Children's Hospital of Philadelphia®

What is ADHD?

This supplemental handout provides information on the characteristics and diagnosis of ADHD.

- ADHD (Attention Deficit Hyperactivity Disorder) is a diagnosis made in children, teens, and adults when high levels of inattention / distractibility or hyperactivity / impulsivity, or both sets of symptoms, impair daily functioning. Inattention and distractibility usually occur together, as do hyperactivity and impulsivity. Specific symptoms and other requirements for making the diagnosis are described in the Diagnostic and Statistical Manual of Mental Disorders- 5th edition (2013) published by the American Psychiatric Association. There are 9 symptoms in each of the two categories and a child must have at least 6 of the 9 in either or both categories that have persisted for at least 6 months and that are not consistent with developmental level. (For example, if a 6-year-old child has the developmental ability of a 3-year-old, we cannot expect the child to show the attention span of a 6-year-old). The symptoms must occur in more than one setting, which for children usually means at home and at school. The child must show impairment from the symptoms in social, educational or daily living activities. Symptoms must not be due primarily to oppositional behavior or a lack of understanding, and must not be due to another disorder (such as psychosis, substance use, or a mood or anxiety disorder). When 6 or more symptoms of inattention / distractibility, but not hyperactivity / impulsivity are present, and the rest of the diagnostic criteria are met, the diagnosis is called ADHD-inattentive presentation. When 6 or more symptoms of hyperactivity /impulsivity, but not inattention / distractibility are present, and the rest of the diagnostic criteria are met, it is called ADHD-hyperactive-Impulsive presentation, and when both sets of symptoms are present, it is called ADHD-combined presentation. These presentations may change over time; hyperactivity/impulsivity tend to decrease with age, while inattention/distractibility do not, and may even increase as demands for attention increase in the upper grades. For teens age 17 or older and adults, 5 rather than 6 symptoms in either or both categories are required (American Psychiatric Association, 2013).

- ADHD should only be diagnosed after a thorough medical, behavioral, and developmental history, a physical exam to rule out medical and neurological conditions that require different treatment, and the collection of supporting evidence for impairment at home and in school. Parent and teacher ADHD rating scales are commonly used to measure the number and severity of symptoms and the ways symptoms affect everyday functioning. The history is used to confirm the other requirements, such as the onset and duration of symptoms, and both history and physical exam are used to rule out other causes of similar symptoms (for example,

hearing or sleep problems, or other diagnoses). Broader behavior rating scales (focused on a broader range of symptoms and diagnoses than ADHD alone) are also sometimes used to screen for other diagnoses which can occur instead of, or in addition to, ADHD (see the list below). A psycho-educational evaluation done by a psychologist, evaluations by speech-language, occupational, or physical therapists, and laboratory or imaging studies are not a required part of the evaluation. However, they may be included when the history or physical findings indicate that there may be either another disorder or other symptoms that need to be investigated.

- When a diagnosis of ADHD is made after a thorough evaluation, it is present in approximately 5-9% of school aged-children and adolescents, and 2.5% of adults (Danielson, et al., 2018; Faraone, et al., 2021; Posner, et al., 2020). An even higher percent of children (10-13%) have elevated parent ratings in large surveys (https://www.cdc.gov/ncbddd/adhd/data.html). The percentage of children and teens diagnosed with ADHD has been gradually increasing over the past 20 years. Other diagnoses commonly co-occur with ADHD; over 60% of children with ADHD have another disorder. The most common ones include oppositional defiant disorder, anxiety disorders, learning disorders affecting language, reading, math and/ or writing, depression, and autism spectrum disorder (https://www.cdc.gov/ncbddd/adhd/conditions.html; Reale, et al., 2017).

- The fact that ADHD is diagnosed largely based on behaviors observed by those around the child, makes the diagnosis less precise than if, for example, a blood test or brain imaging finding could identify the diagnosis of ADHD for certain. While there are brain findings that are more common in individuals with ADHD compared with individuals without ADHD, these findings are not consistent in every individual, so they cannot be used as a diagnostic "test".

- ADHD is not an "all or nothing" condition. Across any population, there is a wide range of levels of inattention, distractibility, hyperactivity, and impulsivity; these characteristics are not simply "present" or "absent". ADHD is a lot like height. People do not only fall into the "short" or "tall" category; they also exist at all heights in between. For this reason, we refer to ADHD as a diagnosis that is ***dimensional***. Most individuals who "fit" all the diagnostic criteria are like those who are very short or very tall- they fall at the far end of the symptom range, but the dividing line between the far end and the rest of the range is not as clear as we would like. This has been addressed, in part, by adding the requirement for the symptoms to cause functional impairment.

Unfortunately, even "subthreshold" ADHD, referring to ADHD symptoms that are below the severity level needed for a diagnosis, can still have a negative impact on a child's functioning (Kirova, et al., 2019). Also, one individual with ADHD may have certain symptoms that are more severe and others that are less so, while a different individual has a different pattern of symptom severity. This is called "heterogeneity". ***ADHD is both dimensional and heterogeneous*** (Posner, et al., 2020; Sonuga-Barke, et al., 2023).

- Even though ADHD is diagnosed based on behavior characteristics, and brain findings are not specific enough at this time to be used diagnostically, we do know a lot about the science of ADHD. First, ADHD is highly genetic. Parents with ADHD are more likely than parents without ADHD to have a child with ADHD, and siblings of a child with ADHD are much more likely to have ADHD than are the siblings of a child who does not have ADHD. Most ADHD is not caused by a single genetic mutation, but rather there are many "susceptibility" genes in the human genome and even single DNA base changes in these genes may alter their function. ADHD likely occurs when enough of these susceptibility genes are present in their altered forms. This makes exact inheritance patterns difficult to predict, but ADHD occurs approximately 8-9 times more often in the sibling of a child with ADHD than in the sibling of a child without (reviewed in Chang, et al, 2020: Faraone & Larsson, 2019). In children who do not have a family history of ADHD, specific genetic syndromes, prenatal exposure to toxins, maternal conditions such as obesity and thyroid disease, malnutrition, pre- and post-birth conditions that cause low oxygen, medical conditions (such as seizures), prematurity/low birth weight and psychosocial deprivation may be associated with an increased risk for ADHD (Glanzman & Sell, 2019; Posner, et al., 2020).

- ADHD has most often been associated with delayed development of the prefrontal cortex, a part of the cortex of the brain that is most developed in humans. Structural MRI studies of over the last few decades supported this idea, showing slightly smaller subregions of the frontal lobes and smaller overall cortical surface area, but they also somewhat unexpectedly showed involvement of multiple subcortical brain regions, including the basal ganglia, cerebellum, hippocampus and amygdala (Zametkin, et al., 1990; Hoogman, et al., 2017, 2019). Over the last decade or so, it has become clear from functional MRI and other types of imaging studies, that the brain carries out specific tasks by activating networks of brain regions rather than single brain regions. Networks are regions of brain cells (neurons) connected to other regions of brain cells by the long tails of neurons that release chemicals to stimulate the function of these next neurons in the chain. Brain regions connected in a network become active and quiet together. Several networks that are related to attention, executive function,

motivation, and social behavior include areas of the prefrontal cortex. The default mode network is a specific network that is active when the brain is "doing nothing". It is also sometimes called the "mind wandering" network. In individuals with ADHD, it seems that the default mode network does not "turn off" effectively, leaving this "mind-wandering network" to compete with networks needed for attention-demanding tasks (Broyd, et al., 2009; Posner, et al., 2016; Raichle, 2015, Rubia, 2018). Various types of brain scans comparing the brains of children and teens with ADHD to those without ADHD continue to suggest a delay in the maturation of brain structure and function across several areas (Janssen, et al., 2017).

- The diagnostic characteristics of ADHD described in the DSM (often referred to as the "core features") do not give the full picture of the underlying information processing characteristics of ADHD. They do not give us enough understanding of all of the kinds of struggles that individuals with ADHD face, or all of the avenues we might explore to help them function better. Information processing (or "neuropsychological") characteristics common in ADHD, identified through neuropsychological tests, include weaknesses in executive functions (verbal and visual working memory, behavioral inhibition, and cognitive flexibility), emotional regulation, slow and/or variable reaction time, reduced alertness or "cognitive energy", and reduced motivation in the absence of immediate rewards (Mahone & Denkla, 2017). In addition to weaknesses in executive function, which lead to challenges with school and social functioning, as described in these presentations, children with ADHD are at increased risk for academic underachievement, injuries, and driving accidents. As they become adults, they are at increased risk for educational and occupational underachievement, substance use and abuse, relationship difficulties, and reduced financial independence. However, in spite of these risks, many children, teens, and adults with ADHD are quite successful. The challenge to us as professionals and parents is to determine what each child needs at each stage of development, and to provide it for as long as it is needed, to give each child the best chance of using their strengths and learning to adapt for their weaknesses. In other words, we should focus on addressing the actual symptoms and their secondary effects rather than the "diagnosis". (See pdf entitled "How is ADHD Treated?")

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