ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD): BEHAVIORAL AND GENETIC ASPECTS

https://doi.org/10.56238/sevened2025.015-004

André Marcelo Lima Pereira[1], Pedro Henrique da Silva Liberato[2], Júlia Vilas Boas Covizzi[3], Alba Regina de Abreu Lima[4], Jessica Gisleine de Oliveira[5] and Uderlei Doniseti Silveira Covizzi[6]

ABSTRACT

Attention Deficit Hyperactivity Disorder (ADHD) occurs during neurodevelopment, being more common in childhood and adolescence, but can last until adulthood. It is usually associated with symptoms involving family and school problems, negative psychological outcomes with increased risk for personality disorders, and psychotics. Indistinctly, they may present symptoms of inattention, while in others there is a predominance of impulsiveness and restlessness. The diagnosis is usually made in childhood, and it is difficult to validate before the age of five because it presents signs that are still nonspecific. There is a tendency for hyperactivity and compulsiveness to decrease in adolescence, although inattention persists. Language and learning problems are considered as common comorbidities for ADHD at this stage. In adults, the difficulty in diagnosis is recurrent due to the non-recognition of the problem, often due to the confusion of symptoms with personality failure due to emotional complaints. ADHD is considered a multifactorial and heterogeneous disorder, with hereditary and environmental contributions that interfere with neurodevelopment. There are strong indications of genetic contribution of this condition, between 70 – 80% heritability. Molecular studies of association of candidate genes and meta-analysis indicate the participation of the dopamine receptor genes (D4 and D5), in addition to the COMT gene, which encodes the enzyme catechol-O-methyltransferase, responsible for the degradation of catecholamines. Epigenetic patterns of methylation of dopaminergic, serotonergic, neurotrophic, and nerve growth factor receptor genes seem to be associated with different symptoms and severity of ADHD. The diagnosis is strictly clinical, based on the behavioral symptoms of inattention, impulsivity, and hyperactivity.

Keywords: Neurodevelopment; Inattention; ADHD heritability; Epigenetics ADHD.

[1]Psychologist Lucy Montoro Institute Fernandópolis SP
Lattes: http://lattes.cnpq.br/5617147383826311
[2]Medical student, Brasil University
Lattes: http://lattes.cnpq.br/0757289505642330
[3]Clinical Psychologist São Paulo State University – UNESP.
[4]Professor, Faculty of Medicine, FAMERP
Lattes: http://lattes.cnpq.br/0802737766517359
[5]Professor of Medicine at the University of Brazil and the Santa Fé do Sul University
CenterLattes:http://lattes.cnpq.br/8901490678564304

[6]Professor at Brasil University, Centro Universitário de Votuporanga, Centro Universitário do Norte de São Paulo UNORTE
Lattes: http://lattes.cnpq.br/3432578311647024

INTRODUCTION

The Diagnostic and Statistical Manual of Mental Disorders DSM-IV (APA, 1994) defined Attention Deficit Hyperactivity Disorder (ADHD) as a typically infantile mental disorder, whose symptoms develop before the age of seven (Dias *et al*., 2007). Subsequently, changes introduced conceptualized it as a neurodevelopmental problem associated with prognostic and risk factors (temperamental, environmental, genetic-physiological, interactional), whose symptoms manifest before the age of twelve, assuming clinical follow-up in childhood and adolescence and even in adult life – a meaning that guides clinical practice today, generally performed by psychiatrists and neurologists (Barbarini, 2020). It can also be conceptualized as a complex phenomenon produced from the interaction of several biological and psychosocial factors (Oliveira, 2022). Adults with ADHD are significantly impacted in different areas, such as affective-emotional, professional performance, financial management, interpersonal relationships, and marital relationships (Castro; Lima, 2018).

Attention Deficit Hyperactivity Disorder presents concepts permeated by consensus and controversies (França, 2012; Bonadio; Mori, 2013; Viégas; Oliveira, 2014). As a consensus, it is found that ADHD is a developmental disorder with a genetic and neurochemical basis whose symptoms usually begin in preschool children or in the early school grades, in an early form and with a chronic evolution, and may persist until adulthood (Couto; Melo-Júnior; Gomes, 2010; Souza *et al*., 2021; Bertoldo; Schuch; Serralta, 2022; Carvalho *et al*., 2022). It is, in essence, a neuropsychiatric disorder, multifactorial and described by persistent patterns of inattention, disorganization, impulsivity, and hyperactivity, which interferes with social functioning and individual evolution (Souza, 2023).

ADHD is a neurobiological disorder that can affect people from childhood to adulthood (Oliveira; Marine; Lemos, 2022). Dalgalarrondo (2019, p. 178) ponders that ADHD, as a very common and important disorder in childhood and adolescence, has a constant presence in adults with "marked difficulty directing and maintaining attention to internal and external stimuli", which show "impaired ability to organize and complete tasks, as well as severe difficulties in controlling their behaviors and impulses". Sulkes (2022, 2023) considers ADHD as a brain disorder that arises at birth or develops soon after birth (usually starting before the age of 4 and invariably before the age of 12) and combines poor ability to concentrate or prolonged attention, difficulty completing tasks, excessive activity, and impulsivity, which influence the child's performance or development.

On the other hand, authors such as Pereira (2009) and Couto, Melo-Júnior and Gomes (2010) propose to investigate the controversies, uncertainties, decisions and competitions in the foundation of the concept (such as neuropsychiatric discourse, genetic studies, historical trajectory, cultural and social possibilities that legitimize the disorder today) in a permanent dialogue in the contextualization of ADHD. As an example of these divergences, in the neuropsychiatric context, there are more frequent manifestations of symptoms such as agitation, impulsivity, difficulty maintaining attention, inattention (Carvalho *et al*., 2022), among others.

Doubts and controversies also arise in the determination and characterization of the subtypes of the disorder. Considering the relationship between inattention, hyperactivity and impulsivity – central symptoms of the disorder (Oliveira; Marine; Lemos, 2022), Santos and Vasconcelos (2010) identify different subtypes of ADHD diagnosis and point out, according to the *Diagnostic Statistical Manual of Mental Disorder's* - DSM IVTM (APA, 2003) and DSM-V (APA, 2014), three subtypes of the disorder: predominance of inattention, predominance of hyperactivity or impulsivity, and combined (or mixed) with symptoms of both previous types (MS, 2022). According to Santos and Vasconcelos (2010), Souza *et al*. (2021), Oliveira, Marinho and Lemos (2022), Sulkes (2023), following the DSM-5 diagnostic criteria (APA, 2014), combined ADHD occurs when six or more symptoms of inattention and six or more symptoms of hyperactivity-impulsivity are present, with a higher incidence in children and adolescents and practically absent in adults. It is still possible to make a diagnosis that indicates the presence or absence of hyperactivity.

Calimman (2010, p. 49) argues that most of the criticisms surrounding ADHD reflect doubts about its characterization and clinical, epidemiological and therapeutic controversies, many of which are pertinent or necessary for public debate: among the diversity of versions offered, the one that comes from the biomedical field, conveyed by neurologists and child psychiatrists, stands out.

ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD) – YOUR STORY

What is now presented as Attention Deficit Hyperactivity Disorder (ADHD) has received, throughout its history, different denominations linked to its characterizations and approaches. The evolution and understanding of the disorder are accompanied by studies that alter its description and the framing of its various symptoms, alternating its prevalence, such as inattention, hyperactivity, or a combination of both, by pointing out specificities, consensus, and contradictions (Carvalho *et al*., 2022).

The first description of the various attention disorders, such as attention deficit hyperactivity disorder, mood disorders (depression and mania), obsessive-compulsive disorder, and schizophrenia (Dalgalarrondo, 2019), appeared in the eighteenth century, when the Scottish physician Alexander Crichton (1763-1856) first described the characteristics of Attention Deficit Hyperactivity Disorder (Rezende, 2016). Crichton's clinical observations of mental illness revealed variations in people's attention levels, some exposing a "pathological inattention," that is, an inability to maintain attention on any event. For the doctor, this deficiency was already present at birth, but it reduced with age and rarely hindered learning, or resulted from diseases. Crichton, however, did not consider the conditions of his patients who could exhibit other disorders associated with inattention, such as metabolic dysfunction, epilepsy or brain trauma – which does not diminish the importance of his work in seeking to systematize the behaviors he observed (Castro; Ferreira; Goulart, 2008; Rezende, 2016).

The expression Attention Deficit Disorder (ADD) was initially established in 1980, with the official publication of the version of the *Diagnostic Statistical Manual of Mental Disorder's III*, the DSM-III (APA, 1980), which maintains few symptomatological differences presented in the diagnosis of the manual disorder (DSM-IV) published by the *American Psychiatric Association* in 1994 (APA, 2003), with the nomenclature attention deficit hyperactivity disorder (ADHD). This nomenclature would spread increasingly and widely in the medical and psychiatric environment, becoming the most frequent disorder in children and adolescents referred to specialized services (Pereira, 2009).

The current concept of ADHD was publicized in 1902, at a conference given by British pediatrician George Frederic Still (1868-1941) in London, in which he reported cases exposing the psychic conditions related to what he called *the defect of moral control in children*. It referred to the child's ability to control his behavior in accordance with moral and social values (Rezende, 2016). In other words, Still linked "attention disorder to a defect of the inhibitory will", thus offering the "clinical basis for the diagnosis of ADHD": it is worth emphasizing, however, that Still conceived the disorder as a defect of moral control (Caliman, 2010, p. 51), the equivalent of a behavioral deficiency in "mentally retarded" children (Rezende, 2016).

George Still warned, however, that this defect in the control of children's behavior (described as impulsive, immediate, incapable of maintaining attention) was not necessarily linked to any intellectual retardation or physical illness (trauma or brain tumor, meningitis, etc.), which means that the disorder did not correspond to a symptom of another disease, such as the current lethargic encephalitis (Rezende, 2016; Duarte, 2018).

Encephalitis lethargica can confuse the diagnosis of ADHD due to the damage done to the brain. This damage results in behavioral problems, headache, drowsiness, lethargy, tremors, and irreversible physical and mental damage in many patients, in addition to personality changes, emotional instability, cognitive deficits, learning difficulties, and other supervening manifestations, with children described as hyperactive, distracted, antisocial, destructive, and undisciplined (Caliman, 2010; Butturi Júnior, 2014). His observations on the "deficiency of moral control" correspond to what he now identifies criteria for the diagnosis of conduct disorder, oppositional defiant disorder, learning disorder, or antisocial personality disorder (Rezende, 2016). This is the reason why Chiaverini (2011) suggests paying attention to disorders in childhood and adolescence and their evolutionary stages, so as not to run the risk of transforming into pathological something that is normal for these stages (such as aggressiveness or mental retardation in adolescence).

In the 30s, the term hyperkinetic appeared, with a characteristic very similar to the current description of hyperactivity in the ICD (F90). In 1932, Franz Kramer (1878 – 1967) and Hans Pollnow (1902 -1943) published studies on childhood hyperkinetic disease, a disorder with marked motor restlessness very similar to ADHD, emphasizing impulsivity and agitation more than moral behaviors. They believed, however, that, despite being a prevalent characteristic in childhood, it could remain in adulthood (Carvalho *et al*., 2022)

Calimann (2010, p. 50) emphasizes that the official history of the diagnosis of ADHD is composed of other "problematic and doubtful psychiatric diagnoses, located on the obscure border between defined and undefined nervous disorders, between the dysfunctions of normal life and the pathological of other problematic and doubtful psychiatric diagnoses". It can be said that the investigation of hyperactivity is permeated by brain damage in children with atypical behaviors, often related to various infectious diseases, intoxication, asphyxia, epilepsy and other conditions (Castro; Ferreira; Goulart, 2008).

Among the ADHD-related harms, according to Rezende (2016), Rohde *et al*. (2019) and Oliveira (2022), appear: minimal brain dysfunction with brain lesions in different degrees of severity, ranging from severe with cerebral palsy or mental disability to minimal lesions, with memory deficits, learning deficits, minimal motor and sensory dysfunctions, or behavior such as hyperactivity; hyperkinetic reaction of childhood, initially observed in the child's atypical behavior and not as a neurological cause, defined as excess activity, restlessness, distraction and lack of attention, tending to decrease from adolescence onwards; attention deficit disorder (1970s), with emphasis on attention deficit which, together with impulse control deficit, best characterized the disorder, appearing in the DSM-

III as Attention Deficit Disorder (ADD); attention-deficit/hyperactivity disorder (1980s) that best conceptualized the diagnosis for ADHD (Caliman, 2010).

From the 1990s onwards, due to the variety of studies describing its neurological underpinnings, ADHD was recognized not as a condition exclusive to childhood, but as a persistent disorder into adulthood (Caliman, 2010; Christian; Melo-Júnior; Gomes, 2010; Rezende, 2016; Carvalho *et al*., 2022; Sulkes, 2023). Although the International Classification of Diseases ICD-10, of 1992 (WHO, 1996; Wells *et al*., 2011) has retained the term "hyperkinetic disorders" (code F90), the diagnostic guidelines indicate that the fundamental characteristics of the disorder refer to impaired attention and hyperactivity – essential for the identification of inattention – and impulsivity, which registers the involvement of different neural mechanisms in the disorder. It is also admitted that social, cultural and environmental risk factors have a direct impact on the development and evolution of the disorder (Regalla; William; Serra-Pinheiro, 2007; Esper *et* al.2021; Oliveira, 2022; Almeida; Muniz; Moura, 2023),

The social and economic development established to date motivated, after more than thirty years of application of the ICD-10, the 11th revision of the International Classification of Diseases, its most recent update in the ICD-11 version, in force as of January 2022. Each update resumes the transformations that have occurred in the epidemiological profile of the populations and incorporates the registration of new nosographic entities reflected and adapted to scientific development (Almeida *et al*., 2020).

It is worth noting that the updates to the ICD are fundamental to the economics of public and private health, used in the financing of health services as a tool usually used for authorization of hospitalization (AIH) and other procedures, as part of the classification diagnostic coding system, configuring itself as a "rich source of administrative and epidemiological data, that can guide care and preventive actions" (Almeida *et al*., 2020, p. 3). Despite the importance of this update, the transition from ICD-10 to ICD-11 should take 2 to 3 years, and may take longer when it comes to locations with a lack of technological or logistical support, being, therefore, a gradual transition, continuous and concomitant with the use of ICD-10 (Who, 2019) – which is still a great challenge whose initial unfavorable aspect is the language that imposes the translation process, adaptation, revision and implementation in the new language, in addition to the projects under development that have the ICD-10 as a support base.

CLINICAL AND BEHAVIORAL CHARACTERISTICS

ADHD, as a neurodevelopmental disorder, although it is more common in childhood and adolescence, can last until adulthood. The disorder motivates a growing demand for mental health services and, compared to the general population, is associated with symptoms, family and school problems, negative psychological outcomes with increased risk for developing personality disorders, and psychotic conditions (Brasil, 2022). Indistinctly, children and adults may present mainly symptoms of inattention, while in others there is a predominance of impulsiveness and restlessness. Particularly in adults, ADHD symptoms, characterized as inattention, impulsivity, restlessness, executive dysfunction, and emotional dysregulation, strongly impact the patient's functioning.

The diagnosis of Attention Deficit Hyperactivity Disorder includes symptoms distributed between inattention and hyperactivity/impulsivity (Araújo; Lotufo Neto, 2013), whose criteria bring together 18 main symptoms of ADHD: 9 signs and symptoms of inattention and 9 symptoms of hyperactivity and impulsivity (APA, 2014). In the diagnostic process, the person must have at least six symptoms (for adults, the number required is five) that persist for at least six months, and these symptoms have started before the age of 12, with negative impacts in at least two environments, usually home and school (Castro; Lima, 2018).

It is necessary to wait up to 16 years to attribute the diagnosis of ADHD to a child or adolescent, who needs to present at least six of the known symptoms, while the older ones (adults), only five from one or both groups, according to DSM-5 guidelines (Braga *et al*., 2022). Symptoms must be present for 6 months or more, be more pronounced than what is considered normal according to the level of development, occur in at least 2 situations (between home, school, work, other environment), appear before 12 years of age, and interfere with functional capacity.

These are symptoms of inattention (Apa, 2014; Sulkes, 2022): does not point out attention to detail and makes careless mistakes (school, activities, tasks), cannot maintain attention on tasks (school, games), inattentive to what is said when approached directly, does not obey instructions or complete tasks, lacks organization (tasks, activities), avoids and resists involvement in tasks that require maintenance of mental effort for a long time, They usually lose useful objects for school tasks or activities, are easily distracted and forget to perform daily activities.

In terms of hyperactivity (excessive motor activity) and impulsivity (hasty actions with a potential negative outcome, such as a child crossing the street without looking, sudden abandonment of school or work without assessing consequences), the child's symptoms

refer to: frequently moving or contorting hands and feet, wandering around the environment, running or climbing frequently at inappropriate times, restless when playing, acts as if she is always "plugged in", talks a lot, gives abrupt answers to questions even before the question is concluded, impatience to wait her turn (to speak, play, play), frequently interrupts people or intrudes in speech (Sulkes, 2022, 2023).

In the recognition of ADHD, however, Diogo, Akerman and Borda (2020) consider a certain disparity between children and adolescents in relation to gender. Girls tend to manifest more inattention than impulsivity and hyperactivity, and prevalence of internalizing symptoms marked by reactions to the individual himself, such as sadness, withdrawal, somatic complaints, fear, anxiety, depression (Hess; Falcke, 2013; Poton; Soares; Gonçalves, 2018). These signs can mask the presence of symptoms of hyperactivity and attention deficit, unless they express externalizing problems, characterized as "a set of impulsive reactions that, externalized by children (or adolescents), produce conflicts and, in a repetitive and persistent pattern, are associated with psychopathological syndromes and disorders" (Guimarães; Silva, 2021, p. 1). In boys, impulsive, hyperactivity, and behavioral behaviors are more common, as well as oppositional/defiant behavior, such as arguing with adults, losing one's temper easily and frequently, defying rules and instructions, harassing people, blaming others for one's mistakes, becoming angry or resentful for no justifiable reason, being cruel, and vindicative (Poton; Soares; Gonçalves, 2018; Diogo; Akerman, Borsa, 2020; Elia, 2023).

In addition, other characteristics can be added to the above: higher failure and school dropout rates, greater difficulty in keeping jobs, higher frequency of teenage pregnancy and broken marriages, propensity to suffer domestic or traffic accidents, use of alcohol, tobacco and illicit drugs (Alarcon; Jorge, 2012; Caliman, 2012; Mayan; Confortin, 2015; Pires *et al*., 2024).

It is important to highlight that the isolated characteristics are incapable of allowing a diagnosis for ADHD, although they may indicate the need for further investigation. In addition, the differentiation between attention-deficit/hyperactivity disorder and other manifestations can be made difficult by the imprecision in the definition and understanding of other conditions expressed already in the preschool period, such as communication and speech problems that also occur in neurodevelopmental dysfunctions, such as autism, anxiety, depression, behavioral disorders (Sulkes, 2022). Therefore, it is extremely important to have an adequate medical evaluation to identify and elucidate the manifestations of a disorder, motivated by internal and environmental factors.

When it occurs in late childhood, ADHD symptoms are most noticeable in hyperactivity /impulsivity or combined types: continuous display of persistent motor movements of the lower limbs (disordered movements) and contortion of the hands, compulsive speech, apparent lack of attention (disconnection with the environment). Children with the predominantly inattentive type may not manifest apparent symptoms or signs. It is known, however, that, in adolescence and adulthood, the symptoms of hyperactivity are usually less evident, but the other difficulties remain unchanged and the losses accumulate with negative effects on self-esteem (Carvalho *et al*., 2021; Ladislau *et al*., 2022).

ADHD in children and adolescents

As ADHD is a neurodevelopmental disorder characterized by a persistent pattern of inactivity and/or hyperactivity with interference in function or behavioral development, its diagnosis is usually made in childhood, but difficult to be validated before the age of five, considering signs that are still nonspecific. As they become adolescents, symptoms of hyperactivity and impulsivity tend to decrease, although symptoms of inattention tend to persist, and learning and language problems should be considered as common comorbidities with ADHD. Thus, early diagnosis and appropriate intervention qualify as potential reducers of the functional decline caused by ADHD (Santos *et al*., 2024).

In childhood and adolescence, the diagnosis of ADHD is produced by the information collected in the detailed anamnesis of symptoms, provided by parents and teachers, whose treatment, done by pharmacological and behavioral measures, improves symptoms, maintains school performance and learning, self-esteem and social interactions (Galvan *et al*., 2018). In children and adolescents, among the most important characteristics of ADHD are: inattention – difficulty in maintaining focus on tasks (inattention to appointments, distraction in daily activities), disorganization and frequent mistakes made by carelessness; hyperactivity: restless or excessively active, they do not tolerate sitting for long periods, that is, they are constantly moving around the environment (these signs decrease compared to childhood); some experience physical restlessness and impulsivity, that is, they make instinctive decisions, with difficulty controlling emotional reactions; frequent problems at school and in social relationships (Dacroce, 2016; Fonseca, 2016).

Symptoms such as agitation, restlessness, moving hands and feet or various objects, talking a lot, having disinterest and difficulty remaining attentive in long or repetitive activities, easy distraction by environmental stimuli or with one's own thoughts deserve to be highlighted (Seno, 2010). Other accentuated peculiarities are: forgetfulness (of school

supplies, errands, studying for the test) which is one of the main complaints of parents; impulsivity: instinctive decisions, without evaluating consequences before acting, poor social relationships, lapses in dispersion, aggressiveness, and problems with self-esteem (Maia; Confortin, 2015; Oliveira, 2022). The following are common: not waiting for one's turn, not waiting for the end of the question to answer, interrupting others, acting without thinking (Castro; Lima, 2018); personal and planning disorganization (Benczik; Casella, 2015), poor financial and time management, without maintaining an effective academic environment, impacts on interpersonal relationships, the parental domain, and marital relationships (Oliveira, 2022); poor or lower school performance than expected for the age group or intellectual capacity (Barros; Coast; Gomes, 2021; Pelligrini *et al*., 2022).

Gilvan *et al*. (2018), Souza *et al*. (2021) and Pires *et al*. (2024) certify that, in children and adolescents, ADHD points to a variable range of negative impacts on development: in social or relational areas – aspects of life in society, relationships, roles, belonging to groups (with conflicting parent-child relationships), functional impairments and impairments in social skills and quality of life, especially when they are associated with comorbidities; behavioral: drug use, delinquency behavior and sexual risk; Biological: gastrointestinal problems, vision problems; neurological: morphological aspects of the brain, such as reduced gray matter, decreased activation of the prefrontal cortex; cognitive: deficits in executive functions (skills that control actions, thoughts, planning, flexible reasoning, concentrated attention, behavioral inhibition and emotions), selective inattention; psychological: low self-esteem, negative self-perception; psychopathological: depression, anxiety, substance use disorder.

ADHD in adults

It is recurrent that difficulties arise in the diagnosis of ADHD in adults due to lack of recognition of the problem, belief that the condition is due to personality failure due to emotional complaints or even because the symptoms overlap and are not clearly identified (Oliveira, 2022). According to Dias *et al*. (2007), the diagnosis of ADHD in adults presents several controversies related to the description of the symptoms of the disorder and admits that the symptoms described and validated in child populations are clearly inappropriate for adults. This age group with ADHD, however, shares clinical characteristics, some comorbidities, neuropsychological dysfunctions, and compromised functionalities similar to those of children with ADHD (Souza, 2023).

In adults, ADHD causes damage in several domains: home life, work, social interactions, community or educational activities, money management, driving, leisure

activities, daily responsibilities, in the family environment (possibility of divorce, emotional exhaustion, lack of father/maternal guidance in relation to children), academic (reduced quality and performance), professional (distraction, perishing effort and focus on work), affective or social (decreased quality), making room for the advent of comorbidities (Gomes; Gabriel; Maestri, 2020; Oliveira, 2022).

In the occupational context, some impacting symptoms refer to: sloppiness in activities, disorganization, lack of concentration and inattention, restlessness, averse to following routines, difficulty in planning and executing tasks, procrastination, anxiety in the face of non-stimulating tasks, mood swings, difficulty listening and waiting for the turn to speak, intolerance to monotonous and repetitive situations, repeated mistakes in the face of simple activities (Castro; Lima, 2018; Rohed *et al*., 2019).

It is worth noting that, when the disorder persists in adulthood, there is a variation in the way ADHD presents its symptoms, or rather, the symptom of childhood impulsivity subtly compromises executive functions in adult life, imposes low speed of processing more complex information and deficits in attention and auditory verbal learning (Saboya *et al*., 2007; Souza *et al*., 2021).

Oliveira and Dias (2015) and Gomes, Gabriel and Maestri (2020) adduce that adults with alterations in executive functions have difficulty, *e.g.*, in organizing their daily routine, have low self-regulation and voluntary self-organization, indecision about where to start and what to do first; they need to-do lists to be performed, but forget them; they are unable to perform many activities at the same time (multitasking) and need longer deadlines to complete them. In university students, this experience has negative repercussions on the performance of their activities, performance and achievement of desired final goals. As a result, stress (due to too many commitments to fulfill and inertia to action) and fear of not being able to handle everything occur; interrupts work, starts a new activity without completing the previous one (Benczik; Casella, 2015; Sulkes, 2023). They fear not being able to perform tasks alone and need to be remembered by others, which results in embarrassment at work, poor school performance and difficulties in relationships. In addition, adults may incur remission of hyperactivity symptoms, although inattention becomes prevalent, and they end up being labeled as negligent, careless, immature, impacting their self-esteem and self-image, making them feel guilty for their failures (Sulkes, 2023).

The most common manifestations of ADHD in adults may be associated with genetic, environmental, social, and cultural factors, as well as changes in brain structure or functioning that lead to the appearance of functional abnormalities (Galvan *et al*., 2018;

Pires *et al*., 2024), such as: lack of focus or instability of attention, difficulty or even repulsion to follow routines, boredom/monotony or unmotivated disinterest, lack of organization or planning and execution of tasks, frequent delays and procrastination, professional instability, anxiety, frequent job changes, difficulties in relationships, higher incidence of traffic accidents (Castro; Lima, 2018; Oliveira, 2022). Other symptoms of ADHD in adults: indecision, forgetfulness (scarce sense of time, loss of objects, forgetting to eat meals or what they just thought, talking too much, exaggerated focus on some moments of their previous life, regulation of emotions important for learning (they live the "all or nothing"), persistent insomnia and low tolerance to frustration (Fonseca, 2016).

Some symptoms in adults may suggest undiagnosed ADHD in childhood/adolescence, such as inattention, lack of attention to detail, inability to set priorities, start and not complete tasks, lack of concentration, poor attention management, and not being able to perform more than one task at the same time – *multitasking* or multitasking (Bailer; Tomitch, 2016; Castro; Lima, 018; Oliveira, 2022; Sulkes, 2022; Broilo; Tisser; Lisbon, 2022).

An individual with ADHD, due to the condition of the disorder, tends to face numerous challenges in personal life and relationships, such as family, group, and social life (Castro; Lima, 2018; Silva; Pear tree; Silva, 2023). The following are common: poor academic performance, due to lack of focus in class or to complete tasks (requires structured study methods, a calm learning environment and open communication with teachers); interpersonal relationships: can negatively affect relationships with people (they need to develop social skills, practice empathy and participate in extra activities); self-esteem and self-concept: making comparisons with peers/other people without ADHD can impact self-esteem (needs: positive reinforcement, promotion of individual achievements, even if minimal, and encouragement of self-acceptance); Autonomy and responsibility: problem maintaining routines and fulfilling responsibilities (needs to establish consistent routines, use visual reminders and receive parental support).

DIAGNOSIS OF ADHD

At first, semi-structured interviews are preferably used to capture the patient's history of the first signs of symptoms, the way they are welcomed, the daily impacts, and a hypothesis is raised, which will be put to the test in the following meetings. Afterwards, some instruments approved by the psychology council (available on the https://satepsi.cfp.org.br/testesFavoraveis.cfm website) are selected by the evaluator in order to measure some cognitive domains such as intelligence, attention (concentrated,

alternating and divided), executive functions, visuconstructive ability, inhibitory control, cognitive flexibility, learning and memory.

The results provided by the psychometric instruments added to the information collected during the interview provide the professional with data for the elaboration of a report based on the criteria of the DSM V (APA, 2014) in order to produce a scientific psychological document to be presented to the patient in a feedback interview. In order to make a diagnosis of ADHD, it is necessary to find a consistent pattern of 6 or more symptoms of inattention and/or 6 or more symptoms of hyperactivity.

ADHD GENETICS

Attention Deficit Hyperactivity Disorder begins in childhood and can persist into adulthood. It is a disorder of neurobiological origin that occurs during the development of the neurological system. Evidence indicates strong genetic components, with a heritability rate between 70 – 80%, indicated by studies using biological siblings, comparing monozygotic and dizygotic siblings, as well as adoptive siblings. Molecular testing for rare mutations is not yet recommended for diagnosis, although guidelines in many countries recommend testing individuals with mild intellectual disability or autism spectrum disorder. Genetic variations common to ADHD still have limited clinical value for diagnosis and pharmacogenomics (Thapar, 2018).

It is not yet fully established, but ADHD is considered a multifactorial and heterogeneous disorder, with a hereditary contribution that interferes with neurodevelopment, favoring brain lesions, neuroinflammation, premature birth, and greater sensitivity to exposure to environmental toxins. Studies that associate neuroimaging with genomics allow deciphering neurobiological pathways that can be used as clinical markers, new forms of treatment, as well as therapeutic interventions for patients (Yadav *et al.,* 2021).

The heritability of ADHD is around 77 to 88%, being considered higher than other psychiatric diseases, such as Autism Spectrum Disorder (ASD), around 80%, bipolar disorder (about 75%) and schizophrenia (about 80%). However, molecular studies based on single nucleotide variants (SNPs) show a 22% heritability for ADHD, indicating the need for further research to understand this huge difference (Grimm *et al*, 2020).

One of the most plausible hypotheses implies that genes with an impact on the central dopaminergic and noradrenergic systems are involved in the etiopathology of ADHD and that they may interact with environmental conditions. Alteration in dopamine transporter

function is the most consistent neurochemical quirk observed in ADHD (Kanarik *et al*., 2022).

Molecular findings from association studies of functional candidate genes in a series of pooled analyses and meta-analyses conducted, indicate the importance of modifications in the dopamine D4 receptor genes and a microsatellite marker of the dopamine D5 receptor gene. The *COMT* variant val158/108 met influences conduct problems in people with ADHD (Thapar, Stergiakouli, 2008). This gene encodes the enzyme Catechol-O-methyltransferase (*COMT*), which has the function of degrading catecholamines in the synaptic cleft, responsible for most of the dopamine degradation in the prefrontal cortex. In this way, this enzyme acts directly on the dopaminergic and noradrenergic balance. The val158met polymorphism of the *COMT gene* presents an exchange of these amino acids, affecting the thermostability of the enzyme. The variation in *COMT* apparently plays a relevant role in the phenotypic heterogeneity found in ADHD, being related to disruptive behavior disorders (Oliveira, 2011).

Candidate gene studies have revealed differential methylation patterns in genes involved in the dopaminergic, serotonergic, and neurotrophic systems, including the genes encoding for the dopamine transporter *SLC6A3* (Kuc *et al.* 2020), *SLC6A4*, DRD4 dopamine receptor gene (Bhart *et al.* 2020), catecholamine-degrading CORT, ANKK1 (Ankyrin Kinase 1) associated with the DRD2 receptor relates to dopaminergic signaling (Habibzadeh, *et al.* 2021), BDNF and NGFR, which respectively produce brain-derived neurotrophic factor (Chow; Wessels; Foster, 2020) and the nerve growth factor receptor (Zhao *et al,* 2022), associated with the symptomatology and severity of ADHD (Kuc *et al*. 2020; Rovira *et al.* 2020).

Recent findings, however, show that ADHD is more than a catecholaminergic disorder. The gene *loci* involved act in the areas for neurite growth, synaptic plasticity, and glutamatergic signal transmission (Grimm; Kranz; Reif, 2020).

In addition to the genetic factors mentioned, the interaction between genes and environment has been shown to be fundamental for the manifestation of ADHD. While genetic inheritance plays an important role, environmental influences cannot be underestimated either. Factors such as maternal smoking during pregnancy, exposure to toxic substances such as lead, and prematurity are among the environmental factors that can contribute to the development of the disorder. Studies indicate that exposure to alcohol and tobacco during pregnancy can alter the child's brain development, affecting areas related to attention and impulse control, with a potential increase in the risk of ADHD (Nigg, 2006).

Research on brain plasticity also suggests that ADHD may be associated with differences in brain structure and functioning, particularly in areas such as the prefrontal cortex, which is involved in executive control, attention, and impulsive behavior. These findings have been corroborated by functional neuroimaging studies showing reduced activation of these areas in individuals with ADHD, especially during tasks requiring sustained attention or inhibition of impulsive responses (Arnsten *et al*., 2009). These results reinforce the idea that ADHD is not just a behavioral issue, but involves neurobiological differences that can be observed directly through neuroimaging techniques.

The serotonergic system, mentioned above, has also been implicated in ADHD, although less clearly than the dopaminergic system. Recent studies demonstrate that the *SLC6A4* gene, which encodes the serotonin transporter, can interact with the dopaminergic system to modulate ADHD symptoms. Modifications in serotonin transport can affect the balance between neurotransmitters and influence emotional regulation and impulsivity, symptoms often observed in the disorder (Barth *et al.*, 2020).

Another relevant point is the relationship of ADHD with psychiatric comorbidities, such as Generalized Anxiety Disorder, Conduct Disorder, Depression and Learning Disorders. The presence of these comorbidities can make it difficult to diagnose and treat ADHD, making a multidisciplinary approach essential. Studies show that children with ADHD are at higher risk of developing other psychiatric conditions, and the presence of comorbidities is associated with a more severe clinical course of the disorder, with more intense impacts on social and academic life (Biederman *et al*., 2009).

In the field of pharmacogenomics, the identification of genetic variants associated with response to pharmacological treatments is one of the most promising advances in the management of ADHD. The most common medications for the treatment of ADHD are psychostimulants, such as methylphenidate and amphetamines, which act by increasing the availability of dopamine and noradrenaline in the brain. However, the response to treatment can vary considerably between patients. Pharmacogenetic studies have identified genetic variants that can influence the efficacy and adverse effects of drugs, which allows for personalization of treatment based on the patient's genetic profile. For example, variants in the *COMT gene*, responsible for the degradation of dopamine in the prefrontal cortex, have been associated with the response to methylphenidate, allowing doctors to choose the best treatment for each patient (Faraone *et al.,* 2018).

In addition, research continues to explore therapeutic alternatives beyond medications. Behavioral interventions, such as Cognitive Behavioral Therapy (CBT), have been shown to be effective in controlling ADHD symptoms, especially when combined with

drug treatment. The use of psychotherapeutic strategies that aim to improve self-control, organization, and problem-solving can help patients better cope with the difficulties associated with the disorder. Social skills training programs have also shown positive results, helping individuals develop interpersonal skills and reduce impulsive behaviors (Faraone *et al.,* 2018).

Recent studies have suggested that the combination of genetic and environmental factors may result in a varied clinical expression of ADHD, which implies the need for diversified therapeutic approaches. For example, genes related to the dopaminergic system may not be sufficient to fully explain the phenotypic heterogeneity of the disorder. This may indicate that, in addition to genetic factors, exposure to adverse environmental conditions during brain development can have a significant impact on the manifestation of symptoms. Behavioral neuroscience points to neuronal plasticity as a key point, suggesting that environmental factors may, to some extent, "modulate" the expression of ADHD-related genes (Nigg *et al*., 2006).

The concept of epigenetics, which refers to changes in gene expression without DNA modification, has been investigated in the context of ADHD. Evidence suggests that factors such as psychological stress, inadequate nutrition, and even sleep quality may influence the expression of genes that affect behavior and cognition (Rovira *et al*., 2020). These findings reinforce the idea that ADHD is not caused by a single factor, but by a complex network of interactions between genetics and the environment, which together can affect the development of the central nervous system.

FINAL CONSIDERATIONS

ADHD is a neuropsychiatric disorder associated with impairment and suffering throughout the patient's life, involving risk factors in childhood, with persistence or remission in adulthood. The diagnosis of ADHD is strictly clinical, based on the behavioral symptoms of inattention, impulsivity, and hyperactivity (Leffa et al., 2022). Improving the accuracy of clinical diagnosis can ensure that patients with ADHD benefit from receiving appropriate treatment. The availability of valid diagnoses helps in reducing misdiagnoses of cultural biases and overlapping ADHD symptoms (Peterson et al. 2024).

Some children may be intellectually gifted and have behavioral and academic difficulties. Cornoldi et al. (2023) found 8.8% of these children, among others, diagnosed with ADHD. This corresponds to twice that found in the normal population. This high representation does not reflect an incorrect diagnosis of ADHD, as these children exhibit the predicted typical characteristics, including lower scores on measures of working

memory and processing speed, combined with the inclusion criteria for giftedness. As it is a neurodevelopmental disorder, it often presents with other psychiatric comorbidities such as anxiety and depression. Ideally, the follow-up of a neuropsychologist enables the so-called differential diagnosis. The evaluator uses known instruments and carries out a thorough process, with stages of hypothesis raising, investigation and feedback.

Fully understanding ADHD remains a challenge. The multifactorial nature of the disorder, which involves the complex interplay between genes, environmental factors, and neurobiology, makes it difficult to identify a single cause or a single treatment that works for all patients. However, the combination of different therapeutic approaches, coupled with progress in the fields of genetics, neuroscience, and neuroimaging, is opening up new possibilities for the management and understanding of ADHD.

REFERENCES

1. Agrela Rodrigues, F. A., & Tiboni Kaiut, R. K. (2023). O cérebro em multitarefas. Ciencia Latina Revista Científica Multidisciplinar, 7(5), 2906–2916.

2. Almeida, J. V. Q., Muniz, R. B., & Moura, L. E. G. (2023). Fatores de risco ambientais para o transtorno de déficit de atenção e hiperatividade. Revista Médica, 102(4), 1–15. https://doi.org/10.11606/issn.1679-9836.v102i4p1-15

3. Almeida, M. S. C., Sousa Filho, L. F., Rabello, P. M., & Santiago, B. M. (2020). Classificação Internacional das Doenças - 11ª revisão: da concepção à implementação. Revista de Saúde Pública, 54, 104–108. https://doi.org/10.11606/s1518-8787.2020054002188

4. American Psychiatric Association. (1980). Diagnostic and statistical manual of mental disorders (3rd ed.). Author.

5. American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.). Author.

6. American Psychiatric Association. (2014). Manual estatístico e diagnóstico dos transtornos mentais: DSM-5 (5th ed., M. I. C. Nascimento et al., Trans.). Artmed.

7. Araújo, Á. C., & Lotufo Neto, F. (2013). A nova classificação americana para os transtornos mentais - o DSM-5. Jornal de Psicanálise, 46(85), 99–116.

8. Arnsten, A. F. T. (2009). The emerging neurobiology of attention deficit hyperactivity disorder: The key role of the prefrontal association cortex. The Journal of Pediatrics, 154(5), I–S43. https://doi.org/10.1016/j.jpeds.2009.01.018

9. Bailer, C., & Tomitch, L. M. B. (2016). Estudos comportamentais e de neuroimagem sobre multitarefa: uma revisão de literatura. Alfa, 60(2), 403–425. https://doi.org/10.1590/1981-5794-1608-7

10. Barbarini, T. A. (2020). Corpos, “mentes”, emoções: uma análise sobre TDAH e socialização infantil. Psicologia & Sociedade, 32, 1–15. https://doi.org/10.1590/1807-0310/2020v32237327

11. Barros, C. A. U., Costa, E. B. S., & Gomes, V. S. S. (2021, March). Dificuldades de aprendizagem de crianças com TDAH nas séries iniciais do Ensino Fundamental. Revista Educação Pública, 21(8).

12. Barth, B., Bizarro, L., Miguel, P. M., Dubé, L., Levitan, R., O'Donnell, K., & Silveira, P. P. (2020). Genetically predicted gene expression of prefrontal DRD4 gene and the differential susceptibility to childhood emotional eating in response to positive environment. Appetite, 148, 104594. https://doi.org/10.1016/j.appet.2020.104594

13. Benczik, E. B. P., & Casella, E. B. (2015). Compreendendo o impacto do TDAH na dinâmica familiar e as possibilidades de intervenção. Revista de Psicopedagogia, 32(97), 93–103.

14. Bertoldo, L. T. M., Schuch, C., & Serralta, F. B. (2022). Relações de apego e Transtorno de Déficit de Atenção com Hiperatividade infantil. Revista Brasileira de Psicoterapia, 24(2), 87–101.

15. Biederman, J., Petty, C. R., Monuteaux, M. C., Mick, E., Clarke, A., Ten Haagen, K., & Faraone, S. V. (2009). Familial risk analysis of the association between attention-deficit/hyperactivity disorder and psychoactive substance use disorder in female adolescents: A controlled study. Journal of Child Psychology and Psychiatry, 50(3), 352–358. https://doi.org/10.1111/j.1469-7610.2008.02040.x

16. Bonadio, R. A. A., & Mori, N. N. R. (2013). Transtorno de déficit de atenção/hiperatividade: Diagnóstico da prática pedagógica. Editora da Universidade Estadual de Maringá.

17. Braga, A. T., Loiola, A. V. B., Napoleão, L. D., & Araújo, B. C. (2022). Transtorno do Déficit de Atenção e Hiperatividade em crianças: uma revisão bibliográfica. Research, Society and Development, 11(16), e407111638321. https://doi.org/10.33448/rsd-v11i16.38321

18. Brasil. Ministério da Saúde. Comissão Nacional de Incorporação de Tecnologias no Sistema Único de Saúde (Conitec). (2022). Protocolo clínico e diretrizes terapêuticas para o transtorno do déficit de atenção com hiperatividade (TDAH) (Relatório recomendação – Protocolos clínicos e diretrizes terapêuticas n. 733). Editora do Ministério da Saúde.

19. Broilo, P. L., Tisser, L., & Lisboa, C. S. M. (2022). Comportamento de 'media multitasking' (MMT) na pré-adolescência: Revisão integrativa e recomendações para pesquisas futuras. Psicologia: Ciência e Profissão, 34(2), 333–354. https://doi.org/10.1590/1982-3703003224088

20. Butturi Júnior, A. (Ed.). (2014). Da encefalite letárgica ao transtorno de déficit de atenção com hiperatividade (TDAH): emergência e consolidação das explicações biológicas reducionistas. Gavagai: Revista Interdisciplinar de Humanidades, 1(1), 27–39.

21. Caliman, L. V. (2012). Drogas de desempenho: a Ritalina e o transtorno do déficit de atenção/hiperatividade (TDAH). In S. Alarcon & M. A. S. Jorge (Eds.), Álcool e outras drogas: diálogos sobre um mal-estar contemporâneo (pp. 223–237). Editora Fiocruz.

22. Caliman, L. V. (2010). Notas sobre a história oficial do transtorno do déficit de atenção/hiperatividade TDAH. Psicologia: Ciência e Profissão, 30(1), 45–61. https://doi.org/10.1590/S1414-98932010000100005

23. Carvalho, A. S. M., Ferreira, L. M., Albuquerque, L. F. S., Jagobucci, L. A., Souza, K. L. A., Triches, J. C., Almeida, L. M., Pereira, I. S., Pereira, E. S., & Souto, P. F. (2022). A história do TDAH – evolução. Research, Society and Development, 11(2), e7611225604. https://doi.org/10.33448/rsd-v11i2.25604

24. Carvalho, A. S. M., Pereira, P. C., & Oliveira, M. M. (2021). Transtorno de Déficit de Atenção/Hiperatividade, Legislação, Escola e PAE – Breve análise. Research, Society and Development, 10(14), e204101421877. https://doi.org/10.33448/rsd-v10i14.21877

25. Castro, C. X. L., & Lima, R. F. (2018). Consequências do transtorno do déficit de atenção e hiperatividade (TDAH) na idade adulta. Revista de Psicopedagogia, 35(106), 61–72.

26. Castro, E. M., Ferreira, R. A., & Goulart, E. M. A. (2008). A epilepsia e os transtornos mentais: a interface neuropsiquiátrica. Revista Médica de Minas Gerais, 18(4, Suppl. 1), S98–S106.

27. Chiaverini, D. H. (Ed.). (2011). Guia prático de matriciamento em saúde mental. Editora do Ministério da Saúde: Centro de Estudo e Pesquisa em Saúde Coletiva.

28. Chow, R., Wessels, J. M., & Foster, W. G. (2020). Brain-derived neurotrophic factor (BDNF) expression and function in the mammalian reproductive tract. Human Reproduction Update, 26(4), 545–564. https://doi.org/10.1093/humupd/dmaa008

29. Cornoldi, C., Giofrè, D., & Toffalini, E. (2023). Cognitive characteristics of intellectually gifted children with a diagnosis of ADHD. Intelligence, 97, 101736. https://doi.org/10.1016/j.intell.2023.101736

30. Couto, T. S., Melo-Júnior, M. R., & Gomes, C. R. A. (2010). Aspectos neurobiológicos do transtorno do déficit de atenção e hiperatividade (TDAH): uma revisão. Ciências & Cognição, 15(1), 241–251.

31. Dacroce, M. (2016). A importância de se conhecer o aluno “TDAH” transtorno do déficit de desatenção/hiperatividade com transtorno de conduta para o ensino aprendizagem. Revista Internacional de apoyo a la inclusión, logopedia, sociedad y multiculturalidad, 2(3), 15–26.

32. Dalgalarrondo, P. (2019). Psicopatologia e semiologia dos transtornos mentais (3rd ed.). Artmed.

33. Dias, G., Segenreich, D., Nazar, B., & Coutinho, G. (2007). Diagnosticando o TDAH em adultos na prática clínica. Jornal Brasileiro de Psiquiatria, 56(Suppl. 1), 9–13.

34. Diogo, M. C. S., Akerman, L. P. F., & Borsa, J. C. (2020). Sintomas de hiperatividade e déficit de atenção em uma amostra de crianças escolares Brasileiras. Contextos Clínicos, 13(3), 828–848. https://doi.org/10.4013/ctc.2020.133.11

35. Duarte, R. C. B. (2018). Deficiência intelectual na criança. Residência Pediátrica, 8(Suppl. 1), 17–25. https://doi.org/10.25060/residpediatr-2018.v8s1-04

36. Elia, J. (2023, May). Transtorno desafiador opositivo. MSD Manuals. https://www.msdmanuals.com/pt-br/casa/problemas-de-sa%C3%BAde-infantil/dist%C3%BArbios-da-sa%C3%BAde-mental-em-crian%C3%A7as-e-adolescentes/transtorno-desafiador-opositivo

37. Esper, M. V., Polita, N. B., Araújo, J. S., & Nascimento, L. C. (2021). Aspectos socioculturais do transtorno de déficit de atenção e hiperatividade na infância. Construção Psicopedagógica, 30(31), 69–81.

38. Faraone, S. V. (2018). The pharmacology of amphetamine and methylphenidate: Relevance to the neurobiology of attention-deficit/hyperactivity disorder and other

psychiatric comorbidities. Neuroscience & Biobehavioral Reviews, 87, 255–270. https://doi.org/10.1016/j.neubiorev.2018.02.001

39. Fonseca, V. (2016). Importância das emoções na aprendizagem: uma abordagem neuropsicopedagógica. Revista de Psicopedagogia, 33(102), 365–384.

40. França, M. T. B. (2012). Transtorno de déficit de atenção e hiperatividade (TDAH): ampliando o entendimento. Jornal de Psicanálise, 45(82), 191–207.

41. Galvan, J. C., Demori, S. D. A., Feldman, L. A., Halpern, R., & Marrone, L. C. P. (2018). Transtorno de déficit de atenção e hiperatividade e transtorno de conduta em adolescentes concluintes do ensino fundamental de Caxias do Sul. Aletheia, 51(1-2), 44–51.

42. Grimm, O., Kranz, T. M., & Reif, A. (2020). Genetics of ADHD: What should the clinician know? Current Psychiatry Reports, 22(4), 1–8. https://doi.org/10.1007/s11920-020-01141-7

43. Guimarães, A., & Silva, L. A. V. (2021). A saúde coletiva e a criança com comportamentos externalizantes: uma revisão de literatura. Physis: Revista de Saúde Coletiva, 31(4), e310424. https://doi.org/10.1590/s0103-73312021310424

44. Habibzadeh, P., Nemati, A., Dastsooz, H., Taghipour-Sheshdeh, A., Paul, M. P., Sahraian, A., Faghihi, M. A., & others. (2021). Investigating the association between common DRD2/ANKK1 genetic polymorphisms and schizophrenia: A meta-analysis. Journal of Genetics, 100(59), 1–16. https://doi.org/10.1007/s12041-021-01306-1

45. Hess, A. R. B., & Falcke, D. (2013). Sintomas internalizantes na adolescência e as relações familiares: Uma revisão sistemática da literatura. Psico-USF, 18(2), 263–276. https://doi.org/10.1590/S1413-82712013000200009

46. Kanarik, M., Grimm, O., Mota, N. R., Reif, A., & Harro, J. (2022). ADHD co-morbidities: A review of implication of gene x environment effects with dopamine-related genes. Neuroscience & Biobehavioral Reviews, 139, 104757. https://doi.org/10.1016/j.neubiorev.2022.104757

47. Kuc, K., Bielecki, M., Racicka-Pawlukiewicz, E., & others. (2020). The SLC6A3 gene polymorphism is related to the development of attentional functions but not to ADHD. Scientific Reports, 10, 6176. https://doi.org/10.1038/s41598-020-63296-x

48. Ladislau, R. S., Silva, F. G. C., Silva, G. L. S., Oliveira, A. B. T., Magalhães, E. Q., & Rodrigues Júnior, O. M. (2022). Ritalina em crianças com déficit de atenção e hiperatividade. Research, Society and Development, 11(13), e525111335033. https://doi.org/10.33448/rsd-v11i13.35033

49. Leffa, D. T., Caye, A., & Rohde, L. A. (2022). ADHD in children and adults: Diagnosis and prognosis. Current Topics in Behavioral Neurosciences, 57, 1–18. https://doi.org/10.1007/7854_2022_329

50. Maia, M. I. R., & Confortin, H. (2015). TDAH e aprendizagem: Um desafio para a educação. Perspectiva, 39(148), 73–84.

51. Ministério da Saúde. (2022). Transtorno do déficit de atenção com hiperatividade: Portaria Conjunta SAES/SCTIE/MS nº 14, de 29 de julho de 2022. Ministério da Saúde.

52. Nigg, J. T. (2006). What causes ADHD? Understanding what goes wrong and why. The Guilford Press.

53. Oliveira, A. S. (2011). O polimorfismo val158met do gene comt e tdah: Um estudo de suscetibilidade genética e farmacogenética [Master's thesis, Universidade Federal do Rio Grande do Sul].

54. Oliveira, C. T., & Dias, M. A. C. G. (2015). Repercussões do Transtorno de Déficit de Atenção/Hiperatividade (TDAH) na experiência universitária. Psicologia: Ciência e Profissão, 35(2), 613–629. https://doi.org/10.1590/1982-3703001202014

55. Oliveira, M. L. T. (2022). Os impactos dos sintomas do TDAH no adulto. Revista Brasileira de Ensino e Aprendizagem, 4, 26–46.

56. Oliveira, M. S., Marinho, M. F. D., & Lemos, S. M. A. (2022). Características clínicas de transtorno do déficit de atenção em crianças e adolescentes: associação com qualidade de vida e aspectos comportamentais. Revista Paulista de Pediatria, 40, e2020342. https://doi.org/10.1590/1984-0462/2022/40/2020342

57. Organização Mundial da Saúde. (1996). Classificação estatística internacional de doenças e problemas relacionados à saúde: CID-10 (3rd ed., Vol. 2, Centro Colaborador da OMS para a Classificação de Doenças em Português, Trans.). Editora USP.

58. Pelligrini, E. F., Nesso, A. C., Berengel, D. C. C., Bolssone, V. A. M., Santos, V. A., Sasso, L. S. A., & André, J. C. (2022). Entre a fronteira do aprender e o fracasso escolar no Transtorno de Déficit de Atenção e Hiperatividade. Brazilian Journal of Development, 8(5), 40966–40987. https://doi.org/10.34117/bjdv8n5-258

59. Pereira, C. S. C. (2009). Conversas e controvérsias: uma análise da constituição do TDAH no cenário científico nacional e educacional brasileiro [Master's thesis, Fundação Oswaldo Cruz].

60. Peterson, B. S., Trampush, J., Brown, M., Maglione, M., Bolshakova, M., Rozelle, M., & others. (2024). Tools for the diagnosis of ADHD in children and adolescents: A systematic review. Pediatrics, 153(4), e2024065854. https://doi.org/10.1542/peds.2024-065854

61. Pires, S. M. A. M., Pontes, F. A. R., Pereira, B. L. S., Amoras, J. D. F., & Silva, S. S. C. (2024). Impactos do TDAH à adolescência: revisão sistemática de literatura. Revista Brasileira de Educação Especial, 30, e0174. https://doi.org/10.1590/1980-54702024v30e0174

62. Poton, W. L., Soares, A. L. G., & Gonçalves, H. G. (2018). Problemas de comportamento internalizantes e externalizantes e uso de substâncias na adolescência. Cadernos de Saúde Pública, 34(9), e00205917. https://doi.org/10.1590/0102-311x00205917

63. Regalla, M. A., Guilherme, P. R., & Serra-Pinheiro, M. A. (2007). Resiliência e transtorno do déficit de atenção/hiperatividade. Jornal Brasileiro de Psiquiatria, 56(Suppl. 1), 45–49.

64. Rezende, E. (2016, November 2). A história completa do TDAH que você não conhecia. PsicoEdu. https://www.psicoedu.com.br/2016/11/historia-origem-do-tdah.html

65. Rohde, L. A., Buitelaar, J. K., Gerlach, M., & Faraone, S. V. (2019). Guia para compreensão e manejo do TDAH da World Federation of ADHD. Artmed.

66. Rovira, P., Sánchez-Mora, C., Pagerols, M., Richarte, V., Corrales, M., Fadeuilhe, C., & others. (2020). Epigenome-wide association study of attention-deficit/hyperactivity disorder in adults. Translational Psychiatry, 10(1), 1–12. https://doi.org/10.1038/s41398-020-00898-1

67. Saboya, E., Saraiva, D., Palmini, A., Lima, P., & Coutinho, G. (2007). Disfunção executiva como uma medida de funcionalidade em adultos com TDAH. Jornal Brasileiro de Psiquiatria, 56(Suppl. 1), 30–33.

68. Santos, K. S., Marinho, M. O., Santos, M. S. B., Trambaioli, V. S., & Bhering, C. A. (2024). A importância do diagnóstico precoce de TDAH para o desenvolvimento infantil. Revista Eletrônica Acervo Médico, 24, 1–8.

69. Santos, L. F., & Vasconcelos, L. A. (2010). Transtorno do déficit de atenção e hiperatividade em crianças: uma revisão interdisciplinar. Psicologia: Teoria e Pesquisa, 26(4), 717–724. https://doi.org/10.1590/S0102-37722010000400017

70. Seno, M. P. (2010). Transtorno do Déficit de Atenção e Hiperatividade (TDAH): o que os educadores sabem? Revista de Psicopedagogia, 27(84), 334–343.

71. Souza, I. L. S., Faria, F. F., Anjos, E. G. C., Meneghelli, C. M. M., Fujita, T. D., Caron, L., & Ivatiuk, A. L. (2021). Relações entre funções executivas e TDAH em crianças e adolescentes: Uma revisão sistemática. Revista de Psicopedagogia, 38(116), 197–213.

72. Souza, W. S. (2023). As comorbidades psiquiátricas do TDAH em adultos. Ciências da Saúde, 27(121), 1–25.

73. Sulkes, S. B. (2022, February). Transtorno de déficit de atenção/hiperatividade (TDA, TDAH). MSD Manuals. https://www.msdmanuals.com/pt-br/profissional/pediatria/dist%C3%BArbios-de-aprendizagem-e-desenvolvimento/transtorno-de-deficit-de-aten%C3%A7%C3%A3o-hiperatividade-tda,-tdah

74. Sulkes, S. B. (2023, December). Transtorno do déficit de atenção com hiperatividade (TDAH). MSD Manuals. https://www.msdmanuals.com/pt-br/casa/problemas-de-sa%C3%BAde-infantil/dist%C3%BArbios-de-aprendizagem-e-do-desenvolvimento/transtorno-do-d%C3%A9ficit-de-aten%C3%A7%C3%A3o-com-hiperatividade-tdah

75. Thapar, A., & Stergiakouli, E. (2008). An overview on the genetics of ADHD. Xin Li Xue Bao, 40(10), 1088–1098. https://doi.org/10.3724/SP.J.1041.2008.01088

76. Thapar, A. (2018). Discoveries on the genetics of ADHD in the 21st century: New findings and their implications. American Journal of Psychiatry, 175(10), 943–950. https://doi.org/10.1176/appi.ajp.2018.18040383

77. Viégas, L. S., & Oliveira, A. R. F. (2014). TDAH: conceitos vagos, existência duvidosa. Nuances: Estudos sobre Educação, 25(1), 39–58. https://doi.org/10.14572/nuances.v25i1.3140

78. Wells, R. H. C., Bay-Nielsen, H., Braun, R., Israel, R. A., Laurenti, R., Maguin, P., & Taylor, E. (2011). CID-10: classificação estatística internacional de doenças e problemas relacionados à saúde. Editora da USP.

79. World Health Organization. (2019). ICD-11 implementation or transition guide. https://icd.who.int/en/docs/ICD-11%20Implementation%20or%20Transition%20Guide_v105.pdf

80. Yadav, S. K., Bhat, A. A., Hashem, S., Nisar, S., Kamal, M., Syed, N., & others. (2021). Genetic variations influence brain changes in patients with attention-deficit hyperactivity disorder. Translational Psychiatry, 11(1), 349. https://doi.org/10.1038/s41398-021-01473-y

81. Zhao, L., Hou, B., Ji, L., Ren, D., Yuan, F., Liu, L., & others. (2022). NGFR gene and single nucleotide polymorphisms, rs2072446 and rs11466162, playing roles in psychiatric disorders. Brain Sciences, 12(10), 1372. https://doi.org/10.3390/brainsci12101372