Attention deficit hyperactivity disorder

Attention deficit hyperactivity disorder (**ADHD**) is a mental disorder of the neurodevelopmental type.[10][11] It is characterized by difficulty paying attention, excessive activity and acting without regards to consequences, which are otherwise not appropriate for a person's age.[1][2] Individuals with ADHD can also display problems with regulating emotions.[12][13][14] The symptoms appear before a person is twelve years old, are present for more than six months, and cause problems in at least two settings (such as school, home, or recreational activities).[3][15] In children, problems paying attention may result in poor school performance.[1] Additionally there is an association with other mental disorders and substance misuse.[16] Although it causes impairment, particularly in modern society, many people with ADHD can have sustained attention for tasks they find interesting or rewarding (known as hyperfocus).[5][17]

Despite being the most commonly studied and diagnosed mental disorder in children and adolescents, the exact cause is unknown in the majority of cases.[4] Genetic factors are estimated to make up about 75% of the risk.[18] Nicotine exposure during pregnancy may be an environmental risk.[19] It does not appear to be related to the style of parenting or discipline.[20] It affects about 5–7% of children when diagnosed via the DSM-IV criteria[2][21] and 1–2% when diagnosed via the ICD-10 criteria.[22] As of 2015 it is estimated to affect about 51.1 million people globally.[9] Rates are similar between countries and depend mostly on how it is diagnosed.[23] ADHD is diagnosed approximately two times more often in boys than in girls,[2] although the disorder is often overlooked in girls because their symptoms differ from those of boys.[24][25][26] About 30–50% of people diagnosed in childhood continue to have symptoms into adulthood and between 2–5% of adults have the condition.[27][28][29] In adults inner restlessness rather than hyperactivity may occur.[30] They often develop coping skills which make up for some or all of their

Attention deficit hyperactivity disorder	
Other names	Attention-deficit disorder, hyperkinetic disorder (ICD-10)
	
People with ADHD may find it more difficult than others to focus on and complete tasks such as schoolwork.	
Specialty	Psychiatry, pediatrics
Symptoms	Difficulty paying attention, excessive activity, difficulty controlling behavior[1][2]
Usual onset	Before age 6–12[3]
Duration	>6 months[3]
Causes	Both genetic and environmental factors[4][5]
Diagnostic method	Based on symptoms after other possible causes ruled out[1]
Differential diagnosis	Normally active young child, conduct disorder, oppositional defiant disorder, learning disorder, bipolar disorder[6]
Treatment	Counseling, lifestyle changes, medications[1]
Medication	Stimulants, atomoxetine, guanfacine, clonidine[7][8]
Frequency	51.1 million (2015)[9]

impairments.[31] The condition can be difficult to tell apart from other conditions, as well as to distinguish from high levels of activity that are still within the range of normative behaviors.[15]

ADHD management recommendations vary by country and usually involve some combination of counseling, lifestyle changes, and medications.[1] The British guideline only recommends medications as a first-line treatment in children who have severe symptoms and for medication to be considered in those with moderate symptoms who either refuse or fail to improve with counseling, though for adults medications are a first-line treatment.[32] Canadian and American guidelines recommend behavioral management first line in preschool-aged children while medications and behavioral therapy together is recommended after that.[33][34][35] Treatment with stimulants is effective for at least 14 months; however, their long-term effectiveness is unclear and there are potentially serious side effects.[36][37][38][39][40][41][42]

The medical literature has described symptoms similar to those of ADHD since the 18th century.[43] ADHD, its diagnosis, and its treatment have been considered controversial since the 1970s.[44] The controversies have involved clinicians, teachers, policymakers, parents, and the media. Topics include ADHD's causes and the use of stimulant medications in its treatment.[45] Most healthcare providers accept ADHD as a genuine disorder in children and adults, and the debate in the scientific community mainly centers on how it is diagnosed and treated.[46][47][48] The condition was officially known as **attention-deficit disorder** (**ADD**) from 1980 to 1987, while before this it was known as **hyperkinetic reaction of childhood**.[49][50]

Contents

Signs and symptoms

Inattention, hyperactivity (restlessness in adults), disruptive behavior, and impulsivity are common in ADHD.[52][53] Academic difficulties are frequent as are problems with relationships.[52] The symptoms can be difficult to define, as it is hard to draw a line at where normal levels of inattention, hyperactivity, and impulsivity end and significant levels requiring interventions begin.[54]

According to the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V), symptoms must be present for six months or more to a degree that is much greater than others of the same age[2] and they must cause significant problems functioning in at least two settings (e.g., social, school/work, or home).[2] The criteria must have been met prior to age twelve in order to receive a diagnosis of ADHD.[2] This requires more than 5 symptoms of inattention or hyperactivity/impulsivity for those under 17 and more than 4 for those over 16 years old.[2]

ADHD symptoms[51]	
Inattention	**Hyperactivity-impulsivity**
▪ difficulty paying close attention to details ▪ has trouble holding attention on tasks ▪ has trouble organizing tasks and activities ▪ loses things necessary for tasks ▪ appears forgetful in daily activities ▪ has a shorter attention span and is easily distracted ▪ difficulty with structured schoolwork ▪ difficulty completing tasks that are tedious or time-consuming	▪ unable to sit still ▪ fidgets, squirms in seat ▪ leaves seat in inappropriate situations ▪ takes risks with little thought for the dangers ▪ "on the go" or "driven by a motor" ▪ talking more than others ▪ often answers quickly ▪ has trouble waiting their turn ▪ interrupts or intrudes on conversations

Subtypes

ADHD is divided into three subtypes: predominantly inattentive (ADHD-PI or ADHD-I), predominantly hyperactive-impulsive (ADHD-PH or ADHD-HI), and combined type (ADHD-C).[2][54]

A person with ADHD inattentive type has most or all of following symptoms, excluding situations where these symptoms are better explained by another psychiatric or medical condition:[2][55]

- Be easily distracted, miss details, forget things, and frequently switch from one activity to another
- Have difficulty maintaining focus on one task
- Become bored with a task after only a few minutes, unless doing something they find enjoyable

- Have difficulty focusing attention on organizing or completing a task
- Have trouble completing or turning in homework assignments, often losing things (e.g., pencils, toys, assignments) needed to complete tasks or activities
- Appear not to be listening when spoken to
- Daydream, become easily confused, and move slowly
- Have difficulty processing information as quickly and accurately as others
- Struggle to follow instructions
- Have trouble understanding details; overlooks details

A person with ADHD hyperactive-impulsive type has most or all of the following symptoms, excluding situations where these symptoms are better explained by another psychiatric or medical condition:[2][55]

- Fidget or squirm a great deal
- Talk nonstop
- Dash around, touching or playing with anything and everything in sight
- Have trouble sitting still during dinner, school, and while doing homework
- Be constantly in motion
- Have difficulty performing quiet tasks or activities
- Be impatient
- Blurt out inappropriate comments, show their emotions without restraint, and act without regard for consequences
- Have difficulty waiting for things they want or waiting their turn in games
- Often interrupt conversations or others' activities

Girls with ADHD tend to display fewer hyperactivity and impulsivity symptoms but more symptoms pertaining to inattention and distractibility.[56] Symptoms of hyperactivity tend to go away with age and turn into "inner restlessness" in teens and adults with ADHD.[27]

People with ADHD of all ages are more likely to have problems with social skills, such as social interaction and forming and maintaining friendships. This is true for all subtypes. About half of children and adolescents with ADHD experience social rejection by their peers compared to 10–15% of non-ADHD children and adolescents. People with attention deficits are prone to having difficulty processing verbal and nonverbal language which can negatively affect social interaction. They also may drift off during conversations, miss social cues, and have trouble learning social skills.[57]

Difficulties managing anger are more common in children with ADHD[58] as are poor handwriting[59] and delays in speech, language and motor development.[60][61] Although it causes significant difficulty, many children with ADHD have an attention span equal to or better than that of other children for tasks and subjects they find interesting.[17]

Associated disorders

In children, ADHD occurs with other disorders about two-thirds of the time.[17] Some commonly associated conditions include:

- Epilepsy[62]
- Tourette's syndrome[62]
- Autism spectrum disorder (ASD): this disorder affects social skills, ability to communicate, behaviour, and interests.[62]

- Anxiety disorders have been found to occur more commonly in the ADHD population.[63]
- Intermittent explosive disorder[2]
- Learning disabilities have been found to occur in about 20–30% of children with ADHD. Learning disabilities can include developmental speech and language disorders and academic skills disorders.[64] ADHD, however, is not considered a learning disability, but it very frequently causes academic difficulties.[64]
- Obsessive–compulsive disorder (OCD) can co-occur with ADHD and shares many of its characteristics.[65]
- Intellectual disabilities[2]
- Reactive attachment disorder[2]
- Substance use disorders. Adolescents and adults with ADHD are at increased risk of substance abuse.[27] This is most commonly seen with alcohol or cannabis.[27] The reason for this may be an altered reward pathway in the brains of ADHD individuals.[27] This makes the evaluation and treatment of ADHD more difficult, with serious substance misuse problems usually treated first due to their greater risks.[66][67]
- Sleep disorders and ADHD commonly co-exist. They can also occur as a side effect of medications used to treat ADHD. In children with ADHD, insomnia is the most common sleep disorder with behavioral therapy the preferred treatment.[68][69] Problems with sleep initiation are common among individuals with ADHD but often they will be deep sleepers and have significant difficulty getting up in the morning.[70] Melatonin is sometimes used in children who have sleep onset insomnia.[71]
- Oppositional defiant disorder (ODD) and conduct disorder (CD), which occur with ADHD in about 50% and 20% of cases respectively.[72] They are characterized by antisocial behaviors such as stubbornness, aggression, frequent temper tantrums, deceitfulness, lying, and stealing.[65] About half of those with hyperactivity and ODD or CD develop antisocial personality disorder in adulthood.[73] Brain imaging supports that conduct disorder and ADHD are separate conditions.[74]
- Primary disorder of vigilance, which is characterized by poor attention and concentration, as well as difficulties staying awake. These children tend to fidget, yawn and stretch and appear to be hyperactive in order to remain alert and active.[75]
- Sluggish cognitive tempo (SCT) is a cluster of symptoms that potentially comprises another attention disorder. It may occur in 30–50% of ADHD cases, regardless of the subtype.[76]
- Stereotypic movement disorder[2]
- Mood disorders (especially bipolar disorder and major depressive disorder). Boys diagnosed with the combined ADHD subtype are more likely to have a mood disorder.[63] Adults with ADHD sometimes also have bipolar disorder, which requires careful assessment to accurately diagnose and treat both conditions.[77]
- Restless legs syndrome has been found to be more common in those with ADHD and is often due to iron deficiency anemia.[78][79] However, restless legs can simply be a part of ADHD and requires careful assessment to differentiate between the two disorders.[80]
- People with ADHD have an increased risk of persistent bed wetting.[81]
- A 2016 systematic review found a well established association between ADHD and obesity, asthma and sleep disorders, and tentative evidence for association with celiac disease and migraine,[82] while another 2016 systematic review did not support a clear link between celiac disease and ADHD, and stated that routine screening for celiac disease in people with ADHD is discouraged.[83]

Intelligence

Overall, studies have shown that people with ADHD tend to have lower scores on intelligence quotient (IQ) tests.[84] The significance of this is controversial due to the differences between people with ADHD and the difficulty determining the influence of symptoms, such as distractibility, on lower scores rather than intellectual capacity.[84] In studies of ADHD, higher IQs may be over represented because many studies exclude individuals who have lower IQs despite those with ADHD scoring on average nine points lower on standardized intelligence measures.[85]

Studies of adults suggest that differences in intelligence are not meaningful and may be explained by associated health problems.[86]

Causes

Most ADHD cases are of unknown causes.[87][88] It is believed to involve interactions between genetics, the environment, and social factors.[87][88][89] Certain cases are related to previous infection or trauma to the brain.[87]

Genetics

Twin studies indicate that the disorder is often inherited from one's parents with genetics determining about 74% of cases.[38][90][91] Siblings of children with ADHD are three to four times more likely to develop the disorder than siblings of children without the disorder.[92] Genetic factors are also believed to be involved in determining whether ADHD persists into adulthood.[93]

Typically, a number of genes are involved, many of which directly affect dopamine neurotransmission.[94][95] Those involved with dopamine include DAT, DRD4, DRD5, TAAR1, MAOA, COMT, and DBH.[95][96][97] Other genes associated with ADHD include SERT, HTR1B, SNAP25, GRIN2A, ADRA2A, TPH2, and BDNF.[94][95] A common variant of a gene called Latrophilin 3 is estimated to be responsible for about 9% of cases and when this variant is present, people are particularly responsive to stimulant medication.[98] The 7 repeat variant of dopamine receptor D4 (DRD4–7R) causes increased inhibitory effects induced by dopamine and is associated with ADHD. The DRD4 receptor is a G protein-coupled receptor that inhibits adenylyl cyclase. The DRD4–7R mutation results in a wide range of behavioral phenotypes, including ADHD symptoms reflecting split attention.[99]

Evolution may have played a role in the high rates of ADHD, particularly hyperactive and impulsive traits in males.[100] Some have hypothesized that some women may be more attracted to males who are risk takers, increasing the frequency of genes that predispose to hyperactivity and impulsivity in the gene pool.[101] Others have claimed that these traits may be an adaptation that help males face stressful or dangerous environments with, for example, increased impulsivity and exploratory behavior.[100][101] In certain situations, ADHD traits may have been beneficial to society as a whole even while being harmful to the individual.[100][101][102] The high rates and heterogeneity of ADHD may have increased reproductive fitness and benefited society by adding diversity to the gene pool despite being detrimental to the individual.[102] In certain environments, some ADHD traits may have offered personal advantages to individuals, such as quicker response to predators or superior hunting skills.[103]

People with Down syndrome are more likely to have ADHD.[104]

The DRD4 gene is both linked to novelty seeking and ADHD.[105] In the Ariaal people of Kenya, the 7R allele of this gene results in better health in those who are nomadic but not those who are living in one spot.[105]

Environment

In addition to genetics, some environmental factors might play a role in causing ADHD.[106] Alcohol intake during pregnancy can cause fetal alcohol spectrum disorders which can include ADHD or symptoms like it.[107] Children exposed to certain toxic substances, such as lead or polychlorinated biphenyls, may develop problems which resemble ADHD.[4][108] Exposure to the organophosphate insecticides chlorpyrifos and dialkyl phosphate is associated with an increased risk; however, the evidence is not conclusive.[109] Exposure to tobacco smoke during pregnancy can cause problems with central nervous system development and can increase the risk of ADHD.[4][110]

Extreme premature birth, very low birth weight, and extreme neglect, abuse, or social deprivation also increase the risk[4][111] as do certain infections during pregnancy, at birth, and in early childhood. These infections include, among others, various viruses (measles, varicella zoster encephalitis, rubella, enterovirus 71).[112] There is an association between long term but not short term use of acetaminophen during pregnancy and ADHD.[113][114] At least 30% of children with a traumatic brain injury later develop ADHD[115] and about 5% of cases are due to brain damage.[116]

Some studies suggest that in a small number of children, artificial food dyes or preservatives may be associated with an increased prevalence of ADHD or ADHD-like symptoms,[4][117] but the evidence is weak and may only apply to children with food sensitivities.[117][118][119] The United Kingdom and the European Union have put in place regulatory measures based on these concerns.[120] In a minority of children, intolerances or allergies to certain foods may worsen ADHD symptoms.[121]

Research does not support popular beliefs that ADHD is caused by eating too much refined sugar, watching too much television, parenting, poverty or family chaos; however, they might worsen ADHD symptoms in certain people.[53]

Society

The youngest children in a class have been found to be more likely to be diagnosed as having ADHD, possibly due to their being developmentally behind their older classmates.[122][123][124] This effect has been seen across a number of countries.[124] They also appear to use ADHD medications at nearly twice the rate as their peers.[125]

In some cases, the diagnosis of ADHD may reflect a dysfunctional family or a poor educational system, rather than problems with the individuals themselves.[126] In other cases, it may be explained by increasing academic expectations, with a diagnosis being a method for parents in some countries to get extra financial and educational support for their child.[116] Typical behaviors of ADHD occur more commonly in children who have experienced violence and emotional abuse.[38]

The social construct theory of ADHD suggests that because the boundaries between "normal" and "abnormal" behavior are socially constructed, (i.e. jointly created and validated by all members of society, and in particular by physicians, parents, teachers, and others) it then follows that subjective valuations and judgements determine which diagnostic criteria are used and, thus, the number of people affected.[127] This could lead to the situation where the DSM-IV arrives at levels of ADHD three to four times higher than those obtained with the ICD-10.[26] Thomas Szasz, a supporter of this theory, has argued that ADHD was " ... invented and then given a name".[128]

Pathophysiology

Current models of ADHD suggest that it is associated with functional impairments in some of the brain's neurotransmitter systems, particularly those involving dopamine and norepinephrine.[129][130] The dopamine and norepinephrine pathways that originate in the ventral tegmental area and locus coeruleus project to diverse regions of the brain and govern a variety of cognitive processes.[129][131] The dopamine pathways and norepinephrine pathways which project to the prefrontal cortex and striatum are directly responsible for modulating executive function (cognitive control of behavior), motivation, reward perception, and motor function;[129][130][131] these pathways are known to play a central role in the pathophysiology of ADHD.[129][131][132][133] Larger models of ADHD with additional pathways have been proposed.[130][132][133]

Brain structure

In children with ADHD, there is a general reduction of volume in certain brain structures, with a proportionally greater decrease in the volume in the left-sided prefrontal cortex.[130][134] The posterior parietal cortex also shows thinning in ADHD individuals compared to controls.[130] Other brain structures in the prefrontal-striatal-cerebellar and prefrontal-striatal-thalamic circuits have also been found to differ between people with and without ADHD.[130][132][133]

The left prefrontal cortex is often affected in ADHD.

The subcortical volumes of the accumbens, amygdala, caudate, hippocampus, and putamen appears smaller in individuals with ADHD compared with controls.[135] Inter-hemispheric asymmetries in white matter tracts have also been noted in ADHD youths, suggesting that disruptions in temporal integration may be related to the behavioral characteristics of ADHD.[136]

Neurotransmitter pathways

Previously it was thought that the elevated number of dopamine transporters in people with ADHD was part of the pathophysiology but it appears that the elevated numbers are due to adaptation to exposure to stimulants.[137] Current models involve the mesocorticolimbic dopamine pathway and the locus coeruleus-noradrenergic system.[129][130][131] ADHD psychostimulants possess treatment efficacy because they increase neurotransmitter activity in these systems.[130][131][138] There may additionally be abnormalities in serotoninergic, glutamatergic, or cholinergic pathways.[138][139][140]

Executive function and motivation

The symptoms of ADHD arise from a deficiency in certain executive functions (e.g., attentional control, inhibitory control, and working memory).[70][130][131][141] Executive functions are a set of cognitive processes that are required to successfully select and monitor behaviors that facilitate the attainment of one's chosen goals.[70][131][141] The executive function impairments that occur in ADHD individuals result in problems with staying organized, time keeping, excessive procrastination, maintaining concentration, paying attention, ignoring distractions, regulating emotions, and remembering details.[70][130][131] People with ADHD appear to have unimpaired long-term memory, and deficits in

long-term recall appear to be attributed to impairments in working memory.[70][142] The criteria for an executive function deficit are met in 30–50% of children and adolescents with ADHD.[143] One study found that 80% of individuals with ADHD were impaired in at least one executive function task, compared to 50% for individuals without ADHD.[144] Due to the rates of brain maturation and the increasing demands for executive control as a person gets older, ADHD impairments may not fully manifest themselves until adolescence or even early adulthood.[70]

ADHD has also been associated with motivational deficits in children.[145] Children with ADHD often find it difficult to focus on long-term over short-term rewards, and exhibit impulsive behavior for short-term rewards.[145]

Diagnosis

ADHD is diagnosed by an assessment of a child's behavioral and mental development, including ruling out the effects of drugs, medications and other medical or psychiatric problems as explanations for the symptoms.[66] It often takes into account feedback from parents and teachers[15] with most diagnoses begun after a teacher raises concerns.[116] It may be viewed as the extreme end of one or more continuous human traits found in all people.[146] Whether someone responds to medications does not confirm or rule out the diagnosis. As imaging studies of the brain do not give consistent results between individuals, they are only used for research purposes and not diagnosis.[147]

In North America, DSM-5 criteria are used for diagnosis, while European countries usually use the ICD-10. With the DSM-IV criteria a diagnosis of ADHD is 3–4 times more likely than with the ICD-10 criteria.[26] It is classified as neurodevelopmental psychiatric disorder.[11][27] Additionally, it is classified as a disruptive behavior disorder along with oppositional defiant disorder, conduct disorder, and antisocial personality disorder.[148] A diagnosis does not imply a neurological disorder.[38]

Associated conditions that should be screened for include anxiety, depression, oppositional defiant disorder, conduct disorder, and learning and language disorders. Other conditions that should be considered are other neurodevelopmental disorders, tics, and sleep apnea.[149]

Diagnosis of ADHD using quantitative electroencephalography (QEEG) is an ongoing area of investigation, although the value of QEEG in ADHD is currently unclear.[150][151] In the United States, the Food and Drug Administration has approved the use of QEEG to evaluate ADHD.[152] The approved test uses the ratio of EEG theta to beta activity to guide diagnosis; however, at least five studies have failed to replicate the finding.[153][154]

Self-rating scales, such as the ADHD rating scale and the Vanderbilt ADHD diagnostic rating scale are used in the screening and evaluation of ADHD.[155]

Diagnostic and Statistical Manual

As with many other psychiatric disorders, formal diagnosis should be made by a qualified professional based on a set number of criteria. In the United States, these criteria are defined by the American Psychiatric Association in the DSM. Based on the DSM criteria, there are three sub-types of ADHD:[2][51]

1. ADHD predominantly inattentive type (ADHD-PI) presents with symptoms including being easily distracted, forgetful, daydreaming, disorganization, poor concentration, and difficulty

completing tasks.[2][3]

2. ADHD, predominantly hyperactive-impulsive type presents with excessive fidgetiness and restlessness, hyperactivity, difficulty waiting and remaining seated, immature behavior; destructive behaviors may also be present.[2][3]
3. ADHD, combined type is a combination of the first two subtypes.[2][3]

This subdivision is based on presence of at least six out of nine long-term (lasting at least six months) symptoms of inattention, hyperactivity–impulsivity, or both.[156] To be considered, the symptoms must have appeared by the age of six to twelve and occur in more than one environment (e.g. at home and at school or work).[3] The symptoms must be inappropriate for a child of that age[3][157] and there must be clear evidence that they are causing social, school or work related problems.[156]

International Classification of Diseases

In the tenth revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) by the World Health Organization, the symptoms of "hyperkinetic disorder" are analogous to ADHD in the DSM-5. When a conduct disorder (as defined by ICD-10)[60] is present, the condition is referred to as *hyperkinetic conduct disorder*. Otherwise, the disorder is classified as *disturbance of activity and attention*, *other hyperkinetic disorders* or *hyperkinetic disorders, unspecified*. The latter is sometimes referred to as *hyperkinetic syndrome*.[60]

In the implementation version of ICD-11, the disorder is classified under 6A05 *(Attention deficit hyperactivity disorder)* and hyperkinetic disorder no longer exists.[158]

Adults

Adults with ADHD are diagnosed under the same criteria, including that their signs must have been present by the age of six to twelve. Questioning parents or guardians as to how the person behaved and developed as a child may form part of the assessment; a family history of ADHD also adds weight to a diagnosis.[27] While the core symptoms of ADHD are similar in children and adults they often present differently in adults than in children, for example excessive physical activity seen in children may present as feelings of restlessness and constant mental activity in adults.[27]

It is estimated that between 2–5% of adults have ADHD.[27] Around 25–50% of children with ADHD continue to experience ADHD symptoms into adulthood, while the rest experiences fewer or no symptoms.[2][27] Currently, most adults remain untreated.[159] Many adults with ADHD without diagnosis and treatment have a disorganized life and some use non-prescribed drugs or alcohol as a coping mechanism.[31] Other problems may include relationship and job difficulties, and an increased risk of criminal activities.[27] Associated mental health problems include: depression, anxiety disorder, and learning disabilities.[31]

Some ADHD symptoms in adults differ from those seen in children. While children with ADHD may climb and run about excessively, adults may experience an inability to relax, or they talk excessively in social situations. Adults with ADHD may start relationships impulsively, display sensation-seeking behavior, and be short-tempered. Addictive behavior such as substance abuse and gambling are common. The DSM-V criteria do specifically deal with adults, unlike those in DSM-IV, which were criticized for not being appropriate for adults; those who presented differently may lead to the claim that they outgrew the diagnosis.[27]

Having ADHD symptoms since childhood is usually required to be diagnosed with adult ADHD. However, a proportion of adults who meet criteria for ADHD would not have been diagnosed with ADHD as children. Most cases of late-onset ADHD develop the disorder between the ages of 12-16 and can therefore be considered early adult or adolescent onset ADHD.[160]

Differential diagnosis

ADHD symptoms which are related to other disorders[161]		
Depression	**Anxiety disorder**	**Bipolar disorder**
▪ feelings of hopelessness, low self-esteem or unhappiness ▪ loss of interest in hobbies or regular activities ▪ fatigue ▪ sleep problems ▪ difficulty maintaining attention ▪ change in appetite ▪ irritability or hostility ▪ low tolerance for stress ▪ thoughts of death ▪ unexplained pain	▪ persistent feeling of anxiety ▪ irritability ▪ occasional feelings of panic or fear ▪ being hyperalert ▪ inability to pay attention ▪ tire easily ▪ low tolerance for stress ▪ difficulty maintaining attention	**in manic state** ▪ excessive happiness ▪ hyperactivity ▪ racing thoughts ▪ aggression ▪ excessive talking ▪ grandiose delusions ▪ decreased need for sleep ▪ inappropriate social behavior ▪ difficulty maintaining attention **in depressive state** ▪ same symptoms as in depression section

Symptoms of ADHD, such as low mood and poor self-image, mood swings, and irritability, can be confused with dysthymia, cyclothymia or bipolar disorder as well as with borderline personality disorder.[27] Some symptoms that are due to anxiety disorders, antisocial personality disorder, developmental disabilities or mental retardation or the effects of substance abuse such as intoxication and withdrawal can overlap with some ADHD. These disorders can also sometimes occur along with ADHD. Medical conditions which can cause ADHD type symptoms include: hyperthyroidism, seizure disorder, lead toxicity, hearing deficits, hepatic disease, sleep apnea, drug interactions, untreated celiac disease, and head injury.[31][83]

Primary sleep disorders may affect attention and behavior and the symptoms of ADHD may affect sleep.[162] It is thus recommended that children with ADHD be regularly assessed for sleep problems.[163] Sleepiness in children may result in symptoms ranging from the classic ones of yawning and rubbing the eyes, to hyperactivity and inattentiveness.[164] Obstructive sleep apnea can also cause ADHD type symptoms.[164] Rare tumors called pheochromocytomas and paragangliomas may cause similar symptoms to ADHD.[165]

Biomarker research

Reviews of ADHD biomarkers have noted that platelet monoamine oxidase expression, urinary norepinephrine, urinary MHPG, and urinary phenethylamine levels consistently differ between ADHD individuals and healthy control.[166] These measurements could potentially serve as diagnostic

biomarkers for ADHD, but more research is needed to establish their diagnostic utility.[166] Urinary and blood plasma phenethylamine concentrations are lower in ADHD individuals relative to controls and the two most commonly prescribed drugs for ADHD, amphetamine and methylphenidate, increase phenethylamine biosynthesis in treatment-responsive individuals with ADHD.[96][166] Lower urinary phenethylamine concentrations are also associated with symptoms of inattentiveness in ADHD individuals.[166] Electroencephalography (EEG) is not accurate enough to make the diagnosis.[167]

Management

The management of ADHD typically involves counseling or medications either alone or in combination. While treatment may improve long-term outcomes, it does not get rid of negative outcomes entirely.[168] Medications used include stimulants, atomoxetine, alpha-2 adrenergic receptor agonists, and sometimes antidepressants.[63][138] In those who have trouble focusing on long-term rewards, a large amount of positive reinforcement improves task performance.[145] ADHD stimulants also improve persistence and task performance in children with ADHD.[130][145]

Behavioral therapies

There is good evidence for the use of behavioral therapies in ADHD and they are the recommended first line treatment in those who have mild symptoms or are preschool-aged.[169][170] Psychological therapies used include: psychoeducational input, behavior therapy, cognitive behavioral therapy (CBT), interpersonal psychotherapy, family therapy, school-based interventions, social skills training, behavioral peer intervention, organization training,[171] parent management training,[38] and neurofeedback.[172] Parent training may improve a number of behavioral problems including oppositional and noncompliant behaviors.[173] It is unclear if neurofeedback is useful.[174]

There is little high quality research on the effectiveness of family therapy for ADHD, but the evidence that exists shows that it is similar to community care and better than a placebo.[175] ADHD-specific support groups can provide information and may help families cope with ADHD.[176]

Training in social skills, behavioral modification and medication may have some limited beneficial effects. The most important factor in reducing later psychological problems, such as major depression, criminality, school failure, and substance use disorders is formation of friendships with people who are not involved in delinquent activities.[177]

Regular physical exercise, particularly aerobic exercise, is an effective add-on treatment for ADHD in children and adults, particularly when combined with stimulant medication, although the best intensity and type of aerobic exercise for improving symptoms are not currently known.[178][179][180] In particular, the long-term effects of regular aerobic exercise in ADHD individuals include better behavior and motor abilities, improved executive functions (including attention, inhibitory control, and planning, among other cognitive domains), faster information processing speed, and better memory.[178][179][180] Parent-teacher ratings of behavioral and socio-emotional outcomes in response to regular aerobic exercise include: better overall function, reduced ADHD symptoms, better self-esteem, reduced levels of anxiety and depression, fewer somatic complaints, better academic and classroom behavior, and improved social behavior.[178] Exercising while on stimulant medication augments the effect of stimulant medication on executive function.[178] It is believed that these short-term effects of exercise are mediated by an increased abundance of synaptic dopamine and norepinephrine in the brain.[178]

Medication

Stimulant medications are the pharmaceutical treatment of choice.[42][181] They have at least some effect on symptoms, in the short term, in about 80% of people.[45][41][181] Methylphenidate appears to improve symptoms as reported by teachers and parents.[41][45][182] Stimulants may also reduce the risk of unintentional injuries in children with ADHD.[183]

There are a number of non-stimulant medications, such as atomoxetine, bupropion, guanfacine, and clonidine that may be used as alternatives, or added to stimulant therapy.[42][184] There are no good studies comparing the various medications; however, they appear more or less equal with respect to side effects.[185] Stimulants appear to improve academic performance while atomoxetine does not.[186] Atomoxetine, due to its lack of addiction liability, may be preferred in those who are at risk of recreational or compulsive stimulant use.[27] There is little evidence on the effects of medication on social behaviors.[185] As of June 2015, the long-term effects of ADHD medication have yet to be fully determined.[187][188] Magnetic resonance imaging studies suggest that long-term treatment with amphetamine or methylphenidate decreases abnormalities in brain structure and function found in subjects with ADHD.[189][190][191] A 2018 review found the greatest short-term benefit with methylphenidate in children and amphetamines in adults.[192]

Guidelines on when to use medications vary by country. The United Kingdom's National Institute for Health and Care Excellence (NICE) recommending use for children only in severe cases, though for adults medication is a first-line treatment. However, most United States guidelines recommend medications in most age groups.[33] Medications are not recommended for preschool children.[38][193] Underdosing of stimulants can occur and result in a lack of response or later loss of effectiveness.[194] This is particularly common in adolescents and adults as approved dosing is based on school-aged children, causing some practitioners to use weight based or benefit based off-label dosing instead.[195][196][197]

While stimulants and atomoxetine are usually safe, there are side-effects and contraindications to their use.[42] There is low quality evidence of an association between methylphenidate and both serious and non-serious harmful side effects when taken by children and adolescents.[36] Careful monitoring of children while taking this medication is recommended.[36] A large overdose on ADHD stimulants is commonly associated with symptoms such as stimulant psychosis and mania.[198] Although very rare, at therapeutic doses these events appear to occur in approximately 0.1% of individuals within the first several weeks after starting amphetamine therapy.[198][199][200] Administration of an antipsychotic medication has been found to effectively resolve the symptoms of acute amphetamine psychosis.[198] Regular monitoring has been recommended in those on long-term treatment.[201] Stimulant therapy should be stopped periodically to assess continuing need for medication, decrease possible growth delay, and reduce tolerance.[202][203] Long-term misuse of stimulant medications at doses above the therapeutic range for ADHD treatment is associated with addiction and dependence.[204][205] Untreated ADHD, however, is also associated with elevated risk of substance use disorders and conduct disorders.[204] The use of stimulants appears to either reduce this risk or have no effect on it.[27][187][204] The safety of these medications in pregnancy is unclear.[206] Antipsychotics may also be used to treat aggression in ADHD.[207]

Diet

Dietary modifications are not recommended as of 2019 by the American Academy of Pediatrics due to insufficient evidence.[35] Though some evidence supports benefit in a small proportion of children with ADHD.[208] A 2013 meta-analysis found less than a third of children with ADHD see some improvement in symptoms with free fatty acid supplementation or decreased eating of artificial food coloring.[118] These benefits may be limited to children with food sensitivities or those who are simultaneously being treated with ADHD medications.[118] This review also found that evidence does not support removing other foods from the diet to treat ADHD.[118] A 2014 review found that an elimination diet results in a small overall benefit.[121] A 2016 review stated that the use of a gluten-free diet as standard ADHD treatment is not advised.[83] A 2017 review showed that a few-foods elimination diet may help children too young to be medicated or not responding to medication, while free fatty acid supplementation or decreased eating of artificial food coloring as standard ADHD treatment is not advised.[209] Chronic deficiencies of iron, magnesium and iodine may have a negative impact on ADHD symptoms.[210] There is a small amount of evidence that lower tissue zinc levels may be associated with ADHD.[211] In the absence of a demonstrated zinc deficiency (which is rare outside of developing countries), zinc supplementation is not recommended as treatment for ADHD.[212] However, zinc supplementation may reduce the minimum effective dose of amphetamine when it is used with amphetamine for the treatment of ADHD.[213] There is evidence of a modest benefit of omega 3 fatty acid supplementation, but it is not recommended in place of traditional medication.[214][215]

Prognosis

ADHD persists into adulthood in about 30–50% of cases.[28] Those affected are likely to develop coping mechanisms as they mature, thus compensating to some extent for their previous symptoms.[31] Children with ADHD have a higher risk of unintentional injuries.[183] One study from Denmark found an increased risk of death among those with ADHD due to the increased rate of accidents.[216] Effects of medication on functional impairment and quality of life (e.g. reduced risk of accidents) have been found across multiple domains. But executive function deficits have a limited respond to ADHD medications.[217] Rates of smoking among those with ADHD are higher than in the general population at about 40%.[218]

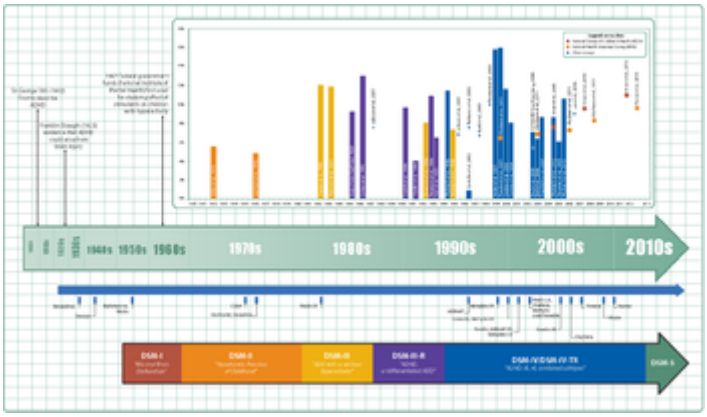
Epidemiology

ADHD is estimated to affect about 6–7% of people aged 18 and under when diagnosed via the DSM-IV criteria.[21] When diagnosed via the ICD-10 criteria rates in this age group are estimated at 1–2%.[22] Children in North America appear to have a higher rate of ADHD than children in Africa and the Middle East; this is believed to be due to differing methods of diagnosis rather than a difference in underlying frequency.[219] If the same diagnostic methods are used, the rates are more or less the same between countries.[23] It is diagnosed approximately three times more often in boys than in girls.[25][26] This difference between sexes may reflect either a difference in susceptibility or that females with ADHD are less likely to be diagnosed than males.[220]

Rates of diagnosis and treatment have increased in both the United Kingdom and the United States since the 1970s.[221] Prior to 1970, it was rare for children to be diagnosed with ADHD while in the 1970s rates were about 1%.[222] This is believed to be primarily due to changes in how the condition is diagnosed[221] and how readily people are willing to treat it with medications rather than a true change in how common the condition is.[22] It is believed that changes to the diagnostic criteria in 2013 with the release of the DSM-5 will increase the percentage of people diagnosed with ADHD, especially among adults.[223]

History

Hyperactivity has long been part of the human condition. Sir Alexander Crichton describes "mental restlessness" in his book *An inquiry into the nature and origin of mental derangement* written in 1798.[224][225] He made observations about children showing signs of being inattentive and having the “fidgets”. The first clear description of ADHD is credited to George Still in 1902 during a series of lectures he gave to the Royal College of Physicians of London.[226][221] He noted both nature and nurture could be influencing this disorder.[227]



Timeline of ADHD diagnostic criteria, prevalence, and treatment

Alfred Tredgold proposed an association between brain damage and behavioral or learning problems which was able to be validated by the encephalitis lethargica epidemic from 1917 through 1928.[227][228][229]

The terminology used to describe the condition has changed over time and has included: in the DSM-I (1952) "minimal brain dysfunction," in the DSM-II (1968) "hyperkinetic reaction of childhood," and in the DSM-III (1980) "attention-deficit disorder (ADD) with or without hyperactivity."[221] In 1987 this was changed to ADHD in the DSM-III-R and the DSM-IV in 1994 split the diagnosis into three subtypes, ADHD inattentive type, ADHD hyperactive-impulsive type and ADHD combined type.[230] These terms were kept in the DSM-5 in 2013.[2] Other terms have included "minimal brain damage" used in the 1930s.[231]

In 1934, Benzedrine became the first amphetamine medication approved for use in the United States.[232] Methylphenidate was introduced in the 1950s, and enantiopure dextroamphetamine in the 1970s.[221] The use of stimulants to treat ADHD was first described in 1937.[233] Charles Bradley gave the children with behavioral disorders benzedrine and found it improved academic performance and behavior.[234][235]

Until the 1990s, many studies "implicated the prefrontal-striatal network as being smaller in children with ADHD".[236] During this same period, a genetic component was identified and ADHD was acknowledged to be a persistent, long-term disorder which lasted from childhood into adulthood.[237] ADHD was split into the current three subtypes because of a field trial completed by Lahey and colleagues.[2][238]

Controversy

ADHD, its diagnosis, and its treatment have been controversial since the 1970s.[44][45][239] The controversies involve clinicians, teachers, policymakers, parents, and the media. Positions range from the view that ADHD is within the normal range of behavior[66][240] to the hypothesis that ADHD is a genetic condition.[241] Other areas of controversy include the use of stimulant medications in children,[45][242] the method of diagnosis, and the possibility of overdiagnosis.[242] In 2009, the National Institute for Health and Care Excellence, while acknowledging the controversy, states that the current treatments and

methods of diagnosis are based on the dominant view of the academic literature.[146] In 2014, Keith Conners, one of the early advocates for recognition of the disorder, spoke out against overdiagnosis in a *The New York Times* article.[243] In contrast, a 2014 peer-reviewed medical literature review indicated that ADHD is underdiagnosed in adults.[29]

With widely differing rates of diagnosis across countries, states within countries, races, and ethnicities, some suspect factors other than the presence of the symptoms of ADHD are playing a role in diagnosis.[244] Some sociologists consider ADHD to be an example of the medicalization of deviant behavior, that is, the turning of the previously non-medical issue of school performance into a medical one.[44][116] Most healthcare providers accept ADHD as a genuine disorder, at least in the small number of people with severe symptoms.[116] Among healthcare providers the debate mainly centers on diagnosis and treatment in the much greater number of people with mild symptoms.[47][48][116][243][245][246]

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In particular, adolescents and adults are vulnerable to underdosing, and are thus at potential risk of failing to receive adequate dosage levels. As with all therapeutic agents, the efficacy and safety of stimulant medications should always guide prescribing behavior: careful dosage titration of the selected stimulant product should help to ensure that each patient with ADHD receives an adequate dose, so that the clinical benefits of therapy can be fully attained."
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Findings from one trial indicate use of antipsychotic medications effectively resolves symptoms of acute amphetamine psychosis."
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Further reading

- Hinshaw SP, Scheffle RM (2014). *The ADHD Explosion: Myths, Medication, Money, and Today's Push for Performance*. Oxford University Press. ISBN 978-0199790555.

External links

Quotations related to Attention deficit hyperactivity disorder at Wikiquote

- Attention deficit hyperactivity disorder (https://curlie.org/Health/Mental_Health/Disorders/Neurodevelopmental/ADD_and_ADHD/) at Curlie
- National Institute of Mental Health on ADHD (http://www.nimh.nih.gov/topics/topic-page-adhd.shtml)
- New Zealand MOH Guidelines for the Assessment and Treatment of Attention-Deficit/Hyperactivity Disorder (https://web.archive.org/web/20141027092517/http://www.health.govt.nz/publication/new-zealand-guidelines-assessment-and-treatment-attention-deficit-hyperactivity-disorder)
- AACAP Practice Parameters for the Assessment and Treatment of attention deficit hyperactivity disorder (http://www.jaacap.com/article/S0890-8567(09)62182-1/pdf)
- Faraone SV, Asherson P, Banaschewski T, Biederman J, Buitelaar JK, Ramos-Quiroga JA, Rohde LA, Sonuga-Barke EJ, Tannock R, Franke B (August 2015). "Attention-deficit/hyperactivity disorder". *Nature Reviews. Disease Primers*. **1**: 15020. CiteSeerX 10.1.1.497.1346 (https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.497.1346). doi:10.1038/nrdp.2015.20 (https://doi.org/10.1038%2Fnrdp.2015.20). PMID 27189265 (https://pubmed.ncbi.nlm.nih.gov/27189265).

Classification	**ICD-10**: F90 (http://apps.who.int/classifications/icd10/browse/2016/en#/F90) · **ICD-9-CM**: 314.00 (http://www.icd9data.com/getICD9Code.ashx?icd9=314.00), 314.01 (http://www.icd9data.com/getICD9Code.ashx?icd9=314.01) · **OMIM**: 143465 (https://omim.org/entry/143465) · **MeSH**: D001289 (https://www.nlm.nih.gov/cgi/mesh/2015/MB_cgi?field=uid&term=D001289) · **DiseasesDB**: 6158 (http://www.disease

	sdatabase.com/ddb6158.htm)
External resources	**MedlinePlus**: 001551 (https://www.nlm.nih.gov/medlineplus/ency/article/001551.htm) · **eMedicine**: med/3103 (https://emedicine.medscape.com/med/3103-overview) ped/177 (http://www.emedicine.com/ped/topic177.htm#) · **Patient UK**: Attention deficit hyperactivity disorder (https://patient.info/doctor/attention-deficit-hyperactivity-disorder-pro)