Journal of High School Science

Attention-Deficit/Hyperactivity Disorder in girls and young women

Kotha A[1], Mo JQ[2]

Submitted: February 20, 2024, Revised: version 1, June 19, 2024, version 2, July 5, 2024
Accepted: July 6, 2024

Abstract
Attention-Deficit Hyperactivity Disorder (ADHD) is a common neurological disorder beginning in early childhood that impacts an individual's relationships and daily functioning. Although diagnosis for ADHD by the DSM-V requires that at least one symptom is present before the age of twelve and therefore must begin in childhood, girls tend to receive their diagnosis much later than boys. A late diagnosis can have detrimental impacts on self-esteem, leading to poorer social function outcomes compared to people without ADHD or those who received treatment earlier. Girls with the disorder are also at higher risk for more psychological impairment than both men and older women with ADHD, furthering the importance of an early recognition of the disorder in younger girls. While current research focuses on treatments and diagnostic procedures in adults, few explore the diagnosis for women under 18. This review examines childhood ADHD in adolescents to understand the reasons behind a late diagnosis and how an effective intervention can be made. To examine the diagnosis factors, this review studies the biological gender differences that affect the prevalence of ADHD in children and influences an accurate diagnosis.

Keywords
ADHD, Attention Deficit Hyperactivity Disorder, Gender dynamics, Mental health, Adolescence diagnosis, DSM-V, Inattention, Social withdrawal, Neurodevelopmental disorder, Sex hormones

[1]Alekhya Kotha, Triangle Math and Science Academy, 312 Gregson Dr, Cary, NC 27511, USA. alekhya0812@gmail.com
[2]Corresponding author, Joyce Q Mo, Chemical and Biological Engineering , Princeton University A217 Engineering Quadrangle, Princeton, NJ 08544, USA. joycemo413@gmail.com

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common behavioral disorder that typically develops between ages as early as three years to twelve years (1). A study conducted in 2020 showed that 9.4% of all children ages 2-17 received an ADHD diagnosis, making it one of the most frequent disorders occurring in children and adolescents (2). The DSM-IV by the American Psychiatric Association even required that "symptoms that caused impairment were present before 7 years [of age]" for an ADHD diagnosis to be considered. This changed by the time of the DSM-V, however, when the age for the diagnosis rose from 7 years to 12 years and the criteria changed from "impairment" to "signs of symptoms" due to the rise in later diagnoses having to be made (3). This later diagnosis among individuals could have transpired because evaluating symptom severity wasn't clearly understood for young children (4). While symptoms of ADHD usually start by the time a child is 4 years old (5), male patients are six times more often diagnosed in childhood than females and three times more than females in the adolescent stage (6). A male-to-female diagnosis ratio of 4:1 was found through a sample from families in Missouri with multiple children above the age of seven (7). Of another study that examined ADHD symptoms in males and females with and without a clinical diagnosis, 72% of those with a clinical diagnosis were boys, indicating that girls are significantly more likely to be undiagnosed for ADHD (8,9). Girls with the disorder are also reported to have fewer hyperactive/impulsive symptoms and more inattentive symptoms, and are less noticed compared to boys who tend to show noticeable acting-out behavior, resulting in the diagnosis gap.

Despite this main difference, there are still similarities between brain functionality and significantly expressed genes among children of both biological sexes with ADHD. Findings from the last decade have shown a connection between early socialization in daycare facilities and how often children interact outside of the family context: by allowing young children to interact with their peers and build free social interactions, prosocial behaviors, intentional acts that benefit another person, are nurtured from the beginning. Dunfield et al. identified that performing a prosocial act is a process involving recognizing social cues and finding a behavior that would benefit the other individual (10).

These prosocial behaviors occur less frequently among those diagnosed with ADHD due to pre-existing genetic components that affect the heritability of ADHD and the presence of stimuli that can create sensory overload. For instance, dopamine receptors and sodium-dependent noradrenaline transporters play large roles in the genetic component of ADHD and changes in these levels of dopamine neurons affect expressions of prosocial behavior (11). For these genes, particularly dopamine receptors and noradrenaline transporters, medications are often prescribed to mitigate the symptoms of ADHD.

Given the prevalence of ADHD in children and adolescents, a timely diagnosis is crucial in preventing the social and academic impairments that persist into adulthood. Early identification allows for the implementation of behavioral therapies and educational support, reducing the risk of developing comorbid conditions such as anxiety and depression. Moreover, early diagnosis helps tailor

treatment plans to the individual's needs, optimizing their overall development and quality of life. During the time of diagnosis, environmental factors are rarely ever considered in order to create a multi-modal approach in the case of women, playing a large role in the underdiagnosis of women with the disorder.

Methods

A literature review was performed using Google Scholar, PubMed, and NIH to find articles that were relevant on the effects of ADHD in girls. Subsequently, String-DB (https://string-db.org/) was utilized to find a list of statistically significant genes associated with ADHD and compare the levels of those genes between genders to connect the symptom expressions differences between girls and boys.

Table 1. General ADHD symptoms

Symptom	Predominance in Gender	Effect of Symptom	Reference
Inattention	Female	Easily overlooked and not referred earlier due to being non-disruptive in the classroom. Lower self-esteem.	(12)
Hyperactivity	Male	Common fidgeting. Difficulty in sitting still or staying quiet for long periods of time. Considered as an important factor for referrals by teachers and observers.	(12,13)
Impulsiveness	Male	Highly noticeable behavior due to frequent disruptions. Engagement of risky behavior.	(12,13)

ADHD is a developmental disorder where individuals express symptoms that vary greatly from person to person. Children and teenagers may experience inattention with difficulty paying attention, hyperactivity, or impulsivity which causes them to act without thinking and have difficulty with self-control. Hyperactivity/impulsivity symptoms are often mistaken for restlessness, especially in a classroom setting where kids have trouble sitting still and listening to directions and are easily recognized. School children with inattention have difficulty participating in group discussions and completing school work. Various studies have shown a strong correlation between ADHD and procrastination due to symptoms of distractibility, forgetfulness, and disorganization (14). Children with ADHD are also much more likely to experience anxiousness, social problems and engage in aggressive behavior, often used as referral tools for the diagnosis of the disorder (15). O'Neill et al. found that generally, hyperactivity/impulsivity typically declined as children developed while the

inattention remained relatively stable throughout the years (16).

Discussion

Symptoms of ADHD in girls and adolescents

Compared to boys, girls with ADHD are prone to having difficulties with inattentive symptoms including zoning off and losing focus rather than exhibiting hyperactive and impulsive symptoms (17). In a study conducted to measure coexisting symptoms on a self-reported scale, it was found that women experience much higher levels of depressive, withdrawn feelings that contribute to their worry and physiological anxiety (15). On the other hand, boys are commonly characterized by presenting hyperactive behavior along with oppositional defiant and conduct disorder (18). Moreover, girls seem to have a higher sense of responsibility for completing school work because of familial and school responsibilities. These expectations are likely to cause young women to attempt and "mask" their symptoms, only leading to higher levels of social withdrawal and prosocial behavior in efforts to hide their inattentive tendencies (18).

Prosocial behaviors, voluntary behaviors done to benefit others, are developed in children and are especially strong when students interact with their peers. Within a sample of almost 4500 girls and 4500 boys, 33% of girls and 46% of boys displayed prosocial behavior within the control group. However, teachers and parents alike reported that only about 23% of girls and 32% of boys with ADHD showed prosocial behavior with their peers (19). However, with girls who experience symptoms of ADHD, prosocial behaviors decreased as the severity of the ADHD symptoms increased (19). Arongo-Tobón et al. found that the Theory of Mind, the knowledge that others' beliefs and intentions differ, is the most affected in children and adolescents with ADHD and more deficits in behaviors including emotional awareness and empathy. These feelings of impaired empathy and as a result, prosocial behavior, can be attributed to feelings of sadness and distress in young children. While this impaired empathy was found to be constant, there was an absence of parent-reported deficits in empathy that may be consistent with children, especially girls, wanting to feel more valued in their homes (20).

The effects of ADHD symptoms in women

These differences in presentation are largely due to societal standards that cause girls to feel that they should stop displaying behaviors consistent with ADHD (9). These issues are exacerbated since a predominance in inattentive symptoms leads to girls having less friends. A large portion of this stems from the decline in prosocial behavior, where girls find it more difficult to form intimate connections with their peers. Girls prefer smaller groups of friendships and a limited social circle, making them more vulnerable to relational victimization from bullying (20). Becker et al. reported that 20% of girls had a peer spread rumors to damage their social reputation in comparison to 9% of males (19). From an academic standpoint, a study found that ADHD symptoms in 11th grade negatively affect academic self-perception (21). Frequently, girls experience shame and frustration when comparing themselves to peers because of feelings of inadequacy both socially and academically (9).

Not only does social behavior with ADHD become more negative, it can also create dangerous habits in young girls. Adolescents are typically more vulnerable to harmful sexual behavior, stemming from their pre-existing low self-esteem that contributes to future depression or anxiety. Most research suggests that "early" sexual intercourse is associated with substance use, depression, and a high risk of coercion by older partners (22). Because of this, unplanned pregnancies are elevated in girls with ADHD and those women are more likely to smoke up to the third trimester, be obese or underweight (23).

Current diagnosis methods for ADHD

The treatment of ADHD is multimodal, and includes approaches that relieve the symptoms, and limit the burden of the disease (24). Current diagnostic trends include tools to capture brain structure or activity, such as magnetic resonance imaging (MRI) to produce detailed images of the brain, electroencephalograms (EEG) that measure the electrical activity in the brain in the form of brain waves, and questionnaires which have proven effective due to the distinct differences in the structure and function of the brain in individuals diagnosed with ADHD when compared with non-ADHD patients (25). In order to diagnose children with Attention-Deficit/Hyperactivity Disorder, clinical assessments are based on interviews with parents to develop an understanding of the problems, a detailed developmental history, and information of the family's lifestyle (6). Clinicians are very likely to explore the family history of ADHD since the disorder is highly heritable, with twin studies showing an estimate of 0.76 (26). While the consideration of family lifestyle can be varied for each individual, a slight association between prenatal exposure to alcohol and illicit drugs has been established.

However, even reaching the clinical diagnosis stage can be difficult for some children, especially girls. Those without disruptive symptoms of ADHD are less noticeable by teachers and parents which makes them less likely to seek further explanations on the causes behind the behavior. The use of teacher- or parent-reported referrals have also allowed clinicians to determine significant impairment (27); something that is difficult when problems are not recognized earlier. This is shown especially in females since the ratio of males to females with diagnosed ADHD is partly due to the lack of recognition and referral bias (23). While boys present a more boisterous and loud personality, girls tend to be overlooked in a highly structured environment where they try to mask and compensate for their symptoms (23). Oftentimes, teachers mistakenly believe the young students did not care about academics or grades despite the effort that girls were putting into their assignments (28) instead of looking at underlying behavioral causes. After a referral, girls are still more likely to be diagnosed with emotional issues, such as anxiety, and administered non-ADHD medication. Commonly, girls are older than boys at the time of diagnosis and have a higher median visits to the Child and Adolescent Psychiatric (CAP) before an official diagnosis is made (29). Taking a developmental approach is critical to making an accurate diagnosis, especially since ADHD-related behaviors can develop quickly once the onset of symptoms begins (30). Receiving an early diagnosis can be critical in the growth of a child and a delay

of diagnosis can affect their self-esteem and future behavior.

Another barrier to receiving an ADHD diagnosis is due to the clinical requirements of a diagnosis. Apart from chromosomal variants, females might need a greater number of genetic factors in ADHD to qualify for diagnosis (31). Additionally, the threshold to meet the diagnosis requirements in females is higher, making it more likely that females with elevated ADHD compared to the normal levels still do not meet the DSM-IV criteria (32). Specifically, there was a notable subthreshold group of females who had ADHD scores that were 1·5 standard deviations above the mean female score, yet were below the threshold for diagnosis, while males had scores either below the mean score or above the diagnosis threshold (31).

ADHD comorbidities in adolescent girls

Not only is ADHD a disorder that is difficult to diagnose in young girls due to the lack of recognition of specific symptoms, but it is also associated with a number of similar comorbidities and clinical phenotypes. In children, the presence of anxiety disorders may change the presentation of ADHD and mask common symptoms of the disorder such as inhibitory dysfunction, making the treatment more difficult (33). Additionally, due to their difficulties with appropriate social skills and emotion recognition, these youth are often bullied by their peers and are more likely to experience depression in the near future (20). These depressive symptoms can also be dangerous, however, and when ADHD and Major Depression are presented together, verbal and physical aggression also become serious problems (34). These conditions, being more commonly recognized, are often diagnosed first and patients that experience symptoms not associated with an underlying attention deficit disorder, may not seem to meet the criteria for an ADHD diagnosis without in-depth analysis (35).

Severity of depression and suicidal thoughts also varies based on the severity of comorbid disorders. With the increase in preadolescent girls with ADHD who are at a risk for nonsuicidal self-injury (NSSI), attention and intervention must be implemented at an early age without waiting for NSSI and suicide attempts to emerge (36).

These conditions also increase an adolescent's risk to develop Substance Use Disorder (SUD) (37). The risk of developing an SUD is twice as high in individuals with ADHD which, as adolescents with SUDs report, is to temper their moods so as to help them sleep (37). While specific subtypes of ADHD do not show different predictions of SUD, risk factors of a drug-use disorder could be linked with executive functioning deficits (38). Girls with ADHD are at a higher risk for impairment in psychiatric, psychological and cognitive functioning compared to boys with ADHD (38). Muñoz-Suazo et al. found that in 240 children aged 6–17 years, perceptual reasoning skills were significantly lower in girls with ADHD as compared to the boys in the study (39).

Biological differences in pre-puberty and post-puberty girls

As a largely behavioral disorder, Attention-Deficit/Hyperactivity Disorder is significantly affected by sex hormones. The changes in those hormonal levels not only affect the

expression of ADHD between girls and boys, but also contribute to a major difference between pre-puberty and post-puberty girls. As females progress through the natural cycle of the premenstrual period and menopause, stages that mark critical points in development, their hormones undergo significant shifts (40). For instance, Estradiol, a form of estrogen present in girls, is 4-9 times higher in adolescence compared to that in childhood (41). The female hormones such as estradiol and progesterone that are present at higher levels post-puberty have been correlated with the increasing levels of depression and anxiety, both comorbid disorders of ADHD (40).

While a decrease in estradiol increases ADHD symptoms (42), changes in hormone levels can influence symptom expression in different ways. Generally, in every episode of a hormonal change in women, whether through menopause or ovulation, women with ADHD showed a 3-fold increase in their mood changes post-puberty (43). Given that ADHD is composed of both the inattentive and hyperactive subtype, declines in estrogen show tendencies towards social withdrawal and turn symptoms more internalized, contributing to the inattentive subtype that is much more difficult to recognize and diagnose (40). On the other hand, impulsivity is a symptom of the hyperactivity subtype that is particularly sensitive to the increase in estrogen and progesterone (42). Due to the diminished levels of hormones at an earlier age, it is likely that the symptoms of ADHD are noticed enough to qualify for an accurate diagnosis, while symptoms post-puberty are more disruptive and noticeable.

Role of biological differences between girls and boys

However, the sex hormone difference does not only exist between pre-puberty and post-puberty females, but also exists between genders. As a part of influencing an individual's behavior, these sex hormones have a direct role in shaping neurological factors of behavioral disorders, especially brain regions such as the prefrontal cortex. The elevated hormone levels play a large role in emotional processing and perception, affecting a girl's behavior. The brain regions associated with hormones also modulate levels of major neurotransmitters such as dopamine and serotonin (44). Since dopamine and serotonin neurotransmitter activity is greater in girls than in boys, the hormones play a more significant role in the expression of ADHD and its comorbid disorders such as mood disorders and sleep and eating disorders in girls (45). While this does not provide strong evidence that sex hormones contribute to the large gender disparity in the diagnosis of ADHD, males usually have more ADHD traits that are noticed and can be diagnosed, indicating that there is a true gender difference in expressing different levels of the hormones and/or neurotransmitters contributing to this disorder (31).

In addition to the levels of sex hormones that contribute to the diagnosis differences between genders, the higher numbers in the diagnosis of ADHD in males is due to the higher frequency at which males develop the disorder. Current scientific literature supports a higher prevalence of the disorder in males (46), that could be caused by sex chromosomes. Females carry the XX sex chromosomes while males have the XY combination. As studied by Tartaglia et al., children with chromosome aneuploidy, an abnormal number of

chromosomes, can be predisposed to an increased risk for ADHD (47). The absence of an X chromosome is correlated with higher expression of hyperactivity while an additional X chromosome is associated with attention problems (48). Specifically, individuals with aneuploidy causing XYY and XXYY genotypes displayed prominent hyperactive/impulsive symptoms while those with XXY and XXX did not (47). The genes of the Y chromosome have also been suggested for being responsible for male incidence of neurodevelopmental disorders such as ADHD (49).

From the biological standpoint, neither pubertal factors or sex hormones alone significantly influence presentations of ADHD in response to sexual maturation. Hence their exact role in the neurodevelopmental disorder needs to be determined (50).

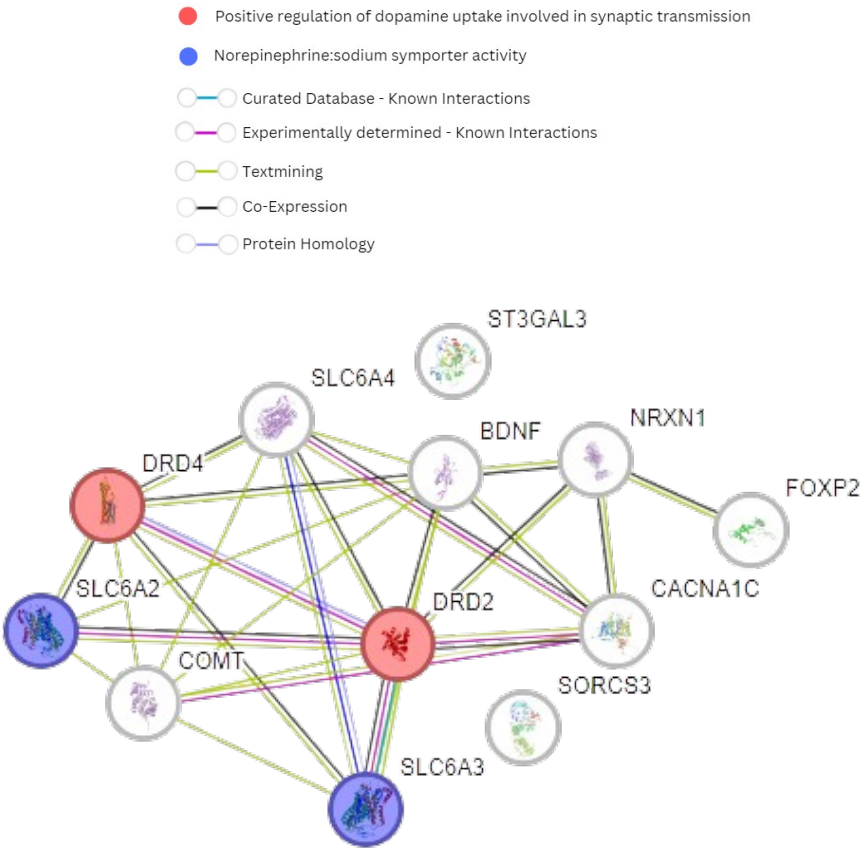

Figure 1. Gene Interaction Networks in ADHD (Homo Sapiens). String-DB

Genes play a vital role in the childhood development of ADHD but whether multiple genes of varying statistical significance are involved is not completely understood (51). Genes related to the function of these areas can be studied to observe for the likely genetic

components, and observe for differences between expression level between different biological sexes and gender.

Among the most influential genes are those involved in the uptake of dopamine and norepinephrine. Shown as DRD2 and DRD4 in Figure 1, these dopamine receptors (Dopamine receptor D2 and Dopamine receptor D4, respectively) are biologically connected to the positive regulation of dopamine uptake involved in synaptic transmission. Despite a lack of research on the association between DRD4 and the environment, it has been found that the DRD4 gene is strongly expressed in prefrontal cortical regions within ADHD (52,53). These genes interact to predict adult antisocial behavior and are involved in complex disorders that often present as comorbidities with ADHD (54). Similarly, the molecular functions of the sodium-dependent noradrenaline transporters, solute carrier family 6 member 2 and 3 (SLC6A2 and SLC6A3), terminate the action of noradrenaline and may be involved in the etiology of ADHD (55).

In previous studies, SLC6A2 has been connected to ADHD and many of its common comorbid disorders such as addictive behavior, and Major Depressive Disorder (MDD) (55). In women especially, there was found to be a significant correlation between these genes and personality expressions of persistence, the opposite of neuroticism which is the extent to which situations could be identified as problematic (56). Beaver et al. showed that with a p-value of 0.01, the interaction between both dopamine transporters D2 and D4 produced a statistically significant effect on conduct disorder. Transporters that regulate the reuptake of synaptic dopamine have been linked to bipolar disorder and other behavioral conditions (57).

The pathophysiology of ADHD, however, has been shown to occur in the frontal lobes and caudate nucleus, which affects executive function and motivation (58). In addition to chromosomal differences, there are sex specific epigenetic effects that play a role in the expression of ADHD. Currently, epigenetic variation of tissues is being studied as a marker of disease development. Most mental disorders are studied as being DNA methylation abnormalities which influence gene expression by disrupting transcription factor binding (59). These epigenetic changes in the expression patterns of the DNA molecule affects each gender differently. Specifically in females, higher methylation levels were associated with a higher risk of ADHD while males exhibited a much weaker, opposite relationship (59). Among children, there were persistent developments in ADHD symptoms that correlated with DNA methylation at ages 4, 6 and 8 (60).

Interventions and treatments

Brain networks involved in ADHD can be strengthened to improve cognitive functions such as memory and visual encoding (61). However, hormonal fluctuation and estrogen's influence on the brain is rarely considered when trying to determine an effective treatment (62). This oversight is a primary reason that adolescent girls only experience a partial remission of ADHD symptoms compared to the treatment's effect on boys. Stimulant medications are a primary prescription for ADHD and have shown efficient and safe results in children and adults (27). However, treatments that do not involve medication can

produce the same, if not better, results in improving ADHD symptoms and presentation. Methylphenidate, a medication that became more popular as amphetamines became less so, showed very few effects on reaction time between ADHD and control variables (63). For this reason, researchers emphasize a multi-modal approach to treating ADHD that includes medication and behavioral therapy. Women, especially, benefit from taking part in support groups, psychotherapy, and medication that focus on the comprehensive treatment of their ADHD symptoms (62). These therapies can improve social skills, responsibility, assertiveness, and feelings of self-esteem (64).

Recommendations

Due to the numerous components that influence the symptom expression of ADHD, especially in girls, it is recommended that the DSM-V criteria be adjusted to account for these additional factors. Firstly, the requirements that are currently listed under "Additional requirements for diagnosis" should be moved to "Inattentive type diagnostic criteria" and should be further modified to account for a wider range of symptoms.

This modification includes keeping the condition that symptoms must be present prior to the age of 12. The language should be changed to specify that symptoms must not be accounted for by a different psychiatric disorder such as a mood disorder, anxiety disorder, or social withdrawal, etc. and should not occur exclusively during a psychotic disorder such as schizophrenia. The DSM-V should also include symptoms of compensatory behavior of maladaptive coping strategies such as bullying, peer victimization, engaging in high risk activities (e.g. criminal activities, promiscuity), that are not exclusively a manifestation of oppositional behavior. Other such behaviors that merit inclusion include spending long hours doing homework, exhibiting perfectionist behavior, and being hyper achievement motivated.

These recommendations support a multi-dimensional approach to the diagnosis of ADHD, where redefining the criteria will cover the full range of ADHD behaviors in girls, and adopting a reliable ordinal scale can avoid distortions in behavior rating scales (65).

Conclusion

This review indicates the importance of an early childhood diagnosis of ADHD on the lives of girls in school and college and provides explanations as to why there are differences in diagnosis. A timely diagnosis can also help girls and women receive effective treatment through medication and behavioral therapy which can help them overcome comorbid disorders such as depression and anxiety. Thus, making an accurate diagnosis is one of the key steps to higher self-esteem, appropriate social behavior, and overall improved well-being. It is important that educators and parents learn the types of ADHD and varying presentations of it in genders, so that they can take steps to help these girls receive a diagnosis and the correct steps that will allow them to lead more satisfying lives. Given the significant biological and genetic factors involved between genders, a true sex difference in ADHD development and diagnosis is likely to exist, and creating specific treatment plans that take these factors into account is important for adolescents, as is updating the criteria for diagnosis in the DSM-V.

Abbreviations

DRD2: Dopamine receptor D2, DRD4: Dopamine receptor D4, SLC6A2: solute carrier family 6 member, SLC6A3: solute carrier family 6 member 3, DSM-V: Diagnostic and Statistical Manual of Mental Disorders Fifth Ed., COMT: Catechol O-Methyl Transferase, BDNF: Brain Derived Neurotrophic Factor, SORCS3: Sortilin-related vacuolar protein sorting 10 domain containing receptor 3 FOXP2: Forkhead box protein P2, CACNA1C: Calcium voltage-gated Channel subunit Alpha1 C, NRXN1: Neurexin 1-alpha, ST3GAL3: ST3 Beta-Galactoside Alpha-2,3-Sialyltransferase 3, SUD: Substance Use Disorder, NSSI: NonSuicidal Self-Injury,

References

1. Mayo Clinic. Attention-deficit/hyperactivity disorder (ADHD) in children. https://www.mayoclinic.org/diseases-conditions/adhd/symptoms-causes/syc-20350889

2. Drechsler R, Brem S, Brandeis D, Grünblatt E, Berger G, Walitza S. ADHD: Current Concepts and Treatments in Children and Adolescents. Neuropediatrics. 2020 Oct;51(05):315–35. https://doi.org/10.1055%2Fs-0040-1701658

3. Abdelnour E, Jansen MO, Gold JA. ADHD Diagnostic Trends: Increased Recognition or Overdiagnosis? Mo Med. 2022;119(5):467–73. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9616454/

4. McClain MB, Hasty Mills AM, Murphy LE. Inattention and hyperactivity/impulsivity among children with attention-deficit/hyperactivity-disorder, autism spectrum disorder, and intellectual disability. Res Dev Disabil. 2017 Nov;70:175–84. https://doi.org/10.1016/j.ridd.2017.09.009

5. Oluwabusi OO. Tourette syndrome associated with attention deficit hyperactivity disorder: The impact of tics and psychopharmacological treatment options. World J Clin Pediatr. 2016;5(1):128. https://doi.org/10.5409/wjcp.v5.i1.128

6. Kelly CA, Kelly C, Taylor R. Review of the Psychosocial Consequences of Attention Deficit Hyperactivity Disorder (ADHD) in Females. Eur J. Med. Health Sci., 2024;6(1): 10-20. https://doi.org/10.24018/ejmed.2024.6.1.2033

7. Ramtekkar UP, Reiersen AM, Todorov AA, Todd RD. Sex and age differences in attention-deficit/hyperactivity disorder symptoms and diagnoses: implications for DSM-V and ICD-11. J Am Acad Child Adolesc Psychiatry. 2010 Mar;49(3):217-228.e1-3. https://pubmed.ncbi.nlm.nih.gov/20410711/

8. Mowlem FD, Rosenqvist MA, Martin J, Lichtenstein P, Asherson P, Larsson H. Sex differences in predicting ADHD clinical diagnosis and pharmacological treatment. Eur Child

Adolesc Psychiatry. 2019 Apr;28(4):481–9. https://doi.org/10.1007/s00787-018-1211-3

9. Attoe DE, Climie EA. Miss. Diagnosis: A Systematic Review of ADHD in Adult Women. J Atten Disord. 2023 May;27(7):645–57. https://doi.org/10.1177/10870547231161533

10. Dunfield KA, Kuhlmeier VA. Classifying Prosocial Behavior: Children's Responses to Instrumental Need, Emotional Distress, and Material Desire. Child Dev. 2013 Sep;84(5):1766–76. https://doi.org/10.1111/cdev.12075

11. Wang J, Li J, Yang Q, Xie YK, Wen YL, Xu ZZ, et al. Basal forebrain mediates prosocial behavior via disinhibition of midbrain dopamine neurons. Proc Natl Acad Sci. 2021 Feb 16;118(7):e2019295118. https://doi.org/10.1073/pnas.2019295118

12. Quinn PO, Madhoo M. A Review of Attention-Deficit/Hyperactivity Disorder in Women and Girls: Uncovering This Hidden Diagnosis. Prim Care Companion CNS Disord [Internet]. 2014 May 15. http://www.psychiatrist.com/pcc/article/pages/2014/v16n03/13r01596.aspx

13. Kieling R, Rohde LA. ADHD in Children and Adults: Diagnosis and Prognosis. In: Stanford C, Tannock R, editors. Behavioral Neuroscience of Attention Deficit Hyperactivity Disorder and Its Treatment [Internet]. (Current Topics in Behavioral Neuroscience) Berlin, Heidelberg: Springer Berlin Heidelberg; 2010 9:1–16. https://link.springer.com/10.1007/7854_2010_115

14. Rostami M, Bakhtiarpour S, Hafezi F, Naderi F. Investigating the Effectiveness of Verbal Self-education Training on Academic Procrastination and Symptoms of Attention Deficit/Hyperactivity Disorder in Adolescent Boys With Attention-deficit/Hyperactivity Disorder. Pract Clin Psychol. 2023 Apr 1;11(2):141–50. https://jpcp.uswr.ac.ir/article-1-839-en.pdf

15. Skogli EW, Teicher MH, Andersen PN, Hovik KT, Øie M. ADHD in girls and boys – gender differences in co-existing symptoms and executive function measures. BMC Psychiatry. 2013 Dec;13(1):298. https://doi.org/10.1186/1471-244X-13-298

16. O'Neill S, Rajendran K, Mahbubani SM, Halperin JM. Preschool Predictors of ADHD Symptoms and Impairment During Childhood and Adolescence. Curr Psychiatry Rep. 2017 Dec;19(12):95. https://doi.org/10.1007%2Fs11920-017-0853-z

17. Nussbaum NL. ADHD and Female Specific Concerns: A Review of the Literature and Clinical Implications. J Atten Disord. 2012 Feb;16(2):87–100. https://doi.org/10.1177/1087054711416909

18. Mowlem F, Agnew-Blais J, Taylor E, Asherson P. Do different factors influence whether

girls versus boys meet ADHD diagnostic criteria? Sex differences among children with high ADHD symptoms. Psychiatry Res. 2019 Feb;272:765–73. https://doi.org/10.1016/j.psychres.2018.12.128

19. Paap MCS, Haraldsen IR, Breivik K, Butcher PR, Hellem FM, Stormark KM. The Link between Peer Relations, Prosocial Behavior, and ODD/ADHD Symptoms in 7–9-Year-Old Children. Psychiatry J. 2013;2013:1–10. https://doi.org/10.1155/2013/319874

20. Simmons JA, Antshel KM. Bullying and Depression in Youth with ADHD: A Systematic Review. Child Youth Care Forum. 2021 Jun;50(3):379–414. https://link.springer.com/article/10.1007/s10566-020-09586-x

21. Scholtens S, Rydell AM, Yang-Wallentin F. ADHD symptoms, academic achievement, self-perception of academic competence and future orientation: A longitudinal study. Scand J Psychol. 2013 Jun;54(3):205–12. https://doi.org/10.1111/sjop.12042

22. Halkett A, Hinshaw SP. Initial Engagement in Oral Sex and Sexual Intercourse Among Adolescent Girls With and Without Childhood Attention-Deficit/Hyperactivity Disorder. Arch Sex Behav. 2021 Jan;50(1):181–90. https://doi.org/10.1007%2Fs10508-020-01733-8

23. Young S, Adamo N, Ásgeirsdóttir BB, Branney P, Beckett M, Colley W, et al. Females with ADHD: An expert consensus statement taking a lifespan approach providing guidance for the identification and treatment of attention-deficit/ hyperactivity disorder in girls and women. BMC Psychiatry. 2020 Dec;20(1):404. https://doi.org/10.1186/s12888-020-02707-9

24. Weibel S, Menard O, Ionita A, Boumendjel M, Cabelguen C, Kraemer C, et al. Practical considerations for the evaluation and management of Attention Deficit Hyperactivity Disorder (ADHD) in adults. L'Encéphale. 2020 Feb;46(1):30–40. https://doi.org/10.1016/j.encep.2019.06.005

25. Loh HW, Ooi CP, Barua PD, Palmer EE, Molinari F, Acharya UR. Automated detection of ADHD: Current trends and future perspective. Comput Biol Med. 2022 Jul;146:105525. https://doi.org/10.1016/j.compbiomed.2022.105525

26. Cherkasova M, Sulla EM, Dalena KL, Pondé MP, Hechtman L. Developmental course of attention deficit hyperactivity disorder and its predictors. J Can Acad Child Adolesc Psychiatry J Acad Can Psychiatr Enfant Adolesc. 2013 Feb;22(1):47–54. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3565715/

27. Wolraich ML, Chan E, Froehlich T, Lynch RL, Bax A, Redwine ST, et al. ADHD Diagnosis and Treatment Guidelines: A Historical Perspective. Pediatrics. 2019 Oct 1;144(4):e20191682.

https://doi.org/10.1542/peds.2019-1682

28. Lynch A, Davison K. Gendered expectations on the recognition of ADHD in young women and educational implications. Ir Educ Stud. 2022 Feb 9;1–21. https://doi.org/10.1080/03323315.2022.2032264

29. Klefsjö U, Kantzer AK, Gillberg C, Billstedt E. The road to diagnosis and treatment in girls and boys with ADHD – gender differences in the diagnostic process. Nord J Psychiatry. 2021 May 4;75(4):301–5. https://doi.org/10.1080/08039488.2020.1850859

30. Miller M, Iosif AM, Young GS, Hill MM, Ozonoff S. Early Detection of ADHD: Insights From Infant Siblings of Children With Autism. J Clin Child Adolesc Psychol. 2018 Sep 3;47(5):737–44. https://doi.org/10.1080/15374416.2016.1220314

31. Martin J. Why are females less likely to be diagnosed with ADHD in childhood than males? Lancet Psychiatry. 2024 Apr;11(4):303–10. https://doi.org/10.1016/S2215-0366(24)00010-5

32. Waschbusch DA, King S, Northern Partners in Action for Children and Youth. Should sex-specific norms be used to assess attention-deficit/hyperactivity disorder or oppositional defiant disorder? J Consult Clin Psychol. 2006;74(1):179–85. https://doi.org/10.1037/0022-006x.74.1.179

33. D'Agati E, Curatolo P, Mazzone L. Comorbidity between ADHD and anxiety disorders across the lifespan. Int J Psychiatry Clin Pract. 2019 Oct 2;23(4):238–44. https://doi.org/10.1080/13651501.2019.1628277

34. Turgay A, Ansari R. Major Depression with ADHD: In Children and Adolescents. Psychiatry Edgmont Pa Townsh. 2006 Apr;3(4):20–32. https://pubmed.ncbi.nlm.nih.gov/21103168/

35. Binder C, McIntosh, Kutcher S, Levitt, Rosenbluth, Fallu. Adult ADHD and comorbid depression: A consensus-derived diagnostic algorithm for ADHD. Neuropsychiatr Dis Treat. 2009 Mar;137. https://doi.org/10.2147%2Fndt.s4720

36. Beauchaine TP, Hinshaw SP, Bridge JA. Nonsuicidal Self-Injury and Suicidal Behaviors in Girls: The Case for Targeted Prevention in Preadolescence. Clin Psychol Sci. 2019 Jul;7(4):643–67. https://doi.org/10.1177/2167702618818474

37. Zulauf CA, Sprich SE, Safren SA, Wilens TE. The Complicated Relationship Between Attention Deficit/Hyperactivity Disorder and Substance Use Disorders. Curr Psychiatry Rep. 2014 Mar;16(3):436. https://doi.org/10.1007/s11920-013-0436-6

38. Rucklidge JJ, Tannock R. Psychiatric, Psychosocial, and Cognitive Functioning of Female Adolescents With ADHD. J Am Acad Child Adolesc Psychiatry. 2001 May;40(5):530–40. https://doi.org/10.1097/00004583-200105000-00012

39. Muñoz-Suazo MD, Navarro-Muñoz J, Díaz-Román A, Porcel-Gálvez AM, Gil-García E. Sex differences in neuropsychological functioning among children with attention-deficit/hyperactivity disorder. Psychiatry Res. 2019 Aug;278:289–93. https://doi.org/10.1016/j.psychres.2019.06.028

40. Eng AG, Nirjar U, Elkins AR, Sizemore YJ, Monticello KN, Petersen MK, et al. Attention-deficit/hyperactivity disorder and the menstrual cycle: Theory and evidence. Horm Behav. 2024 Feb;158:105466. https://doi.org/10.1016/j.yhbeh.2023.105466

41. Shirtcliff EA, Dahl RE, Pollak SD. Pubertal Development: Correspondence Between Hormonal and Physical Development. Child Dev. 2009 Mar;80(2):327–37. https://doi.org/10.1111%2Fj.1467-8624.2009.01263.x

42. Roberts B, Eisenlohr-Moul T, Martel MM. Reproductive steroids and ADHD symptoms across the menstrual cycle. Psychoneuroendocrinology. 2018 Feb;88:105–14. https://doi.org/10.1016/j.psyneuen.2017.11.015

43. Dorani F, Bijlenga D, Beekman ATF, Van Someren EJW, Kooij JJS. Prevalence of hormone-related mood disorder symptoms in women with ADHD. J Psychiatr Res. 2021 Jan;133:10–5. https://doi.org/10.1016/j.jpsychires.2020.12.005

44. Ostojic D, Miller CJ. Association Between Pubertal Onset and Symptoms of ADHD in Female University Students. J Atten Disord. 2016 Sep;20(9):782–91. https://doi.org/10.1177/1087054714535249

45. Haimov-Kochman R, Berger I. Cognitive functions of regularly cycling women may differ throughout the month, depending on sex hormone status; a possible explanation to conflicting results of studies of ADHD in females. Front Hum Neurosci [Internet]. 2014;8. http://journal.frontiersin.org/article/10.3389/fnhum.2014.00191/abstract

46. Rucklidge JJ. Gender Differences in Attention-Deficit/Hyperactivity Disorder. Psychiatr Clin North Am. 2010 Jun;33(2):357–73. https://doi.org/10.1016/j.psc.2010.01.006

47. Tartaglia NR, Ayari N, Hutaff-Lee C, Boada R. Attention-deficit hyperactivity disorder symptoms in children and adolescents with sex chromosome aneuploidy: XXY, XXX, XYY, and XXYY. J Dev Behav Pediatr JDBP. 2012 May;33(4):309–18. https://doi.org/10.1097/dbp.0b013e31824501c8

48. Green T, Flash S, Shankar G, Bade Shrestha S, Jo B, Klabunde M, et al. Effect of sex chromosome number variation on attention-deficit/hyperactivity disorder symptoms, executive function, and processing speed. Dev Med Child Neurol. 2022 Mar;64(3):331–9. https://doi.org/10.1111/dmcn.15020

49. Kim HJ, Jin HJ. Lack of association between the Y chromosome haplogroups and attention deficit hyperactivity disorder (ADHD) in Korean boys. Gene. 2023 Jan;850:146954. https://doi.org/10.1016/j.gene.2022.146954

50. Greenfield B, Hechtman L, Stehli A, Wigal T. Sexual maturation among youth with ADHD and the impact of stimulant medication. Eur Child Adolesc Psychiatry. 2014 Sep;23(9):835–9. https://doi.org/10.1007/s00787-014-0521-3

51. Faraone SV, Larsson H. Genetics of attention deficit hyperactivity disorder. Mol Psychiatry. 2019 Apr;24(4):562–75. https://doi.org/10.1038/s41380-018-0070-0

52. Martel MM, Nikolas M, Jernigan K, Friderici K, Waldman I, Nigg JT. The dopamine receptor D4 gene (DRD4) moderates family environmental effects on ADHD. J Abnorm Child Psychol. 2011 Jan;39(1):1–10. https://doi.org/10.1007%2Fs10802-010-9439-5

53. Swanson JM, Flodman P, Kennedy J, Spence MA, Moyzis R, Schuck S, et al. Dopamine genes and ADHD. Neurosci Biobehav Rev. 2000 Jan;24(1):21–5. https://doi.org/10.1016/s0149-7634(99)00062-7

54. Beaver KM, Wright J, DeLisi M, Walsh A, Vaughn MG, Boisvert D, et al. A gene × gene interaction between DRD2 and DRD4 is associated with conduct disorder and antisocial behavior in males. Behav Brain Funct. 2007;3(1):30. https://doi.org/10.1186%2F1744-9081-3-30

55. Dong C, Wong ML, Licinio J. Sequence variations of ABCB1, SLC6A2, SLC6A3, SLC6A4, CREB1, CRHR1 and NTRK2: association with major depression and antidepressant response in Mexican-Americans. Mol Psychiatry. 2009 Dec;14(12):1105–18. https://doi.org/10.1038%2Fmp.2009.92

56. Beaver KM, Wright J, DeLisi M, Walsh A, Vaughn MG, Boisvert D, et al. A gene × gene interaction between DRD2 and DRD4 is associated with conduct disorder and antisocial behavior in males. Behav Brain Funct. 2007;3(1):30. https://doi.org/10.1186%2F1744-9081-3-30

57. Greenwood TA, Alexander M, Keck PE, McElroy S, Sadovnick AD, Remick RA, et al. Evidence for linkage disequilibrium between the dopamine transporter and bipolar disorder. Am J Med Genet. 2001 Mar 8;105(2):145–51. https://doi.org/10.1002/1096-

8628(2001)9999:9999%3C::aid-ajmg1161%3E3.0.co;2-8

58. Tripp G, Wickens JR. Neurobiology of ADHD. Neuropharmacology. 2009 Dec;57(7–8):579–89. https://doi.org/10.1016/j.neuropharm.2009.07.026

59. Mooney MA, Ryabinin P, Wilmot B, Bhatt P, Mill J, Nigg JT. Large epigenome-wide association study of childhood ADHD identifies peripheral DNA methylation associated with disease and polygenic risk burden. Transl Psychiatry. 2020 Jan 21;10(1):8. https://doi.org/10.1038/s41398-020-0710-4

60. Choi YJ, Cho J, Hong YC, Lee D wook, Moon S, Park SJ, et al. DNA methylation is associated with prenatal exposure to sulfur dioxide and childhood attention-deficit hyperactivity disorder symptoms. Sci Rep. 2023 Mar 1;13(1):3501. https://doi.org/10.1038%2Fs41598-023-29843-y

61. Pandian GSB, Jain A, Raza Q, Sahu KK. Digital health interventions (DHI) for the treatment of attention deficit hyperactivity disorder (ADHD) in children - a comparative review of literature among various treatment and DHI. Psychiatry Res. 2021 Mar;297:113742. https://doi.org/10.1016/j.psychres.2021.113742

62. Quinn PO. Treating adolescent girls and women with ADHD: Gender-Specific issues. J Clin Psychol. 2005 May;61(5):579–87. https://doi.org/10.1002/jclp.20121

63. Miklós, Futó, Komáromy, Balázs. Executive Function and Attention Performance in Children with ADHD: Effects of Medication and Comparison with Typically Developing Children. Int J Environ Res Public Health. 2019 Oct 10;16(20):3822. https://doi.org/10.3390/ijerph16203822

64. Babinski DE, Mills Huffnagle S, Bansal PS, Breaux RP, Waschbusch DA. Behavioral Treatment for the Social-Emotional Difficulties of Preadolescent and Adolescent Girls with ADHD. Evid-Based Pract Child Adolesc Ment Health. 2020 Apr 2;5(2):173–88. https://doi.org/10.1080%2F23794925.2020.1759470

65. Swanson JM, Wigal T, Lakes K. DSM-V and the future diagnosis of attention-deficit/hyperactivity disorder. Curr Psychiatry Rep. 2009 Oct;11(5):399–406. https://doi.org/10.1007%2Fs11920-009-0060-7