

HYPERACTIVITY AND INATTENTION (ADHD)

Children with Attention Deficit Hyperactivity Disorder: Epidemiology, Comorbidity and Assessment

Alice Charach, Msc, MD

Hospital for Sick Children, Canada

April 2020, Rev. ed.

Epidemiology of ADHD

Children with Attention Deficit Hyperactivity Disorder (ADHD), characterized by developmentally excessive levels of inattention, over-activity and impulsiveness, are most frequently identified and treated in primary school. Studies worldwide identify a prevalence rate for ADHD equivalent to 5.29% (95% Confidence Interval: 5.01-5.56) of children and adolescents.¹ Rates are higher for boys than for girls, and for children under 12 years of age compared with adolescents.^{1,2} Prevalence estimates vary based on method of ascertainment, diagnostic criteria used, and whether functional impairment criteria are included.¹ Overall, estimates are remarkably similar from country to country with the exception of African and Middle Eastern countries where rates are lower compared with North America and Europe.¹

Symptoms generally interfere with academic and behaviour functioning at school, and often disrupt family and peer relationships.^{3,4} Children with ADHD use more health services and sustain more injuries than those without.^{5,6} While hyperactivity symptoms lessen in adolescence, the majority of children with ADHD continue to show some cognitive impairment, (eg, poor executive functioning, impaired working memory) relative to same-age peers through their teen years and into adulthood.^{7,8} Childhood hyperactivity is associated with subsequent onset of other psychiatric disorders, including anxiety, conduct problems, mood disorders and suicidal behaviour and antisocial personality disorder.⁹⁻¹¹ Adults with childhood history of ADHD are at greater risk of psychiatric hospitalizations and incarcerations, divorce, risky sexual and driving behaviours, increased emergency room visits, serious injuries and death.^{12,13} In addition, adults with ADHD documented in childhood show anatomical decrements in brain gray matter.¹⁴ Positive factors include parent involvement through high-school and attendance at college or university as these are associated with improved functioning at age 25.¹⁵

ADHD is an important public health concern, not only for the long-term impairments facing individuals and families but also for the heavy burden on educational, health and criminal justice systems.^{16,17}

Population studies identify that childhood inattention and hyperactivity are more common in single parent families, with low parent education attainment, parent unemployment, and low family income.^{18,19} Evidence from family studies identify that symptoms of ADHD are highly heritable,²⁰ however, early environmental factors contribute as well. History of prenatal maternal smoking and drinking, low birth weight, and developmental problems are associated with high levels of inattention and hyperactivity.²¹ Prenatal maternal smoking, maternal depression, poor parenting practices and living in a disadvantaged neighbourhood in the first year of life are all associated with later childhood behaviour problems, including inattention and hyperactivity four years later.²²⁻²⁴

Clinical identification and treatment of ADHD in North America can vary geographically, apparently reflecting differences in community practices or access to services.^{25,26} Treatment with stimulant medications for inattentive and hyperactive symptoms increased in the early to mid 1990s, and likely reflects longer periods of use with treatment extended into adolescent years as well as an increased number of girls identified and treated.²⁷⁻²⁹ Stimulant medications remain the first line pharmacological intervention for addressing symptoms of ADHD. However, combining medications with behavioural and other non-pharmacological interventions is recommended.³⁰

Concurrent (or Comorbid) Disorders

Half to two thirds of school children identified with ADHD also have concurrent psychiatric and developmental disorders, including oppositional and aggressive behaviours, anxiety, low self esteem, tic disorders, motor problems, and learning or language disabilities.³¹⁻³⁴ Sleep difficulties, including enuresis (bed-wetting), are common, with sleep-disordered breathing, a potentially correctable reason for increased inattention.^{35,36} Global impairment in children with ADHD increases with increasing numbers of concurrent disorders.³⁷ The concurrent conditions also increase the likelihood of additional difficulties developing as children become adolescents and young adults.³⁸⁻⁴¹

Neurocognitive difficulties are an important source of impairment in children with ADHD. Areas of executive functioning and working memory as well as specific language and learning disorders are common in clinic groups.⁴²⁻⁵⁰ Approximately a third of children referred for psychiatric, often behaviour problems, may have previously unrecognized language difficulties.⁵¹ Whenever possible the potential for cognitive, language and developmental problems requires evaluation so that appropriate academic interventions can be implemented.

ADHD in Preschoolers

Attention Deficit Hyperactivity Disorder usually begins before children enter school. However in the preschool age group ADHD is characterized not only by impairment in attention span, excessive impulsivity and over-activity but also is frequently accompanied by severe temper tantrums, demanding, uncooperative behaviour and aggressiveness that can interfere with attendance at daycare or preschool, avoidance of family gatherings, and high family burden of care and distress.⁵²⁻⁵⁴ These disruptive behaviours are often the target of parental concern, and many receive a diagnosis of oppositional defiant disorder. Initial interventions should address parenting challenges using behavioural interventions rather than medication in preschool-aged children.⁵⁵

Assessment of ADHD in School-Age Children

Among primary school children, concerns about learning style and behaviour difficulties are often brought to the parents' attention by classroom teachers. Educators generally anticipate that by senior kindergarten and grade 1, children should be able to follow classroom routines, follow simple instructions, play cooperatively with peers, and remain focused for 15 to 20 minutes at a time on academic tasks. Concerns raised by teachers, especially experienced ones, provide important details about a child's academic and social functioning.

The formal diagnosis of ADHD reflects pervasive and detrimental levels of inattention, distractibility, overactivity and impulsiveness. The child's symptoms must be developmentally excessive and cause impaired functioning, most often in academic or social skills, peer or family relationships. Difficulties generally have been present since preschool, although not always recognized. The troublesome behaviours are present in more than one context, at home, at school or in the community, for example on outings to the park or to a grocery store.

There are two sets of formal diagnostic rules used in Canada, DSM 5 (Diagnostic and Statistical Manual, Fifth Edition) and ICD-11 (International Classification of Disorders, Eleventh Edition, accepted in 2019 and in effect in 2022). Both sets of formal diagnostic rules classify ADHD as a neurodevelopmental disorder, in the ICD-11, the term ADHD replaces hyperkinetic disorder from ICD-10.^{56,57} There are three presentations of ADHD, predominantly inattentive presentation, where the child shows six of nine prescribed inattentive symptoms, predominately hyperactive-impulsive presentation, where the child shows six out of nine hyperactive-impulsive symptoms, and combined presentation, where the child shows high levels of both types of symptoms (see Chart 1 for diagnostic symptoms).

The clinical assessment of a child with ADHD is best done by a health professional familiar with pediatric mental health and psychosocial assessments. Since young children frequently respond to stressful circumstances with increased levels of activity and distractibility as well as difficulties in learning and social relationships, assessments of developmental, family and social contexts are required to identify alternative explanations for the impairing symptoms where appropriate. Physical contributions such as poor sleep, or chronic medical conditions should also be evaluated as explanations for or contributors to the child's difficulties. Ideally, the clinician can obtain information about the child's social and academic functioning from more than one informant who knows the child in different situations, for example, the child's parent and a teacher. Self-report surveys for parents and teachers are widely used to elicit information about specific child's behaviours in the home or school settings, respectively.⁴ In addition, a detailed clinical interview with the parents of younger children, and, for older children, with the child or youth themselves, is essential. Reviewing school reports over several years is also helpful to provide a longitudinal perspective from several teachers. An important aspect of the assessment includes identification of concurrent disorders, including learning and language disorders, as

reviewed in the section above. Psychosocial or developmental concerns should also be identified as they may complicate treatment of the ADHD and impact the long-term prognosis.

Chart 1: DSM 5 Criteria for Attention Deficit Hyperactivity Disorder⁵⁷

A. A persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, as characterized by **(1)** and/or **(2)**:

(1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is inconsistent with developmental level and that negatively impacts directly on social and academic activities:

Inattention

- a. often fails to give close attention to details or makes careless mistakes
- b. often has difficulty sustaining attention in tasks or play activities
- c. often does not seem to listen when spoken to directly
- d. often does not follow through on instructions and fails to finish schoolwork, chores or duties
- e. often has difficulty organizing tasks and activities
- f. often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort
- g. often loses things necessary for tasks or activities
- h. is often easily distracted by extraneous stimuli
- i. is often forgetful in daily activities

(2) six or more of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is inconsistent with developmental level and that negatively impacts directly on social and academic activities:

Hyperactivity and Impulsivity

- a. often fidgets with or taps hands or feet or squirms in seat
- b. often leaves seat in situations where remaining seated is expected
- c. often runs about or climbs excessively in situations in which it is inappropriate
- d. often unable to play or engage in leisure activities quietly
- e. is often “on the go”, acting as if “driven by a motor” (unable to be still for extended time)
- f. often talks excessively
- g. often blurts out an answer before a question has been completed
- h. often has difficulty waiting his or her turn
- i. often interrupts or intrudes on others

- B.** Several inattentive or hyperactive-impulsive symptoms were present prior to age 12 years.
- C.** Several inattentive or hyperactive-impulsive symptoms are present in two or more settings (eg, at school and home, in other activities).
- D.** There is clear evidence that the symptoms interfere with, or reduce the quality of, social, academic or occupational functioning.
- E.** The symptoms do not occur exclusively during the course of schizophrenia, or another psychotic disorder and are not better explained by another mental disorder (eg, mood disorder, anxiety disorder, dissociative disorder, personality disorder, substance intoxication or withdrawal).

References

- Polanczyk G, de Lima MS, Horta BL, Biederman J, Rohde LA. The worldwide prevalence of ADHD: a systematic review and meta-regression analysis. *American Journal of Psychiatry* 2007;164(6):942-948.
- Waddell C, Offord DR, Shepherd CA, Hua JM, McEwan K. Child psychiatric epidemiology and Canadian public policy-making: the state of the science and the art of the possible. *Canadian Journal of Psychiatry* 2002;47(9):825-832.
- American Academy of Pediatrics. Subcommittee on Attention-Deficit/ Hyperactivity Disorder and Committee on Quality Improvement. Clinical practice guideline: treatment of the school-aged child with attention-deficit/hyperactivity disorder. *Pediatrics* 2001;108(4):1033-1044.
- Pliszka S, AACAP Work Group on Quality Issues. Practice parameter for the assessment and treatment of children and adolescents with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry* 2007;46(7):894-921.
- Bruce B, Kirkland S, Waschbusch D. The relationship between childhood behaviour disorders and unintentional injury events. *Paediatrics & Child Health* 2007;12(9):749-754.
- Leibson CL, Katusic SK, Barbaresi WJ, Ransom J, O'Brien PC. Use and costs of medical care for children and adolescents with and without attention-deficit/hyperactivity disorder. *JAMA-Journal of the American Medical Association* 2001;285(1):60-66.
- Brassett-Harknett A, Butler N. Attention-deficit/hyperactivity disorder: an overview of the etiology and a review of the literature relating to the correlates and lifecourse outcomes for men and women. *Clinical Psychology Review* 2007;27(2):188-210.
- Spencer TJ, Biederman J, Mick E. Attention-deficit/hyperactivity disorder: diagnosis, lifespan, comorbidities, and neurobiology. *Journal of Pediatric Psychology* 2007;32(6):631-642.
- Barkley RA, Fischer M, Edelbrock CS, Smallish L. The adolescent outcome of hyperactive children diagnosed by research criteria: I. An 8-year prospective follow-up study. *Journal of the American Academy of Child & Adolescent Psychiatry* 1990;29(4):546-557.
- Biederman J, Faraone S, Milberger S, Guite J, Mick E, Chen L, Mennin D, Marris A, Ouellette C, Moore P, Spencer T, Norman D, Wilens T, Kraus I, Perrin J. A prospective 4-year follow-up study of attention-deficit hyperactivity and related disorders. *Archives of General Psychiatry* 1996;53(5):437-446.
- Copeland WE, Miller-Johnson S, Keeler G, Angold A, Costello EJ. Childhood psychiatric disorders and young adult crime: a prospective, population-based study. *American Journal of Psychiatry* 2007;164(11):1668-1675.
- Klein RG, Mannuzza S, Olazagasti MA, Roizen E, Hutchison JA, Lashua EC, Castellanos FX. Clinical and functional outcome of childhood attention-deficit/hyperactivity disorder 33 years later. *Archives of General Psychiatry* 2012;69(12):1295-1303. doi:10.1001/archgenpsychiatry.2012.271
- Ramos Olazagasti MA, Klein RG, Mannuzza S, Belsky ER, Hutchison JA, Lashua-Shriftman EC, Castellanos FX. Does childhood attention-deficit/hyperactivity disorder predict risk-taking and medical illnesses in adulthood? *Journal of the American Academy of Child and Adolescent Psychiatry* 2013;52(2):153-162.e4. doi:10.1016/j.jaac.2012.11.012
- Proal E, Reiss PT, Klein RG, Mannuzza S, Gotimer K, Ramos-Olazagasti MA, Lerch JP, He Y, Zijdenbos A, Kelly C, Milham MP, Castellanos FX. Brain gray matter deficits at 33-year follow-up in adults with attention-deficit/hyperactivity disorder established in childhood. *Archives of general psychiatry* 2011;68(11):1122-1134. doi:10.1001/archgenpsychiatry.2011.117
- Howard AL, Strickland NJ, Murray DW, Tamm L, Swanson JM, Hinshaw SP, Arnold LE, Molina B. Progression of impairment in adolescents with attention-deficit/hyperactivity disorder through the transition out of high school: Contributions of parent involvement and college attendance. *Journal of Abnormal Psychology* 2016;125(2):233-247. doi:10.1037/abn0000100
- Birnbaum HG, Kessler RC, Lowe SW, Secnik K, Greenberg PE, Leong SA, Swensen AR. Costs of attention deficit-hyperactivity disorder

(ADHD) in the US: excess costs of persons with ADHD and their family members in 2000. *Current Medical Research & Opinion* 2005;21(2):195-206.

17. Secnik K, Swensen A, Lage MJ. Comorbidities and costs of adult patients diagnosed with attention-deficit hyperactivity disorder. *Pharmacoeconomics* 2005;23(1):93-102.
18. Fergusson DM, Boden JM, Horwood LJ. Exposure to single parenthood in childhood and later mental health, educational, economic, and criminal behavior outcomes. *Archives of General Psychiatry* 2007;64(9):1089-1095.
19. St Sauver JL, Barbaresi WJ, Katusic SK, Colligan RC, Weaver AL, Jacobsen SJ. Early life risk factors for attention-deficit/hyperactivity disorder: a population-based cohort study. *Mayo Clinic Proceedings* 2004;79(9):1124-1131.
20. Faraone SV, Perlis RH, Doyle AE, Smoller JW, Goralnick JJ, Holmgren MA, Sklar P. Molecular genetics of attention-deficit/hyperactivity disorder. *Biological Psychiatry* 2005;57(11):1313-1323.
21. Fergusson DM, Woodward LJ, Horwood LJ. Maternal smoking during pregnancy and psychiatric adjustment in late adolescence. *Archives of General Psychiatry* 1998;55(8):721-727.
22. Romano E, Tremblay RE, Farhat A, Cote S. Development and prediction of hyperactive symptoms from 2 to 7 years in a population-based sample. *Pediatrics* 2006;117(6):2101-2110.
23. Elgar FJ, Curtis LJ, McGrath PJ, Waschbusch DA, Stewart SH. Antecedent-consequence conditions in maternal mood and child adjustment: a four-year cross-lagged study. *Journal of Clinical Child & Adolescent Psychology* 2003;32(3):362-374.
24. Kohen DE, Brooks-Gunn J, Leventhal T, Hertzman C. Neighborhood income and physical and social disorder in Canada: associations with young children's competencies. *Child Development* 2002;73(6):1844-1860.
25. Brownell MD, Yogendran MS. Attention-deficit hyperactivity disorder in Manitoba children: medical diagnosis and psychostimulant treatment rates. *Canadian Journal of Psychiatry* 2001;46(3):264-272.
26. Jensen PS, Kettle L, Roper MT, Sloan MT, Dulcan MK, Hoven C, Bird HR, Bauermeister JJ, Payne JD. Are stimulants overprescribed? Treatment of ADHD in four U.S. communities. *Journal of the American Academy of Child & Adolescent Psychiatry* 1999;38(7):797-804.
27. Miller AR, Lalonde CE, McGrail KM, Armstrong RW. Prescription of methylphenidate to children and youth, 1990-1996. *CMAJ ? Canadian Medical Association Journal* 2001;165(11):1489-1494.
28. Robison LM, Sclar DA, Skaer TL, Galin RS. National trends in the prevalence of attention-deficit/hyperactivity disorder and the prescribing of methylphenidate among school-age children: 1990-1995. *Clinical Pediatrics* 1999;38(4):209-217.
29. Safer DJ, Zito JM, Fine EM. Increased methylphenidate usage for attention deficit disorder in the 1990s. *Pediatrics* 1996;98(6 Pt 1):1084-1088.
30. Feldman ME, Charach A, Bélanger SA. ADHD in children and youth: Part 2-Treatment. *Paediatrics and Child Health* 2018;23(7):462-472. doi:10.1093/pch/pxy113
31. Fliers E, Vermeulen S, Rijdsdijk F, Altink M, Buschgens C, Rommelse N, Faraone S, Sergeant J, Buitelaar J, Franke B. ADHD and Poor Motor Performance From a Family Genetic Perspective. *Journal of the American Academy of Child & Adolescent Psychiatry* 2009;48(1):25-34.
32. Drabick D, Gadow K, Sprafkin J. Co-occurrence of conduct disorder and depression in a clinic-based sample of boys with ADHD. *Journal of Child Psychology and Psychiatry* 2006;47(8):766-774.
33. Kadesjo B, Gillberg C. The comorbidity of ADHD in the general population of Swedish school-age children. *Journal of Child Psychology and Psychiatry* 2001;42(4):487-492.
34. Shreeram S, He JP, Kalaydjian A, Brothers S, Merikangas KR. Prevalence of enuresis and its association with attention-deficit/hyperactivity disorder among U.S. children: results from a nationally representative study. *Journal of the American Academy of Child & Adolescent Psychiatry* 2009;48(1):35-41.
35. Corkum P, Moldofsky H, Hogg-Johnson S, Humphries T, Tannock R. Sleep problems in children with attention-deficit/hyperactivity disorder: impact of subtype, comorbidity, and stimulant medication. *Journal of the American Academy of Child & Adolescent Psychiatry* 1999;38(10):1285-1293.
36. Owens JA, Maxim R, Nobile C, McGuinn M, Msall M. Parental and self-report of sleep in children with attention-deficit/hyperactivity disorder. *Archives of Pediatrics & Adolescent Medicine* 2000;154(6):549-555.
37. Biederman J, Milberger S, Faraone SV, Kiely K, Guite J, Mick E, Ablon JS, Warburton R, Reed E, Davis SG. Impact of adversity on functioning and comorbidity in children with attention-deficit hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry* 1995;34(11):1495-1503.
38. Fischer M, Barkley RA, Edelbrock CS, Smallish L. The adolescent outcome of hyperactive children diagnosed by research criteria: II. Academic, attentional, and neuropsychological status. *Journal of Consulting & Clinical Psychology* 1990;58(5):580-588.

39. Fischer M, Barkley RA, Fletcher KE, Smallish L. The adolescent outcome of hyperactive children: predictors of psychiatric, academic, social, and emotional adjustment. *Journal of the American Academy of Child & Adolescent Psychiatry* 1993;32(2):324-332.
40. Fergusson DM, Horwood LJ. Early conduct problems and later life opportunities. *Journal of Child Psychology and Psychiatry* 1998;39(8):1097-1108.
41. Biederman J, Monuteaux MC, Mick E, Spencer T, Wilens TE, Klein KL, Price JE, Faraone SV. Psychopathology in females with attention-deficit/hyperactivity disorder: a controlled, five-year prospective study. *Biological Psychiatry* 2006;60(10):1098-1105.
42. Solanto MV, Gilbert SN, Raj A, Zhu J, Pope-Boyd S, Stepak B, Vail L, Newcorn JH. Neurocognitive functioning in AD/HD, predominantly inattentive and combined subtypes. *Journal of Abnormal Child Psychology* 2007;35(5):729-744.
43. Hinshaw SP, Carte ET, Fan C, Jassy JS, Owens EB. Neuropsychological functioning of girls with attention-deficit/hyperactivity disorder followed prospectively into adolescence: evidence for continuing deficits? *Neuropsychology* 2007;21(2):263-273.
44. Thorell LB, Wahlstedt C. Executive functioning deficits in relation to symptoms of ADHD and/or ODD in preschool children. *Infant and Child Development* 2006;15(5):503-518.
45. Loo SK, Humphrey LA, Tapio T, Moilanen IK, McGough JJ, McCracken JT, Yang MH, Dang J, Taanila A, Ebeling H, Jarvelin MR, Smalley SL. Executive functioning among Finnish adolescents with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry* 2007;46(12):1594-1604.
46. Barkley RA, Edwards G, Laneri M, Fletcher K, Metevia L. Executive functioning, temporal discounting, and sense of time in adolescents with attention deficit hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD). *Journal of Abnormal Child Psychology* 2001;29(6):541-556.
47. Beitchman JH, Brownlie EB, Inglis A, Wild J, Ferguson B, Schachter D, Lancee W, Wilson B, Mathews R. Seven-year follow-up of speech/language impaired and control children: psychiatric outcome. *Journal of Child Psychology and Psychiatry* 1996;37(8):961-970.
48. Clark C, Prior M, Kinsella G. The relationship between executive function abilities, adaptive behaviour, and academic achievement in children with externalising behaviour problems. *Journal of Child Psychology and Psychiatry* 2002;43(6):785-796.
49. Calhoun SL, Dickerson Mayes S. Processing speed in children with clinical disorders. *Psychology in the Schools* 2005; 42(4):333-343.
50. Rabiner D, Coie JD, Conduct Problems Prevention Research Group. Early attention problems and children's reading achievement: a longitudinal investigation. *Journal of the American Academy of Child & Adolescent Psychiatry* 2000;39(7):859-867.
51. Cohen NJ, Davine M, Horodezky N, Lipsett L, Isaacson L. Unsuspected language impairment in psychiatrically disturbed children: prevalence and language and behavioral characteristics. *Journal of the American Academy of Child & Adolescent Psychiatry* 1993;32(3):595-603.
52. Cunningham CE, Boyle MH. Preschoolers at risk for attention-deficit hyperactivity disorder and oppositional defiant disorder: family, parenting, and behavioral correlates. *Journal of Abnormal Child Psychology* 2002;30(6):555-569.
53. Keown LJ, Woodward LJ. Early parent-child relations and family functioning of preschool boys with pervasive hyperactivity. *Journal of Abnormal Child Psychology* 2002;30(6):541-553.
54. Greenhill LL, Posner K, Vaughan BS, Kratochvil CJ. Attention deficit hyperactivity disorder in preschool children. *Child & Adolescent Psychiatric Clinics of North America* 2008;17(2):347-366.
55. Charach A, Carson P, Fox S, Ali M, Beckett J, Lim CG. Interventions for preschool children at high risk for ADHD: A comparative effectiveness review. *Pediatrics* 2013;131(5):e1584-606
56. Reed GM, First MB, Kogan CS, et al. Innovations and changes in the ICD-11 classification of mental, behavioural and neurodevelopmental disorders. *World Psychiatry* 2019;18(1):3-19. doi:10.1002/wps.20611
57. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington D.C.: 2013.