie, external validation).

### Is the pattern of ADHD/tic group differences similar for younger versus older pervasive developmental disorder children?

For parent ratings, there was a main effect of age (older > younger) for oppositional defiant disorder, major depressive disorder, dysthymia, and social deficits scores, whereas for language deficits scores, younger children were more impaired than older children. For teacher ratings, age was significant for all pervasive developmental disorder symptoms (younger > older) and dysthymia (older > younger). However, there were no significant age × ADHD/tic group interactions for ratings of psychiatric or pervasive developmental disorder symptoms, which suggests that the patterns of differences between the four ADHD/tic groups were similar for both younger and older children.

### Are ADHD/tic group differences similar for children with and without pervasive developmental disorder?

In general, the pattern of differences between ADHD/tic groups was similar for pervasive developmental disorder and non–pervasive developmental disorder samples. In other words, ADHD and tics are indicators of a more complex symptomatology in children with and without pervasive developmental disorder. The only exceptions were parent oppositional defiant disorder and depressive disorder scores (3 to 5 year olds) and parent oppositional defiant disorder, conduct disorder, obsessive-compulsive, and perseverative behaviors (6 to 12 year olds) scores.

## DISCUSSION

This is the first large-scale study of tics and ADHD in children with pervasive developmental disorder using a categorical model to examine potential differences in co-occurring psychiatric symptoms. As previously noted, prior research indicates that (a) both ADHD and tics are associated with a more complex psychiatric symptomatology in community- and clinic-based non–pervasive developmental disorder samples and (2) children with ADHD + tics are at greater risk than either disorder singly. Recent studies of children with pervasive developmental disorder also indicate that youngsters with ADHD symptoms are more likely to exhibit additional psychiatric symptoms.[29] The findings of the present study examined the relative difference in children with pervasive developmental disorder classified as either ADHD ± tics, tics only, or neither using a *DSM-IV*–referenced rating scale and was modeled on a similar study of 3006 schoolchildren using an identical measure.[31] Our primary objective was to see if group differences in children with pervasive developmental disorder were similar to a non–pervasive developmental disorder sample and, in so doing, examine evidence for *DSM-IV* behavioral syndromes in children with pervasive developmental disorder.

In general, the findings of the present study support the notion that children with pervasive developmental disorder, who also

exhibit ADHD or tic symptoms, are at greater risk of co-occurring psychiatric symptoms and have greater severity of pervasive developmental disorder symptoms, more medication use, and experience more environment problems than children without either disorder. Moreover, children with ADHD and tics tend to be more impaired than children who have only tic symptoms. Interestingly, comparison of ADHD/tic groups in our pervasive developmental disorder versus non–pervasive developmental disorder samples indicated few differences in the relative severity of co-occurring symptoms. This suggests that similar processes might explain the association between tics, ADHD, and psychopathology in both samples. The most noteworthy difference between the findings of the present study and our earlier survey of public schoolchildren is the relatively fewer statistically significant differences between the two ADHD groups (ie, with and without tics) in the pervasive developmental disorder sample.[31]

The number and pattern of ADHD/tic group differences in children with pervasive developmental disorder varied by age and informant. For example, compared with teacher-defined groups, parent-defined ADHD/tic groups showed a greater amount of group differentiation (eg, ADHD only and tic only groups from the group with neither disorder), particularly in 6 to 12 year olds. Moreover, there was greater evidence of diagnostic validity for parent- than for teacher-defined groups, which is the converse of what we found in a related study of ADHD symptom subtypes in children with[29] and children without pervasive developmental disorder.[33] In the present study, the magnitude of differences between ADHD/tic groups was greater for parent- versus teacher-defined groups for a larger number of co-occurring psychiatric symptoms. It is important to emphasize, however, that the number of external validators was limited and that a different set of variables could result in a different interpretation.

With regard to pervasive developmental disorder subtypes, some investigators reported that individuals with Asperger's syndrome, as a group, are higher functioning than patients with more typical autism and that tics are more common among those with Asperger's syndrome.[2,43] Moreover, Burd et al noted that in their autistic group, individuals with tics had significantly higher IQs than the group without tics.[2] Alternatively, others have suggested that tics are more common in more severely impaired people with autism.[3,8] In our pervasive developmental disorder sample, we found little difference in tic rates between pervasive developmental disorder subtypes. Only teacher ratings of 3 to 5 year olds showed evidence of higher tic rates in children with autism compared with those with Asperger's syndrome or pervasive developmental disorder not otherwise specified. Furthermore, comparison of Wechsler Full-Scale IQ scores between ticquers and nonticquers (within each age group and informant-defined tic group) found no differences in IQ. For example, in the teacher-defined groups of 6 to 12 year olds, the mean IQ score was 88 ($n$ = 149) for children with tics and 89 ($n$ = 77) for those without tics. Note that IQ scores were available for an equal percentage (80%) of children in each group.

## LIMITATIONS

The results of this study are subject to several qualifications. First, it is important to emphasize that our findings pertain only to the severity of psychiatric symptoms and that Early Childhood Inventory-4/Child Symptom Inventory-4 screening cutoff scores are not equivalent to *DSM*-based psychiatric diagnoses (eg, expert diagnoses, structured interviews, best estimate diagnoses) because they are not based on the full set of diagnostic criteria (eg, age at onset or duration of symptoms, impairment of social or academic performance, exclusionary criteria). Nevertheless, earlier studies demonstrate that Early Childhood Inventory-4/Child Symptom Inventory-4 tic ratings generate results that are highly similar to the findings of studies of children with a diagnosed tic disorder.[19,31,32,44] Second, generalization of findings is limited by geographic diversity (which might not be particularly important) and to children referred to one evaluation facility.[45] Moreover, information was collected only from care providers able and willing to complete the ratings.

Lastly, investigators have commented on the problem of differential diagnosis of movement disorders in pervasive developmental disorder, most notably stereotypies and tics. Although rules for distinguishing the two disorders have been published, their reliability is unknown, and highly qualified experts note that differential diagnosis is next to impossible in some cases.[3,43] The larger issue, however, is the differential validity of the two disorders with regard to external validators. Because the present study was not designed to disentangle stereotypies from tics, our data do not address the differential validity of the two diagnoses. Nevertheless, correlations between our Early Childhood Inventory-4/Child Symptom Inventory-4 ratings of motor tics and compulsions (which are more similar to stereotypies) ranged from $r$ = .19 to $r$ = .38 across age groups and informants. This suggests that raters were distinguishing these symptoms to at least some degree. Moreover, when we analyzed our data substituting compulsions for tics, the results were highly similar to our reported findings. This suggests that both tics and stereotypies are associated with more severe psychiatric symptoms, a topic that clearly warrants further investigation.

## CLINICAL IMPLICATIONS

The findings of this study support previous research indicating that tic behaviors are relatively common in children with pervasive developmental disorder. Although tics are unlikely to be the primary reason for evaluation, they appear to be a useful indicator of a more severe psychopathology, particularly in combination with ADHD symptoms, which is consistent with our studies of non–pervasive developmental disorder clinically referred and community-based samples.[19,31] The presence of tic symptoms in pediatric patients signals the need for a comprehensive assessment of comorbid psychiatric symptoms and a detailed family history of psychopathology. Owing to the high rate of familial transmission of tic disorder and comorbidity, one or both parents can exhibit psychopathology, which can have important implications for clinical management.[46] Because tics typically fluctuate in frequency and severity, even seemingly innocuous tics at the time of referral can become implicated in later treatment planning. For example, worsening in preexisting but undiagnosed tics consequent to drug treatment might be falsely characterized as induction of tic disorder de novo.

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