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ADHD – A GLOBAL CHALLENGE. ARE WE CLOSER TO THE IDEAL THERAPY?

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ABSTRACT

Introduction and objective: The treatment of ADHD remains a topic of global discussion among researchers and clinicians. Stimulant medications are the primary therapy, but concerns about side effects, addiction, and misuse have led to growing interest in alternative methods, such as behavioral therapy, cognitive training, neurofeedback, and dietary interventions. This review aims to compile data on ADHD treatment and assess whether alternative therapies can replace stimulants.
Brief description of the state of knowledge: Numerous studies describe individual therapeutic methods, but a lack of definitive conclusions persists due to uncertainties and isolated evaluations. More comparative research and studies on combined treatments are needed to determine the most effective approaches. Particularly, there is a shortage of studies on integrating pharmacological and alternative therapies, highlighting the need for future research.
Methods: A literature review was conducted using PubMed and Google Scholar with search terms like "ADHD - diagnostic criteria and symptoms", "Stimulant medications in the treatment of ADHD", "Alternative treatment methods for ADHD", "Dietary treatment and supplementation in ADHD". Articles published within the last five years were prioritized.
Conclusions: Stimulants remain the most effective ADHD treatment but are associated with side effects such as sleep disturbances, appetite loss, and addiction concerns. In response, alternative therapies are gaining popularity, though evidence of their standalone effectiveness is limited. Further comparative and combination therapy studies are necessary to develop a more comprehensive treatment approach that optimizes symptom reduction while minimizing risks. At present, stimulant medications are a safe first-line treatment with proven efficacy.

KEYWORDS

ADHD Treatment, Stimulants in The Treatment of ADHD, Alternative Treatment Methods for ADHD, Side Effects and Controversies in The Use of Stimulants

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Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by persistent problems with attention, excessive activity, and impulsivity. It is estimated that around 5% of children and adolescents worldwide suffer from ADHD, with no significant differences between countries. Furthermore, ADHD is not limited to childhood and adolescence – many individuals continue to struggle with it in adulthood, where its estimated prevalence is 2.5%. Previous research has shown that ADHD has a complex, multifactorial etiology, but it is also characterized by high heritability [1, 2].

According to the ICD-10 (International Classification of Diseases), ADHD is classified as a behavioral and emotional disorder that begins before the age of 7, lasts at least 6 months, and leads to significant impairment in various areas of life, such as school, work, or social relationships. The classification includes criteria such as: inattention (6 out of 9 symptoms required), hyperactivity (3 out of 5 symptoms), and impulsivity (1 out of 4 symptoms) [3, 4].

According to the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, 5th edition), to diagnose ADHD, at least 6 criteria must be met, covering symptoms in two main areas: inattention and hyperactivity-impulsivity. The DSM-5 distinguishes three types of ADHD, depending on the dominant symptoms: inattentive type, hyperactive-impulsive type, combined type (a combination of inattention and hyperactivity-impulsivity).

ADHD is a disorder that can lead to learning difficulties, behavioral problems, low self-esteem, and an increased risk of co-occurring disorders such as anxiety disorders or addictions. The diagnosis and treatment of ADHD require a comprehensive approach, including both pharmacological therapy and psychotherapy, as well as support in education and social functioning [4, 5]. ADHD is diagnosed based on the main and detailed criteria listed in *Table 1*.

Table 1. Symptoms used to diagnose ADHD

Main diagnostic symptom	Detailed symptoms
Inattention	- difficulty concentrating on tasks - easy distractibility - forgetting daily responsibilities - making careless mistakes - difficulty maintaining order
Hyperactivity	- excessive physical activity - difficulty sitting still - running or climbing in inappropriate situations - constant need for movement
Impulsivity	- difficulty waiting for one's turn - interrupting other's conversation - making decisions without thinking - acting impulsively

The treatment of ADHD is a subject of ongoing discussion in the medical literature, particularly in the context of differences in treatment during childhood and adulthood. Although ADHD is widely recognized and treated in children and adolescents, there are no unified guidelines for adults, and treatment is often empirical and used off-label [3, 6]. Treatment for ADHD encompasses a variety of therapeutic approaches, including behavioral therapy, pharmacological interventions, and environmental support. Behavioral therapy focuses on modifying behaviors through structured routines, positive reinforcement, and teaching coping strategies for impulsivity. Pharmacological treatments involve the use of medications such as stimulants (e.g., methylphenidate, amphetamines) and non-stimulants (e.g., atomoxetine) to help manage ADHD symptoms. Environmental support entails adjusting the patient's surroundings, including home and school settings, to promote better functioning and social integration. Combining these methods, tailored to the individual's needs, is essential for effective ADHD management.

The pharmacological treatment of ADHD, particularly with stimulant medications, remains a topic of ongoing debate regarding both its effectiveness and potential long-term consequences. Parents of children with

ADHD often wonder not only about the immediate effects of therapy but also about its impact on their child's future development, including academic achievement and neurological health. While numerous scientific studies confirm the short-term efficacy of stimulant medications, data on their long-term effects remain limited. Long-term studies face significant methodological challenges, such as a high dropout rate from pharmacological treatment over time, making it difficult to draw definitive conclusions. Moreover, observational studies suggest that treatment effectiveness in routine care settings may be lower than in controlled clinical trials. Some hypotheses propose that pharmacotherapy may support the development of executive functions, yet new organizational and social skills can also be effectively acquired through behavioral training and cognitive-behavioral therapy [7]. It is often emphasized that medication alone is not sufficient to establish lasting habits and skills. Given these uncertainties, further research is necessary to examine the long-term effects of ADHD pharmacotherapy and assess its effectiveness compared to other therapeutic approaches. The aim of this scientific paper is to provide information from publications describing the benefits and long-term effects of treating ADHD with psychostimulants. Furthermore, in light of the presented facts about pharmacotherapy, we aim to consider non-pharmacological treatment methods based on the literature [5, 8].

Treatment methods

Pharmacological interventions

The pharmacological treatment of ADHD includes several groups of medications, including stimulants, non-stimulants, antidepressants, and antipsychotics. The most commonly used drugs are stimulants - *methylphenidate (MPH)* and *amphetamine (AMP)*, which are highly effective in reducing ADHD symptoms. In cases where stimulants are contraindicated or comorbid disorders are present, non-stimulant alternatives such as *atomoxetine, guanfacine*, and *clonidine* are used. For patients with ADHD accompanied by symptoms of depression or anxiety, antidepressants such as *bupropion, venlafaxine, reboxetine*, and *imipramine* may be prescribed, while in cases of severe behavioral disturbances or aggression, antipsychotic medications like *risperidone, aripiprazole*, or *thioridazine* can be considered [9].

Psychological interventions

Non-pharmacological treatments for ADHD include various psychological interventions aimed at improving patients 'cognitive and behavioral functioning.

One of the most commonly used methods is *behavioral therapy*, based on principles of social and cognitive learning, which focuses on reinforcing desired behaviors and reducing unwanted reactions. This therapy can be conducted directly with the child or involve parents and teachers, who learn effective behavior management strategies.

Another form of intervention is *cognitive training*, which aims to enhance cognitive functions such as working memory and attention through specialized adaptive exercises [10].

Neurofeedback is also gaining increasing interest as a technique that involves monitoring brain activity and learning to regulate it consciously to improve focus and impulse control. This method is based on principles of operant conditioning and can serve as an effective complementary therapy. Non-pharmacological approaches to ADHD treatment are often combined with pharmacotherapy to achieve optimal therapeutic outcomes. The choice of an appropriate method depends on the patient's individual needs, age, and symptom severity. In many cases, the effectiveness of psychological therapies increases when applied systematically and over the long term [11].

Alternative interventions

Alternative methods of treating ADHD include various approaches that are not part of conventional medicine but may help manage symptoms. One of them is *dietary therapy*, which involves eliminating certain products, such as artificial food colorings (e.g., tartrazine, allura red) or following an elimination diet. *Supplementation* with omega-3 and omega-6 fatty acids, vitamins (e.g., B6, B12, C), and minerals (e.g., magnesium, zinc, iron) is also popular. Some studies suggest potential benefits of *herbal treatments*, such as Ginkgo Biloba, ginseng, or St. John's wort. Alternative methods also include *homeopathy* and interventions based on *movement and physical activity*, which may support concentration and impulse control. Although the effectiveness of these therapies is not unequivocally confirmed, they serve as a complement to pharmacological and psychological treatment, tailored to the individual needs of the patient [12, 13].

Stimulants - mechanism of action and documented benefits

The first-line treatment for patients with ADHD consists of psychostimulants—methylphenidate and amphetamine (availability and indications may vary by country). Their primary mechanism of action involves inhibiting dopamine and norepinephrine transporters. By enhancing the effects of dopamine and norepinephrine, stimulants improve prefrontal cortex activity and optimize executive and attentional functions in patients with ADHD [14]. These medications are available in short-acting and long-acting formulations. Strategies for developing long-acting stimulants include the combination of immediate-release and delayed-release beads, as well as an osmotic-release oral system. Long-acting formulations are likely associated with a lower risk of withdrawal effects, whereas short-acting formulations allow for flexible dosing depending on individual needs and symptom severity. Studies have shown that long-acting stimulants alleviate ADHD symptoms for at least 12 hours. Their safety and tolerability profiles are similar to those of short-acting stimulants [15, 16]. The issue of medication holidays for ADHD remains unresolved. For some patients, especially those experiencing side effects like appetite suppression, periodic breaks from medication on weekends or during vacations may be beneficial. However, this approach should be tailored to individual symptom profiles—patients with significant difficulties at home may find treatment breaks more challenging. After 6–12 months of clinical stabilization, a reassessment of the need for continued pharmacotherapy is recommended, ideally through supervised discontinuation trials during the school year [17]. Methylphenidate was the most commonly used drug in the majority of cited studies on stimulants, followed by amphetamine. However, a review of the literature does not indicate clear differences in efficacy between these medications [18].

Studies have shown that stimulant medications effectively reduce ADHD symptoms, with their efficacy confirmed in the literature. These benefits are linked to regular use and adherence to therapeutic recommendations. Randomized placebo-controlled trials demonstrate that stimulants effectively alleviate ADHD symptoms in the short and medium term [19]. Approximately 70% of patients respond positively to stimulant treatment. Effectiveness analysis using rating scales indicates that the therapeutic effect of these medications, compared to placebo, is significant, with an average effect size of 1.0—one of the highest among all psychotropic drugs [20, 21].

The Multimodal Treatment of ADHD (MTA) study did not provide a definitive answer as to whether stimulant treatment maintains its effectiveness beyond one year [22]. To investigate this further and assess the necessity of long-term therapy, Matthijssen and colleagues conducted the first double-blind, placebo-controlled study on discontinuing methylphenidate in patients who had been using it for at least two years. Participants had been stabilized on a dose of 36 mg or 54 mg of extended-release methylphenidate for at least four weeks before being randomly assigned to either continue treatment for seven weeks or gradually taper off the medication over three weeks, followed by four weeks on placebo.

At the end of the seven-week observation period, symptom deterioration was observed in 40.4% of patients who discontinued the medication and in 15.9% of those who continued treatment. Additionally, the benefits of continuing methylphenidate were particularly evident in younger participants, whereas differences in symptom severity among older patients were less pronounced. This may be due to the more subtle clinical presentation in older individuals, leading to a slower symptom relapse. Notably, 16% of patients who remained on stimulants also experienced some symptom worsening, which may be attributed to the nocebo effect—the psychological belief that their medication had been replaced with a placebo [23].

Although some studies suggest that long-term pharmacotherapy for ADHD remains effective, the findings are not entirely consistent. In the first naturalistic study analyzing adults who had been undergoing pharmacological treatment for over four years, no significant differences in mental functioning were found between those who continued taking medication and those who had discontinued it [24]. This may indicate that treatment effectiveness diminishes over time, particularly when patients do not adhere to prescribed dosages. It is also worth noting that among children, the rate of treatment discontinuation is high, with adherence to therapeutic recommendations ranging from 36% to 84.8%. The most commonly reported reasons for discontinuation were “psychological side effects” (e.g., mood swings, irritability, depression, personality changes) and “perceived inadequate effectiveness” of the medication, which may further contribute to a decline in its long-term efficacy [25].

The inconsistency of the above results indicates that sufficiently thorough studies on the long-term use of stimulants in ADHD treatment have not been conducted. This leaves researchers with an area to further explore, which could influence the planning and course of treatment in the future.

In summary, the benefits of using stimulants in the treatment of ADHD include their high efficacy and rapid onset of action, allowing for the immediate reduction of symptoms such as inattention, impulsivity, and

hyperactivity. Numerous clinical studies confirm their significant impact on improving executive functions, including concentration, working memory, and planning skills, which translates into better functioning in daily life, education, and work. Another advantage is the flexibility of dosing, as both short-acting and long-acting formulations are available, enabling individualized treatment tailored to the patient's needs. Stimulants also play a key role in comprehensive ADHD management by enhancing the effectiveness of behavioral and educational interventions. Furthermore, when appropriately monitored and dosed, they exhibit a favorable safety profile and are well tolerated by most patients, making them one of the preferred pharmacological treatments for ADHD [26, 27].

Potential risks of using stimulants

Despite the widely discussed benefits, stimulants are still under scrutiny by researchers due to numerous concerns about their side effects and potential risks associated with their use.

The first potential risk to mention is misuse and the increased risk of addiction, particularly among individuals using stimulants due to incorrect diagnosis or improper dosage of the medication. In 2011, nearly 14 million prescriptions for ADHD medications were written in the United States for individuals aged 20-39, marking a twofold increase compared to 5.6 million prescriptions just four years earlier. From 1994 to 2009, the number of prescribed stimulants significantly rose, even in cases where patients did not have an official ADHD diagnosis or any other disorders. Among students, there was an increase in prescribed stimulant medications, which was accompanied by a rise in their illegal use. Research clearly indicates that the primary purpose of stimulant use in this age group—both legally and illegally—is to improve academic performance, particularly in areas such as concentration, organization, and the ability to study for extended periods. Since the goal is to achieve better academic outcomes rather than recreational use or leisure, this issue is often not taken as seriously as other forms of substance abuse. However, this approach is misguided, as the illegal use of stimulants can have serious medical and legal consequences, which are often underestimated [28, 29]. In summary, the above information should be noted as not pertaining to properly administered ADHD pharmacotherapy, as they are related to misuse or non-compliant use of medications. However, we deemed it necessary to include this information in our review, as it represents a significant social and medical issue and creates a concerning image of stimulants among the public.

Another negative factor of using stimulants in the treatment of ADHD is the presence of side effects, which are described in many research studies. The most common adverse effects associated with long-term methylphenidate treatment are reduced appetite (~20%), dry mouth (15%), heart palpitations (13%), gastrointestinal infections (~10%), and agitation/anxiety (~10%) [30]. Scientific studies have indicated that amphetamine and atomoxetine cause a statistically significant increase in diastolic blood pressure (DBP), systolic blood pressure (SBP), and heart rate (HR), whereas methylphenidate does not show significant effects in this regard [31]. A study conducted by Carucci et al. found a slight decrease in body weight with long-term use of methylphenidate. However, this reduction did not have significant clinical importance [32]. In subsequent research studies, scientists describe that the use of stimulant medications is associated with an increase in resting heart rate (RHR) and blood pressure (BP) and raises the risk of cardiovascular diseases (CVD) [33]. Another scientific finding was published in the research study by Reiersen et al., describing that the use of methylphenidate resulted in treatment-emergent psychosis in 1.1–2.5% of individuals [34]. Due to the aforementioned potential adverse effects, guidelines suggest monitoring blood pressure and heart rate in patients on long-term stimulant therapy.

Scientific studies continue to provide data that may help assess whether the use of psychostimulant medications is associated with an increased risk of serious adverse events, such as sudden death or suicidal thoughts. However, regarding suicide risk, the latest analyses suggest that psychostimulants may reduce it in patients with ADHD [35]. In a subsequent study conducted among a cohort of 73,177 Department of Veterans Affairs patients diagnosed with ADHD, researchers demonstrated that the use of stimulant medications was associated with a reduced risk of suicide mortality. The analyses also indicated a decrease in the risk of death due to overdose and other external causes, suggesting that this effect was not a result of misclassification of the causes of death. The researchers emphasized that patients receiving stimulant treatment were more likely to engage in psychiatric care, which may have partially contributed to the observed outcomes. They also highlighted the need for further studies in diverse populations to confirm and generalize these findings [36].

To consider the potentially increased risk of addiction to stimulants during their use in the treatment of ADHD, we reviewed research studies providing data on this topic. The researchers found no association between the use of stimulant medications for ADHD and an increased risk of substance abuse. On the contrary,

the results suggest that long-term use of these medications may have a protective effect against substance abuse. However, attention was drawn to the need for monitoring potential misuse and diversion of medications among ADHD patients [37]. In a subsequent study, McCabe et al. demonstrated that earlier initiation of stimulant medication for ADHD and its longer duration were associated with a lower risk of substance use during adolescence, comparable to that in the general population. In contrast, individuals who started treatment at a later age and for a shorter duration had higher odds of substance use. The researchers suggested that earlier and longer stimulant treatment may have a protective effect against substance abuse [38].

Among the potential side effects of stimulant use in ADHD treatment, sleep disturbances are also mentioned. Research studies describe that stimulants used to treat ADHD can affect sleep, causing both positive and negative effects. In studies on adult patients, improvements in sleep efficiency and subjective feelings of better recovery were observed after the use of methylphenidate, while other studies reported a higher incidence of insomnia, particularly with long-acting amphetamines [39]. In another study, it was shown that stimulant use in ADHD treatment can lead to sleep disturbances, such as prolonged sleep latency, shorter total sleep time, and decreased sleep efficiency, particularly with immediate-release methylphenidate. However, paradoxically, stimulants can also alleviate ADHD symptoms and improve sleep quality in some patients. Long-acting stimulant formulations, such as OROS-MPH, may reduce the number of night awakenings and improve sleep quality, although they can also lead to a reduction in total sleep time shortly after treatment initiation [40]. Due to considerable individual variability, a significant percentage of individuals with sleep disturbances unrelated to ADHD or pharmacotherapy, differences in the duration of action of various stimulant formulations, and the variability in dosing times, it is difficult to definitively determine the impact of stimulant medications on sleep disturbances in individuals with ADHD.

In summary, stimulants used in the treatment of ADHD carry potential risks of side effects that continue to raise concerns among researchers. One of the main dangers is improper use of the medications, including misuse, which in cases of incorrect diagnosis or improper dosing can lead to addiction or other serious consequences. The increase in prescriptions for stimulant medications, particularly among younger individuals, is partially linked to their illegal use, mainly for improving academic and professional performance. Studies show that the use of stimulants in ADHD treatment is associated with a range of side effects, including reduced appetite, dry mouth, palpitations, and increased blood pressure. In rare cases, stimulants may also cause more severe reactions, such as psychosis, particularly with long-term use of methylphenidate. While there were concerns in the past that these medications could increase the risk of suicide, recent studies suggest that they may even reduce this risk when properly managed in patients with ADHD. Regarding addiction, studies indicate that appropriate use of stimulants in the treatment of properly diagnosed ADHD does not increase the risk of substance abuse, and may even have a protective effect against addiction with long-term use. Additionally, stimulant use affects sleep quality, causing both positive and negative effects. For some patients, stimulants improve sleep quality and aid recovery, while for others, they lead to disturbances such as prolonged sleep latency, shorter total sleep time, and decreased sleep efficiency, particularly with immediate-release methylphenidate. Due to significant individual variability and the variety of available formulations, the impact of stimulants on sleep in ADHD treatment is not clearly defined.

Alternative Treatment Methods for ADHD

The first alternative to using stimulants in the treatment of ADHD is non-stimulant medications. These are classified into: tricyclic antidepressants, non-tricyclic antidepressants, specific norepinephrine reuptake inhibitors, alpha-2 noradrenergic agonists, non-scheduled stimulants, and others [41].

The most commonly used non-stimulant medication in the treatment of ADHD is atomoxetine [42]. In 2003, Michelson and colleagues conducted six open-label studies and eight controlled trials to assess the efficacy of atomoxetine in treating ADHD. In the first study, which lasted 10 weeks, a 30% improvement in mean scores was observed in patients receiving atomoxetine, while the placebo group showed only a 20% decrease in mean scores. Similar results were obtained for improvements in symptoms of inattention and hyperactivity/impulsivity [43]. Studies indicate that both stimulants, such as methylphenidate, and non-stimulants, like atomoxetine, are effective in treating ADHD. However, stimulant treatment provides faster and longer-lasting improvement of symptoms, particularly in terms of overall functioning. In the group treated with methylphenidate, a significant improvement was observed after six months and one year of treatment, while in the case of atomoxetine, symptom improvement was minimal even after two years of therapy. Both treatment types effectively reduce the aggressiveness of ADHD symptoms, but stimulants provide quicker results and are more effective over time [44, 45, 46]. Despite the presence of numerous studies indicating that

stimulants are more effective than non-stimulant medications in the treatment of ADHD, there are also research papers that describe similar efficacy in alleviating ADHD symptoms between both groups of medications [47]. Given the differences in data described in scientific studies comparing the effectiveness of ADHD treatment with stimulants and non-stimulant medications, further research is necessary. These findings would help determine whether stimulants should remain the first-line treatment for all patient groups diagnosed with ADHD. However, the effectiveness of pharmacotherapy with non-stimulant medications is undeniable and has been repeatedly confirmed in scientific studies. Therefore, these drugs serve as an important alternative, especially in cases of severe side effects or contraindications to stimulant use [48, 49].

Cognitive-behavioral therapy (CBT) is an effective treatment method for adults with ADHD, focusing on modifying negative self-beliefs, improving executive functions, and developing strategies to manage impulsivity and distractibility. Studies indicate that CBT is a well-tolerated and acceptable treatment, with randomized controlled trials confirming its effectiveness in enhancing the functioning of adults with ADHD. It is also important to note that some patients do not respond to pharmacological treatment, and medications can cause numerous side effects, highlighting the need for effective non-pharmacological interventions. Furthermore, successful psychosocial therapy can help counteract the negative consequences of ADHD, such as difficulties in work, education, or social relationships. Young et al. conducted a systematic review of nine studies and two meta-analyses of some of these studies, concluding that CBT effectively reduces ADHD symptoms [50, 51].

Despite the presence of numerous scientific studies demonstrating the positive effects of CBT in treating ADHD, some research articles suggest that CBT, particularly as a standalone therapeutic method, is not sufficient and serves only as a supplementary support to pharmacotherapy [52]. Due to these conflicting findings, further research is necessary to assess the effectiveness of the aforementioned therapy in treating ADHD in both adults and children.

Another alternative method for reducing the negative symptoms of ADHD, mentioned in the literature, is cognitive training. To assess the scientific review of this therapeutic approach, we examined the study by Cortese et al. The authors of this publication conducted a meta-analysis of randomized controlled trials to evaluate the effectiveness of cognitive training in reducing ADHD symptoms, improving neuropsychological functions, and enhancing academic performance in children and adolescents. They analyzed available studies from multiple databases, considering the risk of systematic bias. The results indicate that cognitive training leads to improvements in working memory and parent-rated executive functions. However, its impact on overall ADHD symptoms is limited and less pronounced in assessments conducted by blinded raters. No significant effects were observed in terms of hyperactivity, impulsivity, or academic performance. The authors suggest that the effectiveness of this type of intervention may be greater if it encompasses a broader approach, addressing various neuropsychological deficits associated with ADHD [53]. The results of the aforementioned review study are supported by other research studies [54]. Based on these extensive findings from multiple studies, it is not possible to determine definitively whether cognitive training, particularly as a standalone therapeutic method, can effectively reduce the negative symptoms of ADHD or should be considered only as an adjunctive treatment.

Another therapeutic method used in ADHD is neurofeedback. To assess the effectiveness of this therapeutic approach in reducing ADHD symptoms, we reviewed research studies describing the results of its application in both children and adults. Enriquez-Geppert et al. presented scientific evidence of the efficacy of neurofeedback in treating ADHD, highlighting the effectiveness of three standard training protocols: theta/beta, sensorimotor rhythm, and slow cortical potential. However, they note that the use of neurofeedback in clinical practice is not currently regulated. They emphasize the need for further research to better understand the mechanisms of these protocols and to develop training standards and clinical norms in this area [55]. Researchers conducted a well-designed randomized controlled trial to assess the efficacy of functional MRI-based neurofeedback (fMRI-NF) as a treatment for children with ADHD. The study found no differences between active neurofeedback and placebo, despite a clearly defined brain target and solid methodology. The authors emphasized that the benefits observed in other neurofeedback studies might be attributed to nonspecific factors, such as coaching and placebo effects, rather than actual changes in brain activity. The literature on neurofeedback in ADHD is full of contradictions, and results from previous studies, both positive and negative, are difficult to interpret due to numerous methodological limitations [56, 57, 58]. In light of the lack of conclusive evidence supporting its efficacy, the authors suggest that neurofeedback may be unjustified as an ADHD treatment. These conclusions highlight the need for further research and a critical approach to the use of neurofeedback in ADHD treatment, especially given the effectiveness of traditional therapies like pharmacotherapy.

The last alternative method for reducing symptoms in ADHD is a properly managed diet and supplementation of nutrients. Since this topic is extensive and could warrant a separate literature review, we focused on evaluating data from the largest research studies. Researchers have indicated that while supplementation with micronutrients, omega-3 fatty acids, and probiotics in the treatment of ADHD has not been conclusively proven, certain subgroups of children and adolescents may benefit from the elimination of specific foods or, conversely, from supplementation with certain nutritional components. Based on clinical observations, it has been concluded that the elimination of food ingredients that may be sources of intolerances or allergies can lead to positive effects in reducing ADHD symptoms. Although the findings of observational studies suggest a role of diet in managing ADHD, there is no evidence to establish a causal relationship between the two factors. The researchers emphasize that future studies should focus on precisely identifying patient groups that may benefit from a food-elimination-based diet, as well as determining the optimal doses of dietary supplements [59]. In their scientific work, Pinto et al. indicated that diet may influence ADHD symptoms, highlighting the link between unhealthy dietary patterns and a higher risk of developing the disorder. There is evidence of the positive impact of vitamin D supplementation and the combination of vitamin D with magnesium on improving ADHD symptoms, particularly in children with deficiencies in these nutrients. In terms of probiotics, some effectiveness of Lactobacillus rhamnosus GG and multi-strain probiotic supplements in alleviating symptoms has been demonstrated. On the other hand, elimination diets, while potentially beneficial, carry the risk of nutritional deficiencies and require caution in their use [60, 61, 62]. In conclusion, the researchers suggest that although there are indications of the role of diet and supplementation in treating ADHD, further, more detailed studies are needed for these interventions to become part of the treatment for this disorder.

Studies indicate a variety of alternative methods for treating ADHD, including the use of non-stimulant medications, cognitive-behavioral therapy (CBT), cognitive training, neurofeedback, and appropriately tailored diet and supplementation. Non-stimulant medications, such as atomoxetine, are effective, although they are slower and less durable than stimulants. CBT has also proven effective, particularly for adults, but it is not always sufficient as a standalone treatment and is typically used as an adjunct to pharmacotherapy. Cognitive training improves working memory but does not significantly affect overall ADHD symptoms. Neurofeedback, despite promising initial results, requires further research, as current studies do not provide a clear assessment of its effectiveness. Regarding diet, some studies suggest benefits from eliminating foods that cause intolerances and supplementing with vitamin D, magnesium, and probiotics, although the results are inconclusive and require further investigation. In conclusion, alternative methods for treating ADHD can offer valuable support, especially in cases where pharmacotherapy is insufficient, but each approach requires further validation and should be applied with an individualized patient approach.

Summary and conclusions:

The treatment of ADHD remains the subject of numerous studies, with ongoing discussions regarding its effectiveness and safety. Stimulants such as methylphenidate and amphetamines are the most commonly used therapy, demonstrating high efficacy in reducing ADHD symptoms. However, their use is associated with significant side effects, including sleep disturbances, appetite loss, and concerns about the potential risk of addiction and misuse. Despite these concerns, pharmacotherapy remains the gold standard, particularly for severe cases where symptoms significantly impair daily functioning.

In response to concerns about pharmacotherapy, alternative treatment methods such as cognitive-behavioral therapy, neurofeedback, cognitive training, and dietary interventions are gaining popularity. While some studies suggest potential benefits, there is a lack of conclusive evidence supporting their high effectiveness as standalone treatments. However, many of these interventions can serve as valuable adjuncts to pharmacotherapy, helping to optimize treatment and minimize side effects.

A review of the available research highlights the need for further comparative analyses and studies on combining different therapeutic approaches. Developing strategies that effectively integrate pharmacological and non-pharmacological treatments appears particularly important, as this could lead to more personalized therapeutic approaches tailored to individual patient needs. However, there is still a lack of long-term studies assessing both the efficacy and safety of various treatment strategies.

This paper, based on extensive data from numerous research studies, provides a comprehensive analysis of both pharmacotherapy and alternative treatment methods. It emphasizes the need for further research on optimal therapeutic strategies and their long-term impact on patient outcomes. A holistic approach to ADHD treatment is essential for developing more effective and safer therapies, minimizing the risk of adverse effects while maximizing benefits for patients.

Disclosures

Author's contribution: conceptualization, KG; methodology, KG, KP, NK and AR; software, AG; check, KG and KP; formal analysis, KG and NK; investigation, AR; resources, AG; data curation, AR and AG; writing - rough preparation, KP, AR and AG; writing - review and editing, KG, NK and KP; visualization, AG; supervision, AR; project administration, KG

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