Published in final edited form as:

Clin Pediatr (Phila). 2020 September ; 59(9-10): 874–884. doi:10.1177/0009922820924692.

Symptom Level Associations Between Attention-Deficit Hyperactivity Disorder and School Performance

Megan Rigoni, MPH[1], **Lynn Zanardi Blevins, MD, MPH**[2], **David C. Rettew, MD**[3,4], **Laurin Kasehagen, MA, PhD**[1,3,5]

[1]Vermont Department of Health, Burlington, VT, USA

[2]University of Vermont, Burlington, VT, USA

[3]University of Vermont, Larner College of Medicine, Burlington, VT, USA

[4]Vermont Department of Mental Health, Waterbury, VT, USA

[5]Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Reproductive Health, Field Support Branch, MCH Epidemiology Program Team, Atlanta, GA, USA

Abstract

Attention-deficit hyperactivity disorder (ADHD) is associated with reduced school performance. To determine which ADHD symptoms and subtypes have the strongest association, we used type and frequency of symptoms on the 2014 National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome (NS-DATA) to create symptom scores for inattention and hyperactivity-impulsivity and define subtypes (ADHD-Inattentive [ADHD-I], ADHD-Hyperactive-Impulsive, ADHD-Combined [ADHD-C]). Regression methods were used to examine associations between symptoms and subtype and a composite measure of school performance. Children with ADHD-C and ADHD-I had higher adjusted odds of having reduced overall school performance (ADHD-C = 5.8, 95% confidence interval [CI] = 3.1–10.9; ADHD-I = 5.5, 95% CI = 3.1–10.1) compared with children without ADHD. All inattentive symptoms were significantly related to reduced school performance in reading, writing, and handwriting, while 6 of 9 symptoms were significantly associated in mathematics. Children with ADHD-I were significantly more likely than children with other ADHD subtypes to receive a school-based Individualized Education Program or 504 Plan. ADHD-I symptoms may be broadly linked to reduced school performance.

Corresponding Author: Laurin Kasehagen, Vermont Department of Health, 108 Cherry Street, Suite 306, Burlington, VT 05401, USA. Laurin.Kasehagen@partner.vermont.gov.

Author Contributions

MR, LZB, and LK contributed to the analyses, inter-prepretation of results, and writing of this article. DCR contributed to the interpretation of results and writing of this article.

The findings and conclusions in this analysis are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention, the Vermont Department of Health, the Vermont Department of Mental Health, or the University of Vermont, Robert Larner, M.D. College of Medicine.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Keywords

attention-deficit hyperactivity disorder; inattention; subtypes; school performance; NICHQ Vanderbilt Assessment Scale; The National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome

Introduction

Attention-deficit hyperactivity disorder (ADHD) is defined as a "persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development" that is inappropriate for the individual's age.[1] ADHD is a common neurodevelopmental disorder that begins in childhood and affects social, academic, or occupational functioning.[1] The 2016 National Survey of Children's Health indicates that about 5.4 million children in the United States between the ages of 3 and 17 years—approximately 8.9%—currently meet criteria for ADHD.[2]

Children with ADHD are more likely to have poor academic outcomes including lower academic performance, grade retention, and higher dropout rates.[3,4] Those with persistent (current) symptoms experience greater challenges in school performance compared with those with nonpersistent symptoms and children without ADHD.[5] Severity of ADHD symptoms has been found to predict lower academic performance in reading, writing, and mathematics in children[6] and overall academic performance in adolescents.[7] While specific learning disorders are common comorbid conditions with ADHD, learning disorders do not completely account for the lower academic performance.[8]

Three subtypes of ADHD have been recognized by the *Diagnostic and Statistical Manual, Fifth edition* (*DSM-5*), reflecting key differences in symptom presentation. These subtypes include combined inattentive and hyperactive-impulsive (ADHD-C), predominantly inattentive (ADHD-I), and predominantly hyperactive-impulsive (ADHD-HI). Evidence suggests that the academic outcomes of children with ADHD differ by clinical presentation. In particular, symptoms of inattention, but not hyperactivity/impulsivity, have been associated with poor school performance generally and in multiple domains,[5,9] including reading, writing, and mathematics.[10] Children meeting diagnostic criteria for the 2 subtypes that include inattentive symptoms (ADHD-C and ADHD-I) have worse performance on mathematics calculations, written expression, fluid reasoning, and visual-motor tests,[11] and lower overall academic performance.[12] Furthermore, children with ADHD-C and ADHD-I have been found to use more special education services than children with ADHD-HI and children without ADHD,[13] although concern has been raised that some children with ADHD-I may not be identified clinically due to a lack of more salient disruptive behavior.[9]

While previous research has been informative in delineating the link between various subtypes of ADHD and poorer school performance, some limitations of these studies have prevented more detailed conclusions in this area. One of these limitations is a lack of control for learning disabilities—a common comorbid condition with ADHD that may confound the link between ADHD and school performance.[8] Previous work also has not analyzed data

on the level of individual ADHD symptom that might be of practical benefit to clinicians looking to treat the most impairing symptoms. The current study aims to advance knowledge in the association between ADHD and school performance by addressing some of these previous limitations by examining data from a large cross-sectional survey on US children in which information about individual ADHD symptoms, ADHD subtypes, and other important variables, such as the presence of learning disorders, was obtained. An additional aim was to examine the link between ADHD subtype and educational service utilization, given some of the inconsistent results found previously. We hypothesized that, similar to previous work, reduced school performance would be most strongly related to inattentive ADHD symptoms, but that some specific behaviors within the inattentive ADHD domain would emerge as particularly relevant. We also expected that children with more prominent hyperactive/impulsive symptoms would be more likely to be receiving school-based services in comparison to children with primarily inattentive symptoms.

Methods

The 2014 National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome (NS-DATA) is a follow-up survey to the 2011–2012 National Survey of Children's Health (NSCH), a national cross-sectional survey of children younger than 18 years of age.[14–16] The National Center on Birth Defects and Developmental Disabilities (NCBDDD) and the National Center for Health Statistics (NCHS) sponsored the NS-DATA.[14] Under the guidance of NCBDDD and NCHS, National Opinion Research Center (NORC) at the University of Chicago conducted telephone interviews of parents/guardians who completed the NSCH and reported that they had ever been told by a doctor or other health care provider that the child had ADHD or Tourette syndrome, and were 2 to 15 years of age in 2011–2012. The eligibility criteria for the NS-DATA ensured that the child was younger than 18 years of age, lived in the same household during the NSCH and the NS-DATA, and parents/guardians had ever been told by a doctor or other health care provider that the child had ADHD or Tourette syndrome.[14] The survey data were de-identified, and some survey variables were suppressed or collapsed by the NCHS in order to ensure confidentiality and protect the identities of children in the survey.[14] We analyzed a subset of children in the NS-DATA who were between the ages 8 and 17 years and for whom information on ADHD and school performance was collected. Children younger than 8 years were excluded due to small sample size and lack of comparable age-appropriate school performance information in the NS-DATA.

ADHD Symptoms, Additive Scores, and Subtype

We determined type of symptoms, number of symptoms, additive symptom scores, and ADHD subtype categories from 18 NS-DATA questions about the child's ADHD symptoms. These questions reflect the 18 *DSM-5* criteria for ADHD and were derived from The Vanderbilt ADHD Parent Rating Scale (VAPRS), a validated, parent-completed questionnaire, which is included as a module in the NS-DATA.[17] The VAPRS is used to aid in the determination of ADHD in children and differentiate ADHD subtypes through assessment for core inattentive and hyperactive/impulsive symptoms. Parents were asked to report their child's symptoms as perceived when the child was not taking medication.

Identifying Symptoms of Inattention and Hyperactivity/Impulsivity

Symptoms of inattention and hyperactivity and impulsivity are listed in Table 1. NS-DATA respondents used a 4-point Likert-type scale (“never,” “occasionally,” “often,” and “very often”) to denote how frequently their child exhibited each behavior.

Additive Scoring for Symptoms of Inattention and Hyperactivity/Impulsivity

We created summary variables, using the validated approach in the VAPRS, for each child who had current ADHD and who had a response for all 18 of the NS-DATA questions about the child’s ADHD symptoms. One summary variable represents the additive score of the 9 inattentive symptoms, and the other summary variable represents the additive score of the 9 hyperactive/impulsive symptoms. Inattentive symptom questions that had responses of “never” were coded as 1, responses of “occasionally” were coded as 2, responses of “often” were coded as 3, and responses of “very often” were coded as 4. The sum of the scores from the 9 inattentive symptom questions became the additive score for inattention. Similarly, the 9 questions related to hyperactive/impulsive symptom questions were coded, as noted above, and summed to give the additive score for hyperactivity/impulsivity.

Identifying ADHD Subtype

To determine a child’s ADHD subtype, we applied the VAPRS criteria for subtype determination and validated approach for determining subtype.[17] Children with the ADHD-C subtype had to have at least 6 inattentive symptoms, each with a score of 3 (“often”) or 4 (“very often”), of the 9 inattentive symptoms and had to have at least 6 hyperactive/impulsive symptoms, each with a score of 3 (“often”) or 4 (“very often”), of the 9 hyperactive/impulsive symptoms. Conversely, children with the ADHD-I subtype had to have at least 6 inattentive symptoms, each with a score of 3 (“often”) or 4 (“very often”), of the 9 inattentive symptoms while not scoring at least a 3 on 6 or more or the hyperactive/impulsive symptoms. Children with the ADHD-HI subtype had to have at least 6 hyperactive/impulsive symptoms, each with a score of 3 (“often”) or 4 (“very often”), of the 9 hyperactive/impulsive symptoms while not scoring at least a 3 on 6 or more or the inattentive symptoms. Children who were reported to have ADHD but did not have enough reported symptoms to be classified into 1 of the 3 subtypes were categorized as “does not meet subtype criteria” and included as a separate group in analyses as this may represent a group of children with ADHD who are responding well to treatment. Children whose parent/guardian reported that their child did not currently have or no longer had an ADHD diagnosis (ie, changed diagnosis, outgrew symptoms) were categorized as “does not have ADHD,” included as a separate group in analyses, and served as our referent group in multivariate analyses.

School Performance

The VAPRS module in the NS-DATA included 5 questions to assess school performance: overall school performance and specific performance in mathematics, reading, writing, and handwriting. Parents were asked to describe their child’s performance in each of the 5 school domains as either “problematic,” “somewhat problematic,” “average,” “above average,” or “excellent.” For regression modeling, we chose children with “average”

performance for comparison because average performance reflects the minimum expected performance in schools. A binary outcome variable was created from the “problematic” and “somewhat problematic” response categories and the “average” response category. Analyses of school performance using a 3-level outcome variable (problematic/somewhat problematic, average, and above average/excellent responses) are available on request to the authors.

Demographic Characteristics and Potentially Confounding Variables

Age was reclassified into 2 levels: 8 to 11 years and 12 to 17 years, based on typical primary and secondary school age ranges and treatment recommendations.[18] Due to small sample sizes of children not classified as non-Hispanic white, race and ethnicity were recombined into a single variable with 2 response levels: non-Hispanic white and all others. Household poverty was categorized into a 3-level variable derived from 2 survey questions that the NCHS suppressed and converted into percentage of the federal poverty level (FPL): 0% to 199% FPL, 200% to 399% FPL, and more than 399% FPL.[14] Parent-reported co-occurring conditions were conduct disorder, mood disorders, oppositional defiant disorder (ODD), obsessive-compulsive disorder (OCD), learning disorder, and language disorder. Each condition was recoded as “currently has” or “currently does not have” for each child. Individualized Education Program (IEP) and/or 504 Plan was recoded to denote the presence of IEP, a 504 Plan, or both.

Analytic Methods

We used linear regression methods to examine the association between additive inattentive symptom scores of children with ADHD and school performance and additive hyperactive-impulsive symptom scores of children with ADHD and school performance. Assumptions (eg, approximately normal distribution of residuals and constant variance) for linear modeling were checked. We calculated crude odds ratios (ORs), adjusted ORs (AORs), and 95% confidence intervals (CI) to examine associations between ADHD subtype and school performance. We used the Hosmer-Lemeshow goodness-of-fit test to determine which variables were significantly associated with school performance and used the goodness-of-fit test results to help guide our decisions on which variables to retain in the regression models. We retained sex, age, race/ethnicity, household poverty level, and co-occurring conditions of anxiety, ODD, OCD, learning disorder, and language disorder in the final multivariate logistic regression models. Linear regression and multivariate logistic regression analyses were carried out using SAS and SAS-callable SUDAAN version 10 (SAS, Cary, NC; RTI International, Research Triangle Park, NC). As the data for these analyses are from a complex weighted sample, we used appropriate procedures for examining a specific population subgroup, applied weights, adjusted for the survey’s complex sampling design structure (ie, the clustering of children within households and stratification by state and sample type [landline or cell phone]), and used SUDAAN or SAS SURVEY procedures for variance estimation as required for these complex weighted data.

The NS-DATA are publicly available from the NCHS and use of the data does not require institutional review board approval. However, the Confidential Information Protection and Statistical Efficiency Act (Section 512b) and the Public Health Service Act (Section 308d) provide that these data collected by NCHS may be used only for the purpose of health

statistical reporting and analysis. Any effort to determine the identity of any reported case is prohibited by these laws. NCHS takes extraordinary measures to assure that the identity of survey subjects cannot be disclosed. All direct identifiers, as well as any characteristics that might lead to identification, have been omitted from the data set. Any intentional identification or disclosure of a person or establishment violates the assurances of confidentiality given to the providers of the information. Therefore, users must (1) use the data in this data set for statistical reporting and analysis only; (2) make no use of the identity of any person discovered, inadvertently or otherwise, and advise the Director, NCHS, of any such discovery; and (3) not link this data set with individually identifiable data from any other NCHS or non-NCHS data sets. We signify that we complied with the statutory-based requirements in the use of these data.

Results

Of the 2782 children included in the study subpopulation, 538 children were classified as having ADHD-C (22.8%, 95% CI = 19.9–25.7), 771 children as ADHD-I (27.6%, 95% CI = 24.7–30.6), and 99 ADHD-HI (3.7%, 95% CI = 2.5–5.0; Table 2). Of the remaining 1374 children, 998 children did not meet the criteria for an ADHD subtype (31.9%, 95% CI = 28.9–35.0) and 376 children were reported to no longer have ADHD (13.9%, 95% CI = 11.7–16.1; Table 2). In this study subpopulation, 62% of children with ADHD-C, 54% of children with ADHD-I, and 30% of children with ADHD-HI were getting services through an IEP and/or 504 Plan (data not shown).

Table 3 describes each ADHD symptom and the distribution of the number of responses to each symptom by ADHD subtype, among those who did not meet criteria for a subtype, and as reference, among those reported to no longer have ADHD. Among children with ADHD-C, the proportion of responses to individual symptoms of inattention ranged from 85.6% to 96.0%, and the proportion of responses to individual symptoms of hyperactivity-impulsivity ranged from 71.6% to 95.4%. Among children with ADHD-I, the proportion of responses to individual symptoms of inattention ranged from 69.7% to 92.3%, and the proportion of responses to individual symptoms of hyperactivity-impulsivity ranged from 10.5% to 47.3%. Among children with ADHD-HI, the proportion of responses to symptoms of inattention ranged from 16.9% to 68.5%, and the proportion of responses to symptoms of hyperactivity-impulsivity ranged from 41.7% to 95.0%.

Table 4 shows the adjusted ORs of problematic/somewhat problematic school performance by each of the VAPRS inattentive symptoms. All of the inattentive symptoms were significantly associated with problematic/somewhat problematic school performance overall and in reading, writing, and handwriting after controlling for other variables. Six of 9 inattentive symptoms were significantly associated with problematic/somewhat problematic performance in mathematics. Inattentive symptoms with the highest adjusted odds were the following: failing to follow through on instruction and finish schoolwork; difficulty organizing tasks and activities; difficulty paying attention to detail; being easily distracted by extraneous stimuli; difficulty sustaining attention to tasks or activities; and losing things necessary for and forgetting tasks or activities. A table of the adjusted ORs of hyperactive-

impulsive symptoms by overall school performance, mathematics, reading, writing, and handwriting is available on request.

At the symptom level, a linear relationship was observed between the additive inattentive scores for children with ADHD and overall school performance and school performance in mathematics, reading, and writing. The increased likelihood of poor school performance with the combination of number of reported inattentive symptoms and the frequency of inattentive symptoms suggests a dose-like effect between inattentive ADHD symptoms and problematic school performance, mathematics, reading, and writing. In overall school performance, we observed a decrease in 1 performance level (eg, from average to somewhat problematic overall school performance) for every 10 points in the additive inattentive score. In mathematics and writing, we observed a decrease in 1 performance level for every 15 points in the additive inattentive score; in reading, we observed a decrease in 1 performance level for every 20 points in the additive inattentive score. A dose-like effect also was observed for hyperactive-impulsive symptoms and school performance; however, the effect was not as pronounced as that observed for additive inattentive scores (data not shown).

At the subtype level, the odds of problematic/somewhat problematic school performance, compared with average school performance, differed by subtype in both crude models (data not shown) and after adjusting for age, sex, race/ethnicity, household poverty level, anxiety, ODD, OCD, learning disorders, and language disorders (Table 5). Children with ADHD-C had higher odds of having problematic/somewhat problematic overall school performance (AOR = 5.8, 95% CI = 3.1–10.9) compared with children who no longer manifested clinical ADHD (“does not have”). Children with ADHD-C also had higher odds of having problematic/somewhat problematic reading (AOR= 3.8, 95% CI= 2.0–7.3), writing (AOR = 2.3, 95% CI = 1.3–4.2), and handwriting (AOR = 2.4, 95% CI = 1.3–4.5) school performance compared with children who did not have ADHD. In mathematics, school performance approached statistical significance (AOR = 1.8, 95% CI= 1.0–3.3).

Children with ADHD-I had higher odds of having problematic/somewhat problematic overall school performance (AOR = 5.5, 95% CI = 3.1–10.1) compared with children who did not have ADHD. Children with ADHD-I also had higher odds of having problematic/somewhat problematic reading (AOR = 2.7, 95% CI = 1.5–4.8) and writing (AOR = 2.8, 95% CI = 1.6–4.7) school performance compared with children who did not have ADHD. In mathematics (AOR = 1.8, 95% CI = 1.0–3.1) and handwriting (AOR = 1.7, 95% CI = 1.0–3.0), school performance approached statistical significance.

Among children with parent-reported diagnoses of ADHD-HI, no significant statistical associations with any school performance measures were observed.

Discussion

While the link between reduced school performance and ADHD is widely known, this study offers more detailed information regarding particular ADHD subtypes and even individual symptoms that may underlie this association. This study in many ways supports earlier research on ADHD subtypes and differences in academic achievement and adds strength

to the existing research on inattention[4,13,19–22] by using nationally drawn data designed to control for important confounding variables, including co-occurring conditions, such as learning disorders. As others have found, poorer school performance was found to be significantly associated with inattentive, but not hyperactive/impulsive symptoms, in a dose-like pattern.

More unexpected, however, was our finding that children with predominantly inattentive symptoms were more likely to be identified and supported at schools through IEP and 504 Plans. Although the American Academy of Pediatrics views the "school environment, class placement, instructional placement, and behavioral supports [as] a necessary part of any treatment plan,"[18] a 2016 letter from the US Department of Education Office for Civil Rights states "many students with ADHD are still experiencing academic and behavioral challenges in the educational setting."[23] IEP and 504 Plans document educational supports and accommodations for children with disabilities, respectively. Yet despite these guidelines and the known link between inattentive symptoms and poorer school performance, there has been concern that inattentive symptoms when not accompanied by hyperactive/impulsive symptoms can evade clinical detection because these children are not exhibiting high levels of disruptive behavior at school.[24,25] In this study subpopulation, however, 62% of children with ADHD-C, 54% of children with ADHD-I, and 30% of children with ADHD-HI were found to have an IEP and/or 504 Plan, suggesting that inattentive more than hyperactive-impulsive symptoms were being brought to clinical attention. It is possible that parents of children with inattentive ADHD symptoms who have poor school performance have sought out formal clinical assessment and/or clinicians over the years have become more vigilant in picking up inattentive ADHD symptoms for further evaluation or treatment. We also note that our sample had a relatively high rate of children with the inattentive subtype. Regardless of subtype, however, more comprehensive use of 504 Plans in ADHD populations could help these students manage symptoms of inattention and improve the potential for educational success.

Another unique aspect of this study was the analysis of ADHD and school performance at the level of the individual symptom. Our study suggests that problematic school performance is highly associated with particular inattentive ADHD symptoms—notably, being easily distracted by external stimuli and forgetful in daily activities, and to a lesser extent, losing things necessary for tasks or activities, and avoiding tasks that require significant mental effort. Modification of the school environment is one mechanism in the overall treatment plan for children with ADHD.[18] Classroom interventions and accommodations may help address inattentive symptoms, if present, and may be effective. For example, seating assignments may reduce distractions, and daily reminder systems may help children remember to bring home assignments or where to place items. Last, assignments may be divided into smaller parts or modified to reduce the length of tasks as research indicates that children with ADHD may respond better to regular reward and/or positive feedback.[21,26,27]

Our findings identify school performance issues with children diagnosed with ADHD-I. Timely diagnosis of ADHD-I resulting in evidence-based behavioral therapy with classroom accommodation and, if necessary, prescription medications, at an earlier age may improve

academic success and reduce frustration. Additionally, careful assessment of inattentive symptoms in children with ADHD-I and ADHD-C can help target classroom interventions specific to symptoms.

This study has several strengths including data from a large, nationally drawn sample specifically composed of children with ADHD. Additionally, we were able to control for many confounding variables and some co-occurring conditions, including anxiety, ODD, OCD, learning disorders, and language disorders. However, we also acknowledge some limitations of this study. Data for the analysis were obtained from the NS-DATA that relies on parent/guardian report and may be subject to social desirability bias. Although the completion rate of successfully recontacting households was very high (80.8%), the overall response rate for this study (11%) is low as it is the product of the response rates of the 2 telephone surveys.[14] This suggests that study participants may differ from children with ADHD in the general population (eg, the children may be older because the ADHD diagnosis was maintained over 2 survey time periods; NS-DATA did not include any children who had a recent ADHD diagnosis) and may be an underestimate of the ADHD population. Subtype classification and school performance were determined in this study using only parent/guardian respondent information. Teacher perception—another important aspect of the ADHD diagnosis and evaluation of school performance—was not part of the survey or this study. It is possible that either ADHD subtype or school performance could be misclassified leading to either over- or underestimation of ADHD symptoms and school performance outcomes. Additionally, as with other studies, this study has a smaller number of children with ADHD-HI than the other subtypes, resulting in lower statistical power for this subtype. Last, the referent group of children with a past diagnosis of ADHD, but not a current diagnosis, is different than referent groups of many other ADHD studies. The majority of parent reports for children in this group indicated that the “condition seemed to go away on its own as the child outgrew the ADHD” diagnosis.[28] Given that it is likely that many of these children retained at least some residual ADHD symptoms, it is possible that we have underestimated the academic impact of ADHD in these analyses.

To more fully understand the impact of ADHD and, specifically, individual symptoms of inattention, on school performance, it may be useful to evaluate which classroom accommodations and behavioral therapies are most effective in reducing symptoms of inattention and improving school performance. Population-based efforts directed at timely diagnosis of ADHD characterized by inattentive symptoms and reduction of symptoms of inattention, either through behavioral therapy (with classroom accommodations) and/or medication, may improve school performance. Due to the high prevalence of ADHD characterized by inattention among children, small improvements may have an overall large effect on population health and academic performance. Since inattentive symptoms often persist into adulthood, effective management in childhood and adolescence also may result in improved occupational and life opportunities.

Acknowledgments

We thank the Centers for Disease Control and Prevention, SLAITS, The National Center on Birth Defects and Developmental Disabilities (NCBDDD), the National Center for Health Statistics, the families involved for their

role in the NS-DATA survey, and the National Institute for Children's Health Quality for use of the Vanderbilt Assessment Scale.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Washington, DC: American Psychiatric Association; 2013.
2. Danielson ML, Bitsko RH, Ghandour RM, Holbrook JR, Kogan MD, Blumberg SJ. Prevalence of parent-reported ADHD diagnosis and associated treatment among U.S. children and adolescents, 2016. J Clin Child Adolesc Psychol. 2018;47:199–212. doi:10.1080/15374416.2017.1417860 [PubMed: 29363986]
3. Barbaresi WJ, Katusic SK, Colligan RC, Weaver AL, Jacobsen SJ. Long-term school outcomes for children with attention-deficit/hyperactivity disorder: a population-based perspective. J Dev Behav Pediatr. 2007;28:265–273. doi:10.1097/DBP.0b013e31811ff87d [PubMed: 17700078]
4. Loe IM, Feldman HM. Academic and educational outcomes of children with ADHD. J Pediatr Psychol. 2007;32:643–654. doi:10.1093/jpepsy/jsl054 [PubMed: 17569716]
5. Wu S, Gau SS. Correlates for academic performance and school functioning among youths with and without persistent attention-deficit/hyperactivity disorder. Res Dev Disabil. 2013;34:505–515. doi:10.1016/j.ridd.2012.09.004 [PubMed: 23063730]
6. Barry TD, Lyman RD, Klinger LG. Academic underachievement and attention-deficit/hyperactivity disorder: the negative impact of symptom severity on school performance. J Sch Psychol. 2002;40:259–283. doi:10.1016/S0022-4405(02)00100-0
7. Birchwood J, Daley D. Brief report: the impact of attention deficit hyperactivity disorder (ADHD) symptoms on academic performance in an adolescent community sample. J Adolesc. 2012;35:225–231. doi:10.1016/j.adolescence.2010.08.011 [PubMed: 20880572]
8. Taanila A, Ebeling H, Tiihala M, et al. Association between childhood specific learning difficulties and school performance in adolescents with and without ADHD symptoms: a 16-year follow-up. J Atten Disord. 2014;18:61–72. doi:10.1177/1087054712446813 [PubMed: 22751677]
9. Merrell C, Sayal K, Tymms P, Kasim A. A longitudinal study of the association between inattention, hyperactivity and impulsivity and children's academic attainment at age 11. Learn Individ Differ. 2017;53:156–161.
10. Rodriguez A, Järvelin M, Obel C, et al. Do inattention and hyperactivity symptoms equal scholastic impairment? Evidence from three European cohorts. BMC Public Health. 2007;7:327. doi:10.1186/1471-2458-7-327 [PubMed: 17999767]
11. Semrud-Clikeman M The role of inattention on academics, fluid reasoning, and visual-spatial functioning in two subtypes of ADHD. Appl Neuropsychol Child. 2012;1:18–29. doi:10.1080/21622965.2012.665766 [PubMed: 23428274]
12. DeLisi M, Vaughn M, Beaver KM, Wexler J, Barth AE, Fletcher JM. Fledgling psychopathy in the classroom: ADHD subtypes psychopathy, and reading comprehension in a community sample of adolescents. Youth Violence Juv Justice. 2011;9:43–58. doi:10.1177/1541204010371932 [PubMed: 21318082]
13. Todd RD, Sitdhiraksa N, Reich W, et al. Discrimination of DSM-IV and latent class attention-deficit/hyperactivity disorder subtypes by educational and cognitive performance in a population-based sample of child and adolescent twins. J Am Acad Child Adolesc Psychiatry. 2002;41:820–828. doi:10.1097/00004583-200207000-00014 [PubMed: 12108807]
14. Centers for Disease Control and Prevention; National Center for Health Statistics. State and Local Area Integrated Telephone Survey. 2014 National survey of the diagnosis and treatment of ADHD and Tourette syndrome Published 2015. Accessed April 4, 2018. http://www.cdc.gov/nchs/slaits/ns_data.htm

15. Centers for Disease Control and Prevention; National Center for Health Statistics. National survey of children's health. Published 2013. Accessed April 4, 2018. http://www.cdc.gov/nchs/slaits/nsch.htm
16. Bramlett MD, Blumberg SJ, Zablotsky B, et al. Design and operation of the National Survey of Children's Health, 2011–2012. Vital Health Stat 1. 2017; (59):1–256.
17. Bard DE, Wolraich ML, Neas B, Doffing M, Beck L. The psychometric properties of the Vanderbilt attention-deficit hyperactivity disorder diagnostic parent rating scale in a community population. J Dev Behav Pediatr. 2013;34:72–82. doi:10.1097/DBP.0b013e31827a3a22 [PubMed: 23363972]
18. Wolraich ML, Hagan JF Jr, Allan C, et al. ; Subcommittee on Children and Adolescents with Attention-Deficit/Hyperactive Disorder. Clinical practice guideline for the diagnosis, evaluation, and treatment of attention-deficit/hyperactivity disorder in children and adolescents. Pediatrics. 2019;144:e20192528. doi:10.1542/peds.2019-2528 [PubMed: 31570648]
19. Weiss M, Worling D, Wasdell M. A chart review study of the inattentive and combined types of ADHD. J Atten Disord. 2003;7:1–9. doi:10.1177/108705470300700101 [PubMed: 14738177]
20. Milich R, Balentine AC, Lynam DR. ADHD combined type and ADHD predominantly inattentive type are distinct and unrelated disorders. Clin Psychol (New York). 2001;8:463–488. doi:10.1093/clipsy.8.4.463
21. Daley D, Birchwood J. ADHD and academic performance: why does ADHD impact on academic performance and what can be done to support ADHD children in the classroom? Child Care Health Dev. 2010;36:455–464. doi:10.1111/j.1365-2214.2009.01046 [PubMed: 20074251]
22. Marshall RM, Hynd GW, Handwerk MJ, Hall J. Academic underachievement in ADHD subtypes. J Learn Disabil. 1997;30:635–642. doi:10.1177/002221949703000607 [PubMed: 9364901]
23. US Department of Education, Office for Civil Rights. Dear colleague letter and resource guide on students with ADHD. Published 2016. Accessed April 4, 2018. https://www2.ed.gov/about/offices/list/ocr/letters/colleague-201607-504-adhd.pdf
24. Gershon JA. A meta-analytic review of gender differences in ADHD. J Atten Disord. 2002;5:143–154. doi:10.1177/108705470200500302 [PubMed: 11911007]
25. Quinn PO, Madhoo M. A review of attention-deficit/hyperactivity disorder in women and girls: uncovering a hidden diagnosis. Prim Care Campanion CNS Disord. 2014;16:PCC.13r01596. doi:10.4088/PCC.13r01596
26. DuPaul GJ, Weyandt LL, Janusis GM. ADHD in the classroom: effective intervention strategies. Theory Pract. 2011;50:35–42. doi:10.1080/00405841.2011.534935
27. US Department of Education. Teaching children with attention deficit hyperactivity disorder: instructional strategies and practices. Published 2008. Accessed May 9, 2018. http://www2.ed.gov/rschstat/research/pubs/adhd/adhd-teaching_pg3.html
28. National Center for Health Statistics; Centers for Disease Control and Prevention. 2014 National survey of the diagnosis and treatment of attention-deficit/hyperactivity disorder and Tourette syndrome. Published 2014. Accessed April 4, 2018. http://ftp.cdc.gov/pub/Health_Statistics/NCHS/slaits/ns_data/NS_DATA_Questionnaire.pdf

Table 1.

List of Vanderbilt ADHD Parent Rating Scale Symptoms by Type, 2014 National Survey of the Diagnosis and Treatment of Attention Deficit Hyperactivity Disorder and Tourette Syndrome.

Inattention symptoms	1.	Does not pay attention to details or makes careless mistakes, such as in homework
	2.	Had difficulty sustaining attention to tasks or activities
	3.	Does not seem to listen when spoken to directly
	4.	Does not follow through on instruction and fails to finish schoolwork (not due to oppositional behavior or failure to understand)
	5.	Has difficulty organizing tasks and activities
	6.	Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort
	7.	Loses things necessary for tasks or activities (school assignments, pencils, or books)
	8.	Is easily distracted by extraneous stimuli
	9.	Is forgetful in daily activities
Hyperactive/impulsive symptoms	10.	Fidgets with hands or feet or squirms in seat
	11.	Leaves seat when remaining seated is expected
	12.	Runs about or climbs excessively in situations when remaining seated is expected
	13.	Has difficulty playing or engaging in leisure activities quietly
	14.	Is “on the go” or often acts as if “driven by a motor”
	15.	Talks too much
	16.	Blurts out answers before questions have been completed
	17.	Has difficulty waiting [his/her] turn
	18.	Interrupts or intrudes on others (butts into conversations or games)

Table 2.

Characteristics of Children 8 to 17 Years of Age by Attention-Deficit Hyperactivity Disorder (ADHD) Subtype, 2014 National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome.

Characteristics	Number in study subpopulation[a]	ADHD subtype[a]				
		Combined inattentive and hyperactive-impulsive (ADHD-C)	Predominantly inattentive (ADHD-I)	Predominantly hyperactive-impulsive (ADHD-HI)	Did not meet symptom criteria[b] for an ADHD subtype[a]	Does not have ADHD[a]
Total	2782 (100.0)	538 (22.8)	771 (27.6)	99 (3.7)	998 (31.9)	376 (13.7)
Age (years)						
8–11	737 (28.7)	238 (9.4)	174 (6.7)	45 (1.6)	222 (8.6)	58 (2.4)
12–17	2045 (71.3)	300 (13.4)	597 (20.9)	54 (2.1)	776 (23.3)	318 (11.5)
Sex						
Male	1958 (69.8)	397 (16.6)	548 (20.5)	68 (1.8)	679 (21.4)	266 (9.4)
Female	824 (30.2)	141 (6.2)	223 (7.1)	31 (1.9)	319 (10.5)	110 (4.5)
Race/ethnicity						
White, Non-Hispanic	2032 (63.4)	374 (13.3)	583 (19.3)	76 (1.9)	734 (20.0)	265 (8.8)
All others	737 (36.6)	162 (9.5)	185 (8.4)	22 (1.8)	261 (11.9)	107 (5.0)
Household poverty level						
<200% FPL	895 (48.4)	218 (13.8)	220 (12.2)	38 (2.1)	286 (14.1)	133 (6.3)
200% to 399% FPL	819 (28.3)	168 (5.6)	225 (7.5)	33 (1.2)	286 (9.7)	107 (4.3)
>400% FPL	916 (23.2)	128 (3.5)	297 (8.2)	23 (0.5)	360 (7.9)	108 (3.2)
Anxiety						
Currently has	456 (14.7)	124 (4.6)	154 (4.9)	24 (1.1)	113 (3.1)	41 (1.0)
Currently does not have	2310 (85.3)	411 (18.0)	608 (22.9)	75 (2.6)	881 (28.8)	335 (12.9)
Oppositional defiant disorder						
Currently has	298 (11.4)	115 (5.0)	89 (3.4)	17 (0.6)	60 (1.8)	17 (0.6)
Currently does not have	2446 (88.6)	414 (17.4)	670 (24.3)	79 (3.1)	924 (30.3)	359 (13.6)
Obsessive-compulsive disorder						
Currently has	266 (10.5)	112 (4.8)	60 (2.3)	12 (0.9)	55 (1.6)	27 (0.8)
Currently does not have	2495 (89.5)	423 (18.1)	705 (25.3)	87 (2.9)	933 (30.2)	347 (13.1)
Learning disorder						

Characteristics	Number in study subpopulation[a]	ADHD subtype[a]			Did not meet symptom criteria[b] for an ADHD subtype[a]	Does not have ADHD[a]
		Combined inattentive and hyperactive-impulsive (ADHD-C)	Predominantly inattentive (ADHD-I)	Predominantly hyperactive-impulsive (ADHD-HI)		
Currently has	773 (31.0)	195 (9.8)	242 (9.5)	21 (0.5)	247 (9.1)	68 (2.3)
Currently does not have	1964 (69.0)	339 (13.3)	508 (17.9)	75 (3.2)	739 (23.1)	303 (11.6)
Language disorder						
Currently has	257 (11.8)	78 (4.6)	71 (2.9)	9 (0.1)	77 (3.4)	22 (0.9)
Currently does not have	2515 (88.2)	459 (18.2)	696 (24.7)	90 (3.6)	916 (28.6)	354 (13.0)

Abbreviations: FPL, federal poverty level.

[a]Each column contains unweighted counts and weighted percentages. Children younger than 8 years were excluded from study (n = 101).

[b]Subtype is determined by having at least 6 of 9 symptoms of inattention or hyperactivity-impulsivity that occur “often” or “very often.” Combined subtype requires at least 6 of 9 symptoms in both inattention and hyperactivity-impulsivity that occur “often” or “very often.”

Clin Pediatr (Phila). Author manuscript; available in PMC 2023 June 09.

Table 3.

Number of Responses to the Vanderbilt ADHD Parent Rating Scale (VAPRS) Symptom Questions Within Each ADHD Subtype, 2014 National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome[a].

	ADHD subtype				
Vanderbilt ADHD Parent Rating Scale symptoms	**Combined inattentive and hyperactive-impulsive (ADHD-C)**	**Predominantly inattentive (ADHD-I)**	**Predominantly hyperactive-impulsive (ADHD-HI)**	**Did not meet symptom criteria for an ADHD subtype**	**Does not have ADHD**
	n (Weighted %)	**n (Weighted %)**	**n (Weighted %)**	**n (Weighted %)**	**n (Weighted %)**
Total	538 (22.8)	771 (27.6)	99 (3.7)	998 (31.9)	376 (13.7)
Inattentive symptoms					
1. Does not pay attention to details or makes careless mistakes, such as in homework	510 (95.1)	703 (89.3)	51 (52.1)	303 (34.4)	113 (24.7)
2. Had difficulty sustaining attention to tasks or activities	513 (93.4)	714 (92.3)	54 (48.7)	309 (36.7)	94 (23.8)
3. Does not seem to listen when spoken to directly	474 (87.5)	510 (69.7)	43 (51.9)	228 (21.9)	82 (19.4)
4. Does not follow through on instruction and fails to finish schoolwork (not due to oppositional behavior or failure to understand)	497 (88.9)	665 (86.2)	19 (26.9)	212 (25.3)	83 (24.1)
5. Has difficulty organizing tasks and activities	505 (91.8)	708 (91.5)	43 (36.1)	285 (29.2)	110 (30.9)
6. Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort	466 (86.7)	613 (78.1)	29 (27.8)	237 (21.7)	99 (29.0)
7. Loses things necessary for tasks or activities (school assignments, pencils, or books)	450 (85.6)	575 (76.1)	28 (16.9)	136 (15.5)	84 (23.0)
8. Is easily distracted by extraneous stimuli	525 (96.0)	716 (90.6)	74 (68.5)	433 (48.5)	134 (35.6)
9. Is forgetful in daily activities	474 (89.2)	613 (79.5)	33 (36.3)	153 (15.0)	78 (16.3)
Hyperactive/impulsive symptoms					
10. Fidgets with hands or feet or squirms in seat	492 (88.1)	335 (39.4)	87 (90.3)	262 (27.9)	75 (19.1)
11. Leaves seat when remaining seated is expected	445 (85.8)	177 (24.1)	68 (55.8)	102 (12.5)	47 (14.1)
12. Runs about or climbs excessively in situations when remaining seated is expected	348 (71.6)	67 (10.5)	43 (46.1)	38 (3.1)	24 (5.2)
13. Has difficulty playing or engaging in leisure activities quietly	390 (71.9)	104 (16.2)	58 (41.7)	62 (7.4)	40 (8.8)
14. Is “on the go” or often acts as if “driven by a motor”	477 (88.9)	230 (33.7)	80 (83.5)	173 (17.8)	67 (18.3)
15. Talks too much	482 (86.7)	288 (37.2)	89 (95.0)	269 (29.7)	104 (27.5)
16. Blurts out answers before questions have been completed	475 (85.5)	221 (31.4)	78 (87.3)	158 (15.5)	56 (14.7)
17. Has difficulty waiting [his/her] turn	504 (95.4)	235 (34.3)	85 (84.1)	148 (18.0)	62 (18.4)

Vanderbilt ADHD Parent Rating Scale symptoms	ADHD subtype				
	Combined inattentive and hyperactive-impulsive (ADHD-C)	Predominantly inattentive (ADHD-I)	Predominantly hyperactive-impulsive (ADHD-HI)	Did not meet symptom criteria for an ADHD subtype	Does not have ADHD
	n (Weighted %)	n (Weighted %)	n (Weighted %)	n (Weighted %)	n (Weighted %)
18. Interrupts or intrudes on others (butts into conversations or games)	504 (94.5)	327 (47.3)	89 (92.0)	237 (26.4)	90 (19.2)

Abbreviation: ADHD, attention-deficit hyperactivity disorder.

[a]Symptoms 1 to 9 assess inattention, and symptoms 10 to 18 assess hyperactivity/impulsivity.

Table 4.

Adjusted Odds Ratios of School Performance by Each Vanderbilt ADHD Parent Rating Scale (VAPRS) Inattentive Symptom, 2014 National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome[a].

	Problematic or somewhat problematic school performance				
	Overall	Mathematics	Reading	Writing	Handwriting
ADHD inattentive symptoms	**AOR (95% CL)**	**AOR (95% CL)**	**AOR (95% CL)**	**AOR (95% CL)**	**AOR (95% CL)**
1. Does not pay attention to details or makes careless mistakes, such as in homework	3.66 (2.52–5.32)	1.61 (1.11–2.34)	2.34 (1.57–3.49)	2.35 (1.66–3.32)	1.87 (1.32–2.65)
2. Had difficulty sustaining attention to tasks or activities	3.22 (2.23–4.67)	1.68 (1.16–2.42)	1.83 (1.25–2.68)	2.01 (1.42–2.83)	1.98 (1.41–2.79)
3. Does not seem to listen when spoken to directly	2.24 (1.59–3.17)	1.24 (0.86–1.77)	2.04 (1.39–3.01)	2.12 (1.52–2.97)	1.52 (1.08–2.12)
4. Does not follow through on instruction and fails to finish schoolwork (not due to oppositional behavior or failure to understand)	4.66 (3.24–6.70)	1.63 (1.14–2.34)	1.93 (1.33–2.81)	2.04 (1.47–2.85)	1.68 (1.21–2.32)
5. Has difficulty organizing tasks and activities	4.14 (2.84–6.03)	1.24 (0.86–1.81)	1.93 (1.32–2.84)	1.95 (1.38–2.75)	1.99 (1.41–2.81)
6. Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort	2.25 (1.58–3.20)	1.81 (1.26–2.61)	1.89 (1.29–2.76)	1.99 (1.42–2.78)	1.58 (1.13–2.21)
7. Loses things necessary for tasks or activities (school assignments, pencils, or books)	3.09 (2.16–4.42)	1.38 (0.96–1.99)	2.25 (1.54–3.28)	2.24 (1.59–3.15)	2.08 (1.49–2.90)
8. Is easily distracted by extraneous stimuli	3.31 (2.22–4.95)	1.73 (1.15–2.61)	2.08 (1.38–3.14)	1.81 (1.25–2.60)	1.59 (1.11–2.29)
9. Is forgetful in daily activities	3.06 (2.18–4.30)	1.71 (1.20–2.43)	1.85 (1.27–2.69)	2.06 (1.48–2.88)	1.76 (1.26–2.45)
Does not have ADHD[b]	1.00	1.00	1.00	1.00	1.00

Abbreviations: ADHD, attention-deficit hyperactivity disorder; AOR, adjusted odds ratio; CL, confidence limit.

[a]Each model of the symptom question controlled for age, sex, race/ethnicity, family poverty level, hyperactive symptoms, and chronic conditions/disorders: anxiety, oppositional defiant disorder, obsessive-compulsive disorder, language disorder, and learning disorder.

[b]Children who do not have ADHD served as the referent group.

Table 5.

Adjusted Odds Ratios of School Performance by ADHD Subtype, 2014 National Survey of the Diagnosis and Treatment of ADHD and Tourette Syndrome[a].

	Problematic or somewhat problematic school performance				
	Overall	Mathematics	Reading	Writing	Handwriting
ADHD subtype	**AOR (95% CL)**	**AOR (95% CL)**	**AOR (95% CL)**	**AOR (95% CL)**	**AOR (95% CL)**
Combined Inattentive and Hyperactive-Impulsive Subtype (ADHD-C)	5.84 (3.13–10.91)	1.79 (0.96–3.25)	3.78 (1.97–7.26)	2.34 (1.31–4.17)	2.42 (1.29–4.51)
Predominantly Inattentive Subtype (ADHD-I)	5.54 (3.05–10.05)	1.80 (1.04–3.12)	2.66 (1.48–4.82)	2.75 (1.63–4.65)	1.67 (0.95–2.96)
Predominantly Hyperactive-Impulsive Subtype (ADHD-HI)	2.61 (0.79–8.56)	0.73 (0.25–2.16)	2.34 (0.68–8.00)	0.55 (0.24–1.26)	1.07 (0.43–2.65)
Did not meet symptom criteria for ar ADHD Subtype	1.40 (0.79–2.50)	1.30 (0.74–2.27)	1.64 (0.93–2.88)	1.31 (0.79–2.18)	1.15 (0.66–2.00)
Does not have ADHD[b]	1.00	1.00	1.00	1.00	1.00

Abbreviations: ADHD, attention-deficit hyperactivity disorder; AOR, adjusted odds ratio; CL, confidence limit.

[a]Each model was controlled for age, sex, race/ethnicity, family poverty level, and chronic conditions/disorders: anxiety, oppositional defiant disorder, obsessive-compulsive disorder, language disorder, and learning disorder.

[b]Children who did not have ADHD served as the referent group.