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Attention-Deficit / Hyperactivity Disorder in Children: Overcoming Diagnostic Challenges and Exploring Modern Treatment Approaches

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Abstract

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder with significant functional impact. It is characterized by inattention, hyperactivity, and impulsivity. Its diagnosis remains challenging due to informant discrepancies, developmental variations, and gender- or culture-related biases. Disparities in healthcare access and stigma further contribute to under- and over-diagnosis, particularly in marginalized populations.

This narrative review synthesizes recent literature on advances in ADHD assessment and management. Structured diagnostic tools, digital health innovations, and equity-aware algorithm design are emerging as promising solutions to improve accuracy and reduce bias. In Europe, methylphenidate remains the most commonly prescribed first-line treatment, supported by robust evidence for symptom reduction. Non-stimulant options, such as atomoxetine, guanfacine, and clonidine, provide alternatives for patients with contraindications or poor tolerance to stimulants.

Beyond pharmacology, evidence-based psychosocial interventions; including Parent Management Training (PMT) and Cognitive Behavioral Therapy (CBT), play a critical role in promoting long-term functional outcomes. Lifestyle modifications, particularly structured physical activity and dietary interventions, e.g., balanced nutrition, omega-3 supplementation, show benefits in symptom management. The expansion of telemedicine and digital platforms has enhanced care delivery, enabling remote monitoring, parent training, and behavioral support in underserved areas.

Effective ADHD care requires an individualized, developmentally sensitive, and culturally competent approach that integrates medical, psychological, and social dimensions. Continued research into digital diagnostics, bias mitigation, and personalized treatment pathways will be essential to ensure equitable, accessible, and comprehensive care.

Keywords: Attention-Deficit/Hyperactivity Disorder, ADHD, diagnostic challenges, symptoms managements, stimulant medication, non-stimulant medication, multimodal treatment,

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurodevelopmental disorders that affects over 5% of the population of children and adolescents around the world . Disorder is characterized by persistent symptoms of inattention, hyperactivity, and impulsivity which influence daily life, social functioning and academic or work performance [1], [2], [3].

First medical cases of patients with symptoms resembling ADHD come from the 18th/19th century, described by Sir Alexander Crichton. Since then, concepts, classification criteria and ADHD terminology and description of disorder have undergone significant modifications. The modern concept of ADHD was proposed by The American Academy of Pediatrics in 2000, following treatment recommendations in 2001. In the last 2 decades the concepts evolved as a result of neuroscience progression, growing of understatement of behavioral psychology and changing fundamentals of clinical practices.

Despite the increase of the awareness of ADHD in the last 20 years, diagnosis still remains a significant challenge. The main reasons for the difficulty are core symptoms of ADHD which overlap with a wide range of typical childhood behaviors. The overlap causes difficulty to distinguish between normal neurodevelopment and clinical pathology. Parental observations are crucial in early recognition of neurodevelopment issues, especially in preschool-aged children. Assessments often rely on subjective rating scales and reports from various sources, which can lead to inconsistencies and misdiagnoses. Furthermore cultural, gender, social, and economic factors also influence diagnostic outcomes. For instance, ADHD is frequently underdiagnosed in girls - who may present more inattentive than hyperactive symptoms - and overdiagnosed in boys or in specific social contexts [4], [5].

Employing a variety of techniques results in more effective ADHD management. While medication, especially stimulants like methylphenidate or amphetamines are key components of treatment, they are not the only available method. Modern treatment plans could also include psychotherapy, like cognitive behavioral therapy (CBT) or other forms of psychological

advisory, regular physical exercise and dietary modification [2], [6].

The effectiveness of these approaches increases when they are customized to match the individual's symptoms and environmental circumstances. Furthermore, cooperation between healthcare workers, educators and families is essential for long-term success. School-based interventions and behavioral support in the classroom are increasingly recognized as important components of comprehensive care [7]. Additionally, educating parents and teachers about ADHD and its treatment can lead to reduction of stigma and improve the child's developmental outcomes.

This review looks at the challenges of diagnosing ADHD in pediatric patients, new tools that help with diagnosis, and possible current treatments.

2. Diagnostic challenges; over- and under-diagnosis

Diagnosing ADHD in children remains a complicated process influenced by multiple factors. This section discusses key difficulties healthcare providers face, including over- and under-diagnosis, inconsistencies between sources of information, biases related to gender and age, limited resources and stigma.

2.1 Gender, race and ethnic minority biases

Increasing awareness, greater understanding and acceptance of ADHD, along with improved access to healthcare, have contributed positively to faster diagnosis and treatment. However, these factors also raise concerns about the potential risk of overdiagnosing children. This happens when a child exhibits normal behaviour with mild or borderline symptoms which are falsely identified as ADHD symptoms. It can lead to unnecessary treatment, adverse effects of medications, financial costs and stigmatization.[5], [8]

On the other hand, underdiagnosis is still common, especially among populations that do not present with typical hyperactivity behaviour. For example, girls often present inattentive symptoms, perfectionism, and emotional sensitivity rather than hyperactive behavior, which is more easily recognized in boys. As a result, girls are often overlooked or diagnosed later in life rather than hyperactivity, causing delays in diagnosis and following treatment [8], [9].

Moreover, ethnic minority groups are less likely to receive ADHD diagnosis because of cultural factors and traditions, and limited access to healthcare. Additionally, researchers argue that children from lower socioeconomic backgrounds are less likely to receive an ADHD diagnosis,

even when typical symptoms, like hyperactivity are present. This inequality is usually the result of lack of knowledge or unawareness of ADHD among parents. They may interpret ADHD symptoms as misbehavior instead of recognizing them as signs of neurodevelopment disorder [10], [11], [12].

2.2 Age biases

In young children, both over- and under-diagnosis of ADHD frequently occur because of developmental expectations and subtle symptom profiles. One classic example of overdiagnosis is the relative-age effect. Children born just before school enrollment cutoffs are almost a year younger than their classmates. Studies show these younger children are more likely to be diagnosed with ADHD and prescribed medication, suggesting that normal developmental immaturity is sometimes mistaken for a disorder [5], [13], [14].

2.3 Multi-information inconsistencies

Assessing ADHD in children often involves collecting information and observations from multiple sources - commonly parents and teachers. However these reports frequently differ significantly, reflecting situational differences, making accurate diagnosis more difficult. Studies show that agreement between parents and teachers is often low, especially in younger children . Indicating that young children may behave significantly differently at home versus in school [13], [14]

In older children and adolescents, differing parental and teacher characteristics also affect agreement. One large study showed that parent-teacher differences were greater in families with socioeconomic challenges and when children had homework issues or disruptive behaviors [15] In addition, a sample of middle school students demonstrated that higher maternal education, parental stress, or teacher training and their role (e.g., special education vs. general classroom) noticeably influenced rating differences[16]. Moreover, certain ADHD assessment tools may evaluate symptoms differently depending on the informant, making interpretation even more challenging [17].

2.4 Resource, time and stigma constraints

Diagnosing ADHD in children can be a complex and time-consuming process. It typically requires comprehensive interviews, input from multiple caregivers and teachers, and sometimes formal cognitive testing. These steps are often challenging to complete in low-resource environments, where long waiting times and limited availability of trained professionals create additional delays. Many primary care providers lack confidence in making diagnostic decisions, and long waitlists mean that evaluations may take months or even years [18].

Access to diagnostic services is also shaped by broader systemic inequalities. Families living in rural areas, lacking adequate insurance, or relying solely on public health systems often face more obstacles in securing timely evaluations. [10]

Meanwhile, those with access to private healthcare may receive quicker diagnoses, contributing to disparities in both under- and over-identification across different populations [11]

Stigma surrounding mental health, and ADHD in particular, can discourage families from seeking care. Many caregivers worry about being judged or blamed for their child's behavior. Studies show that this perceived stigma can delay or even prevent families from initiating evaluations, especially in communities where neurodevelopmental disorders are poorly understood or heavily stigmatized.[19], [20], [21], [22] . Together, these barriers limit early diagnosis and intervention, widening gaps in ADHD care and support.

3. Diagnostic Advances

3.1 Traditional Diagnostic Methods

Clinical assessment of ADHD still relies heavily on standardized tools such as behavioral rating scales, semi-structured interviews, and neuropsychological testing. Widely used instruments such as the Vanderbilt and the Child Behavior Checklist (CBCL) offer essential information but require data from multiple contexts to be most effective. Using structured methods improves diagnostic consistency and supports more effective treatment planning [23].

3.2 Digital and objective technologies

Objective tools such as Continuous Performance Tests (CPTs) and imaging methods, like electroencephalogram (EEG) [23], [24] or functional magnetic resonance imaging (fMRI) [25] are augmenting traditional assessment by capturing performance under standardized conditions.

In one study, objective metrics alone yielded around 78-79 % accuracy, and combining them with subjective reports raised overall classification accuracy to 86-90 % in both children and adults.[5]

Innovative platforms - like the FishFinder video game screener-have demonstrated over 90% diagnostic accuracy in young children [26] . Similarly, EEG-based deep learning models have reported sensitivity rates of 99% and specificity of 98.8% [24]. These digital methods show promise for reducing diagnostic subjectivity and expanding early access to care.

3.3 Equity-aware diagnostic designs

New efforts in digital health and human-computer interaction (HCI) are addressing disparities in ADHD diagnosis by designing systems that consider race, gender, and cultural context. These equity-aware algorithms are being trained to account for demographic and contextual differences. It may help reduce underdiagnosis in underrepresented populations. Such inclusive designs are essential for ensuring more equitable and accurate assessments going forward [25], [27], [28].

4. Management Strategies

4.1 Pharmacologic treatments

In Europe stimulants, especially methylphenidate, are widely recommended as the primary pharmacological treatment for ADHD in children and adolescents, supported by strong evidence from large-scale clinical trials and meta-analyses which show significant reductions in core symptoms [2], [29], [30]. Unfortunately as any other medication, the methylphenidate also has side effects. The most frequently reported are: headache, insomnia or sleep disturbance, appetite suppression and weight loss, which may cause temporary growth suppression [31], [32]. Methylphenitade can also lead to drug abuse and drug dependence [33]. Stimulants belong to sympathomimetic agents, their mechanism of action involves stimulation of the central nervous system. This may cause subtle escalation of resting heart rate and blood pressure which makes them medications with the highest risk of cardiovascular complications among all ADHD medications [32].

When stimulants cannot be used as a first line treatment, for example as a result of intolerance, patient preference or contraindications - non-stimulant options should be considered.

The non-stimulants medications include atomoxetine, which is a selective norepinephrine

reuptake inhibitor, and alpha-2 adrenergic agonists: guanfacine and clonidine.

Atomoxetine has demonstrated efficacy comparable to methylphenidate in many studies, although its onset of action usually requires several weeks to reach full effect.

The non-stimulant medications are particularly useful for patients with other psychological disorders like anxiety, tic disorders, or sleep disturbances. They have fewer risks of misuse and may be preferred in individuals with a history of substance use. The other side effects include fatigue, dizziness, dry mouth, and possible disturbances in blood pressure and might cause orthostatic hypotension but in the opposition of methylamphetamine does not suppress growth.[34]

Before the launch of atomoxetine, there was no approved alternative for ADHD treatment. One group of antihypertensive drugs: alpha-2 adrenergic agonists (guanfacine and clonidine) were used off-label as a second line of medical ADHD management [34]. Comparing ADHD symptoms reduction of alpha-2 adrenergic agonists to methylphenidate, the alpha-2 adrenergic agonists are not that effective [2], [31]. Usually due to their impacts on blood pressure and heart rate, sometimes for specific patients they are the first line or monotherapy managements of ADHD [31].

4.2 Psychosocial interventions

Additionally to pharmacological treatment, psychological interventions play a central role in ADHD management. A Parent Management Training (PMT) focuses on improving parenting strategies and reduction of disruptive children behaviors. The PMT has consistently demonstrated effectiveness in reducing ADHD-related symptoms and enhancing family dynamics [35], [36].

An increasing number of studies support the use of integrated, multimodal treatment strategies that combine pharmacology, behavioral therapy, especially CBT [37] and psychosocial interventions. These integrated approaches are associated with better outcomes than relying on a single type of treatment [2], [38]. Additionally, the rise of telemedicine and digital health tools has enhanced access to ADHD care, especially for families living in rural or underserved communities. Telehealth-based services, like remote parent training and virtual medication follow-ups, have been particularly useful in maintaining continuity of care in the post-pandemic time. Central to these models are strategies like shared decision-making and motivational

interviewing, which are now widely acknowledged as key in promoting patient engagement and improving treatment adherence in both children and adults.

4.3 Physical Activity and Dietary Interventions in ADHD Management

In recent years, there has been increasing recognition of lifestyle-based interventions like physical activity and dietary modification, as valuable components in the non-pharmacological management of ADHD symptoms in children and adolescents. These strategies are particularly appealing due to their safety, accessibility, and potential to support core and associated symptoms of ADHD, especially when included in a multimodal treatment plan. Recent studies show that physical activities significantly reduce core ADHD symptoms and improve social functioning, improving working memory, emotional control. The most effective interventions appear to combine physical exertion with cognitive engagement, such as games or sports requiring planning, reaction, and cooperation [36], [39], [40].

At the same time, there is growing interest in the role of nutrition and dietary supplementation in ADHD management. Broad elimination diets or general dietary restrictions have limited empirical support [41]. The dietary approach to stop hypertension (DASH) shows potential in reduction of ADHD symptoms and increase of nutritional intake [42]. Supplementation of omega-3 fatty acids, iron, zinc, magnesium and vitamin D has potential contributors to ADHD symptoms [43].

Importantly, dietary strategies should be personalized and closely monitored by healthcare professionals. Supplementation without medical supervision may be ineffective or, in rare cases, harmful due to medical interactions or excess intake. Furthermore, while physical activity and diet are not substitutes for evidence-based pharmacotherapy in moderate-to-severe ADHD, they can play a crucial adjunctive role—improving quality of life, enhancing cognitive function, and potentially reducing medication dosages or side effects.

Conclusion

ADHD presents a complex diagnostic and therapeutic challenge that demands holistic, context-aware and multimodal approaches. Accurate diagnosis often remains difficult due to informant inconsistencies, gender and age-related biases, and disparities related to access and stigma - particularly in marginalized communities. Fortunately, advances in structured diagnostic tools,

digital technologies, and equity-conscious algorithm design offer promising pathways toward more precise and inclusive identification of ADHD across diverse populations.

Management strategies, likewise, have evolved from symptom-based pharmacologic treatments toward more dynamic, individualized care. While stimulant medications remain the cornerstone of treatment, non-stimulant options provide flexibility for individuals with contraindications, intolerance or poor response. Crucially, the incorporation of evidence-based psychosocial interventions, such as PMT and CBT has demonstrated long-term benefits on functional outcomes across developmental stages. The rise of digital health platforms and telemedicine services has further expanded the reach of ADHD care, offering enhanced accessibility and continuity, especially for families living in rural areas or with limited access to resources.

Non-pharmacological strategies, including dietary modifications and regular physical activity, are gaining increasing recognition as complementary components of ADHD management. Evidence suggests that structured exercise programs can improve attention, executive functioning, and emotional regulation, while balanced nutrition - particularly diets rich in omega-3 fatty acids, vitamins, and minerals, may help support cognitive performance and reduce symptom severity. These lifestyle-based interventions, cannot replace medical treatment, can enhance overall well-being and may improve treatment adherence when integrated into comprehensive care plans.

To optimize outcomes, ADHD care must be individualized, developmentally informed, and culturally sensitive, balancing objective data with subjective context. Continued innovation in digital diagnostics, bias reduction, and patient-centered program design will be essential in bridging the remaining gaps. As research progresses, a collaborative, interdisciplinary approach involving clinicians, families, educators, and researchers will remain key to ensuring that every individual with ADHD receives timely, equitable, and effective care.

Limitations

This review is subject to several limitations that should be considered when interpreting its findings. The literature search was not conducted as a formal systematic review, which may have resulted in the omission of relevant studies, particularly unpublished or non–peer-reviewed research. Included publications were in English, potentially excluding important evidence from non-English language sources. Additionally, the majority of available studies on

pediatric ADHD diagnosis and management originate from high-income countries, which may limit the generalizability of the conclusions to diverse cultural and socioeconomic contexts. The current literature may also be affected by publication bias, with studies showing significant results more likely to be published. Furthermore, ADHD research is a rapidly evolving field, especially in digital assessment tools and new treatment, and public health strategies;some recent findings may not be reflected in this review. Finally, variations in study design, sample characteristics, and outcome measures across the reviewed literature make direct comparisons challenging and highlight the need for more standardized research protocols.

Disclosure

Author's Contribution

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