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THE ROLE OF DIET AND LIFESTYLE IN THE TREATMENT OF ATTENTION DEFICIT HYPERACTIVITY DISORDER: A NARRATIVE REVIEW

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ABSTRACT

Background

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by impaired concentration, impulsivity, and excessive motor activity. Although conventional therapy is effective in many patients, it may be associated with high costs, adverse effects, and incomplete symptom control. Therefore, complemen-

tary methods, such as dietary modifications and lifestyle factors, are gaining increasing importance in the management of ADHD.

Aims

The aim of this narrative review was to critically integrate current evidence on the role of diet, nutritional supplementation, the gut microbiota, and physical activity in the management of ADHD, and to evaluate which of these interventions are supported by stronger evidence and which remain at a preliminary stage.

Materials and Methods

A narrative review of the literature was conducted using the PubMed database, focusing on selected keywords. The search was limited to English-language publications published between 2015 and 2026. Eligible studies included meta analyses, systematic reviews, randomized controlled trials, cohort studies, and original research articles. After screening and eligibility assessment by all authors, 50 studies met the inclusion criteria and were included in the qualitative synthesis.

Results

The reviewed evidence indicates that appropriately selected dietary patterns, supplementation with omega 3 polyunsaturated fatty acids, and physical activity may reduce ADHD symptom severity and improve daily functioning, with the strongest and most consistent evidence supporting omega 3 polyunsaturated fatty acids. Evidence for micronutrient supplementation and microbiota targeted interventions, including probiotics and fermented foods, remains preliminary and is largely based on small studies, although it suggests potential benefits for impulsivity, attention, and sleep quality.

Conclusions

Dietary interventions and lifestyle modifications may be considered as potential supportive strategies in the management of ADHD, complementing rather than replacing standard pharmacological and psychotherapeutic treatment. However, despite promising findings, the evidence remains inconclusive, and further high quality studies are needed to establish their effectiveness and support more personalized treatment approaches.

Keywords: ADHD, dietary intervention, gut microbiota, omega 3 fatty acids, physical activity, vitamin and mineral supplementation

INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is a group of mental disorders resulting from abnormal development and functioning of the central nervous system. It is characterized by problems with concentration, hyperactivity, excessive motor activity or impulsivity [1]. ADHD is one of the most common neurodevelopmental disorders of childhood, the symptoms of which may persist throughout life. It is estimated that the disorder affects approximately 5–7% of the population, and the number of diagnoses has shown an upward trend in recent years [2]. Although the exact mechanisms underlying ADHD have not yet been fully elucidated, disturbances in the balance between the dopaminergic and noradrenergic systems in the central nervous system are considered to play a key role in the pathogenesis of the disease. These disturbances may result from the interaction of genetic and environmental factors, including lifestyle, diet, and exposure to stress [3]. The diagnosis of ADHD is clinical in nature and is based on the assessment of symptoms in accordance with the diagnostic criteria contained in the DSM-5-TR and ICD-11 classifications [1, 4]. These criteria encompass three main areas of functioning: inability to focus attention, excessive psychomotor activity, and impulsivity. In addition, patients with ADHD may present deficits in executive functions such as planning, organization, cognitive flexibility, and self-control [5]. As a consequence, patients experience numerous difficulties in daily functioning, including problems with learning and memory, as well as in building and maintaining relationships with family and peers [1]. They often experience failures at school and at work and encounter conflicts in interpersonal relationships, which makes them more susceptible to rejection [6]. In addition, individuals with ADHD may suffer from sleep disorders, including insomnia, restless legs syndrome, and sleep apnea. They frequently show prolonged sleep onset latency, reduced sleep efficiency, and shorter periods of uninterrupted sleep [7]. Patients are also burdened with an increased risk of accidents, substance abuse, obesity, and suicide attempts [8]. All of these factors significantly reduce the quality of life of individuals with ADHD and may lead to diminished self-esteem, thereby increasing the risk of developing comorbid mental disorders [6]. Current scientific evidence indicates that appropriately selected treatment can reduce the severity of the disorder's symptoms and improve patients' daily functioning. Nevertheless, complete remission of symptoms is rarely achieved, and therapy is often

associated with substantial costs. Consequently, increasing attention is being devoted to alternative methods that complement ADHD treatment [9, 10]. Nutrition and lifestyle, which can influence brain function as well as cognitive, emotional, and behavioral processes, are attracting particular interest in this area [11, 12].

RELEVANCE AND NOVELTY

Numerous reviews have examined individual aspects of non-pharmacological ADHD management, typically focusing on dietary patterns, micronutrient supplementation, omega-3 polyunsaturated fatty acids (PUFAs), the gut microbiota, or physical activity separately [9, 11, 12, 18]. However, these factors do not operate in isolation. Dietary quality, nutritional status, the gut microbiota, and physical activity are closely interconnected and may jointly influence key neurobiological mechanisms implicated in ADHD, including dopaminergic and noradrenergic neurotransmission, neuroinflammation, oxidative stress, and the gut-brain axis [3].

Given the multifactorial pathophysiology of ADHD, increasing attention has been directed toward a more holistic approach to its management, in which dietary, nutritional, microbiota-related, and lifestyle factors are considered together rather than as isolated interventions. Evaluating these strategies within an integrated framework may provide a more comprehensive understanding of their potential interactions and complementary effects in supporting conventional ADHD treatment.

Although numerous reviews have summarized evidence for individual non-pharmacological interventions, relatively few have integrated these complementary strategies within a single narrative framework. This review addresses this gap by synthesizing evidence published through 2026 and providing an integrated overview of their potential role in ADHD management.

AIMS AND RESEARCH OBJECTIVES

The aim of this narrative review is to summarize and critically integrate current evidence on the role of diet, nutritional supplementation, the gut microbiota, and physical activity in the management of ADHD, and to highlight which of these interventions are supported by stronger evidence and which remain preliminary.

Research objectives of the article:

- To evaluate the impact of dietary patterns and nutritional supplementation, including vitamins, minerals, and polyunsaturated fatty acids, on ADHD symptoms.
- To assess the potential role of the gut microbiota and probiotic interventions in modulating ADHD symptoms.
- To analyze the impact of physical activity on cognitive and behavioral functioning in individuals with ADHD.

MATERIALS AND METHODS

This article is a narrative review aimed at providing a comprehensive and qualitative synthesis of the current literature concerning the role of diet and lifestyle in the management of ADHD. This narrative review offers a broad, integrative overview of heterogeneous evidence, allowing for critical interpretation and contextualization of available findings within the framework of current clinical practice.

Publications considered eligible for inclusion comprised meta-analyses, systematic reviews, randomized controlled trials, prospective cohort studies, and original research articles evaluating dietary interventions, nutritional and micronutrient supplementation, gut microbiota-targeted therapies (including probiotic supplementation and fermented food consumption), and physical activity interventions in the context of ADHD.

The literature search was conducted using the PubMed database as the primary source of publications. The search strategy combined MeSH terms and title/abstract keywords related to ADHD and lifestyle- or nutrition-based interventions. The following terms were used: "Attention Deficit Disorder with Hyperactivity" [MeSH], ADHD, "Attention Deficit Hyperactivity Disorder", combined with terms related to dietary patterns and lifestyle factors, including the Mediterranean diet, DASH diet, elimination diets, omega-3 polyunsaturated fatty acids, gut microbiota, probiotics, fermented foods, physical activity, exercise, and vitamins and minerals, including iron, zinc, magnesium, and vitamin D. The search was restricted to English language publications published between January 2015 and May 2026.

Studies were included if they were peer-reviewed, published in English, available in full text, and investigated the relationship between dietary or lifestyle factors and ADHD. Exclusion criteria included publications unrelated to the topic of interest, case reports, conference abstracts, editorials, commentaries without original data, and duplicate

publications. Titles and abstracts were initially screened for relevance, followed by full-text assessment of potentially eligible articles.

The literature search identified 690 records from the PubMed database. Titles and abstracts were screened for relevance, resulting in the exclusion of 378 records. The remaining 312 articles were assessed in full text, of which 262 were excluded due to lack of relevance, inappropriate study population, insufficient information regarding investigated lifestyle factors in ADHD, or limited contribution to the objectives of the review. Finally, 50 publications met the eligibility criteria and were included in the qualitative synthesis.

For each included study, the following information was extracted: authors, year of publication, study design, study population, type of intervention or exposure, and main outcomes. Extracted data were grouped into thematic categories reflecting the principal areas addressed in this review: dietary patterns, vitamin and mineral supplementation, polyunsaturated fatty acids, the microbiota-gut-brain axis and probiotic interventions, and physical activity. Findings within each category were narratively synthesized and critically discussed.

Titles, abstracts, and full-text articles were reviewed by all authors according to predefined eligibility criteria, and any disagreements were resolved through discussion until consensus was reached.

RESULTS

Conventional methods of ADHD treatment

Conventional methods of ADHD treatment include pharmacological and psychotherapeutic interventions, the selection of which is individualized and depends on the patient's needs. Pharmacotherapy employs stimulant medications, including methylphenidate and amphetamine derivatives, as well as non-stimulant medications such as atomoxetine, guanfacine, and clonidine. Their use regulates neurotransmitter activity in the dopaminergic and noradrenergic systems, thereby contributing to a reduction in the severity of ADHD symptoms [13, 14]. Pharmacotherapy, despite dose modification or a change of preparation, does not always produce the expected results, and its beneficial effects are generally limited to the period of medication use [15]. Moreover, pharmacological treatment may cause adverse effects such as decreased appetite, weight loss, insomnia, headaches and abdominal pain, or nausea,

which contributes to poor tolerability and reluctant continuation of treatment by patients [16]. In light of this, increasing attention is being devoted to non-pharmacological methods of ADHD treatment. These include dietary and lifestyle modifications as well as cognitive-behavioral psychotherapy, the aim of which is to change maladaptive cognitive patterns and behavioral schemas. Research emphasizes that it is precisely combined treatment, integrating both forms of therapy, that yields the best results [17].

Dietary interventions in the treatment of ADHD

The limitations of conventional treatment methods and the possibility of adverse effects contribute to growing interest in dietary interventions in ADHD. They are increasingly used as a supportive element of therapy, and a growing body of scientific evidence emphasizes the importance of nutrition not only in reducing the risk of developing ADHD but also in reducing the severity of cognitive and behavioral symptoms [18]. Available literature data indicate that anti-inflammatory diets, in particular the Mediterranean diet and the Dietary Approaches to Stop Hypertension (DASH) diet, exhibit the strongest neuroprotective effects and correlate with a milder course of the disorder. Recent systematic reviews have drawn particular attention to the quality, rather than merely the quantity, of carbohydrates. Foods with a high glycemic index that are low in dietary fiber, together with a high intake of added sugars, cause abrupt fluctuations in blood glucose levels. This negatively affects emotional regulation, triggering irritability, fatigue, and concentration problems in patients with ADHD. The brain is characterized by high metabolic demand, and its development, structure, and the course of neurobiological processes depend on adequate supplementation of amino acids, fatty acids, vitamins and minerals [19, 20].

Dietary patterns

There is currently a growing body of literature indicating that a diet consisting mainly of highly processed products containing synthetic chemical substances, saturated fats, and large amounts of salt and sugar may worsen the course of ADHD [21]. In addition, a systematic review and meta-analysis has shown that adherence to a healthy dietary pattern (rich in vegetables, fruit, legumes, and fish) was associated with up to a 37% lower risk of ADHD, whereas adherence to the so-called Western dietary pattern, based on highly processed products (including processed red meat and cold cuts, refined grains, hardened fats, sweetened beverages, and desserts), was associated with an approximately 92% higher risk of ADHD [22].

One recent study assessed the association between adherence to the Mediterranean diet and the occurrence of ADHD. Higher intake of products characteristic of this dietary pattern, such as fruit, vegetables, legumes, fish, nuts, and olive oil, was found to be associated with a lower risk of the disorder. Notably, individuals with the highest degree of adherence to the Mediterranean diet had approximately 51% lower risk of ADHD compared with the group with the lowest adherence [23].

Another publication examined the effect of the DASH diet on the clinical presentation of ADHD. This dietary model was developed for the prevention and treatment of arterial hypertension. It is based on a high intake of vegetables, fruit, low-fat dairy products, fish, nuts, legumes, and whole-grain cereal products, combined with restriction of salt, saturated fats, highly processed foods, and simple sugars. A 12-week intervention based on the DASH diet was observed to lead to a significant reduction in the severity of ADHD symptoms compared with the control group. The greatest improvement was observed in the maintenance of concentration and attention, with a lesser degree of improvement in hyperactivity and impulsivity [24].

Studies have also been conducted on the effects of elimination diets on the clinical presentation of ADHD. These included both the removal of eggs, milk, soy, nuts, fish and seafood, simple sugars, and artificial colorings and preservatives from the diet, as well as a more restrictive diet containing a limited number of products, known as the Few Foods Diet (FFD), which additionally involves the exclusion of gluten, dairy, and most fruits and vegetables. After approximately 5 weeks of intervention, a significant reduction in ADHD symptoms, including attention deficits and impulsivity, was observed in approximately 35% of patients. Notably, in the same randomized trial, a standard, non-restrictive healthy diet used as the comparator arm was associated with an even higher response rate (approximately 51% of children) than the elimination diet itself, suggesting that improved overall dietary quality, rather than the removal of specific food triggers, may account for a substantial part of the observed benefit. However, this effect was transient in nature and dependent on the duration of dietary adherence, with no unequivocal evidence of sustained long-term improvement. It should also be emphasized that, due to the restrictive nature of elimination diets and the high risk of nutritional deficiencies, such interventions should be applied exclusively under strict specialist supervision [25, 26].

Vitamins and minerals

Meeting nutrient requirements is also an important area of research concerning the supplementation of ADHD therapy. Patients exhibit insufficient intake of vitamins as

well as macro- and micronutrients, which may negatively affect the functioning of the central nervous system, including the brain. For this reason, increasing attention is being devoted to the potential benefits of nutrient supplementation, particularly iron, zinc, magnesium, and vitamin D [27]. Maintaining proper concentrations of vitamins and minerals may reduce the severity of ADHD symptoms and improve patient functioning, among others through better emotional control, reduced irritability, and alleviation of attention deficits and hyperactivity [28].

Iron is a key trace element involved in numerous metabolic processes, including oxygen transport and storage, as well as DNA synthesis. It also functions as a cofactor in the synthesis of neurotransmitters such as dopamine and noradrenaline, which play an important role in maintaining concentration and self-regulation. Patients with ADHD have been found to have reduced levels of ferritin and iron in the brain, particularly in the thalamus, which may be related to the clinical presentation of this disorder [29]. A randomized clinical trial demonstrated that 12 weeks of oral supplementation with 80 mg of iron in patients with iron deficiency may lead to moderate improvement in selected symptoms, particularly in the areas of impulsivity and emotional control [30].

Zinc is another element important for the functioning of the central nervous system. It participates in the modulation of the dopaminergic system and exhibits neuroprotective effects by reducing oxidative stress. Patients with ADHD show reduced zinc concentrations more frequently than healthy individuals, which may be related to the occurrence of the disorder's symptoms. An 8-week randomized, double-blind trial in children with ADHD demonstrated that daily supplementation with 22 mg of zinc sulfate, as an adjunct to methylphenidate, led to a significant improvement in symptom severity compared with the control group, specifically among children with the inattentive subtype of ADHD [31].

The effects of magnesium and vitamin D on the clinical presentation of ADHD have also been analyzed. These substances participate in the modulation of neurotransmitter release and the regulation of neuronal excitability, and exhibit neuroprotective effects, which may be significant in the pathophysiology of hyperactivity and attention disorders. Eight weeks of supplementation with vitamin D (50,000 IU weekly) and magnesium (6 mg/kg/day) was shown to be associated with a reduction in the severity of emotional and behavioral symptoms and improved functioning in some children with ADHD [32, 33].

Polyunsaturated fatty acids

Polyunsaturated fatty acids (PUFAs) are essential nutrients that, by influencing a range of cellular processes and molecular pathways, support the proper functioning of the nervous system and exert anti-inflammatory effects. Since they are not synthesized in the human body, they must be continuously supplied through daily diet. Their main dietary sources are fatty marine fish, seafood, and vegetable oils [34, 35]. PUFAs can be divided into two groups: omega-3 polyunsaturated fatty acids (ω -3 PUFAs) and omega-6 polyunsaturated fatty acids (ω -6 PUFAs). Particular importance in the functioning of the central nervous system is attributed to ω -3 PUFAs, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These compounds, by modulating serotonin and dopamine activity, influence nerve signal transmission and exhibit antioxidant properties. Furthermore, DHA is one of the main lipid components of the brain, participating in the formation of neuronal cell membranes and myelin sheaths [36].

According to recent scientific reports, patients with ADHD have been reported to exhibit lower concentrations of ω -3 PUFAs, which may be of significant importance in the pathogenesis of the disorder's symptoms. Accordingly, it has been examined whether meeting the body's requirement for ω -3 PUFAs may contribute to reducing attention deficits, impulsivity, and excessive motor activity, as well as associated behavioral and psychological difficulties [37]. It has been observed that ω -3 PUFA supplementation, particularly EPA and DHA, resulted in a significant reduction in symptom severity in children with ADHD [38, 39]. Detailed results of these and other dietary and nutritional interventions discussed throughout this section, including dietary patterns, minerals, vitamins and PUFA supplementation, and microbiota-targeted interventions, are summarized jointly in Table 1.

However, the authors of these studies emphasize that the efficacy of ω -3 PUFA supplementation in patients with ADHD may depend on individual concentrations of these compounds, and the effects obtained are generally moderate in nature. Therefore, ω -3 PUFA supplementation should not be regarded as a standalone method of ADHD treatment, but rather as a complementary element of standard therapy [40, 41].

The microbiota-gut-brain axis

The microbiota-gut-brain axis constitutes a connection between the gastrointestinal tract and the central nervous system, encompassing biochemical and neurohumoral signaling. Metabolites produced by the gut microbiota, which can influence neuronal

activity and processes occurring in the brain, play an important role in its functioning. The gut microbiota participates in the synthesis of numerous neurotransmitters, including dopamine and serotonin, and also regulates the immune response and inflammatory processes. Numerous studies have shown that disturbances in the quantitative and qualitative composition of the gut microbiota may lead to so-called dysbiosis, thereby negatively affecting the regulation of processes in the nervous system [42]. Individuals with ADHD are increasingly found to have disturbances in gut microbiota composition, which has led to growing interest in the effect of probiotics on the disorder's symptoms [43].

Clinical studies have shown that probiotic intake in patients with ADHD may result in an increase in the abundance of beneficial bacteria within the gut microbiota and may contribute to a reduction in the severity of the disorder's symptoms [44, 45]. A detailed characterization of the strains, doses, and effects obtained is summarized jointly with the other dietary and nutritional factors in Table 1.

Increased intake of kefir, which is a source of diverse microbiota including bacteria and yeast, has also been considered. One study found that regular consumption of 125 ml of kefir daily for 6 weeks had a positive effect on sleep continuity in patients with ADHD, including a reduction in wake-after-sleep-onset time and less pronounced sleep fragmentation [7].

The results obtained indicate that modulation of the microbiota-gut-brain axis through preparations and products containing probiotic bacteria may constitute a potential complement to therapeutic management in individuals with ADHD. Nevertheless, further randomized studies are needed, involving larger groups of patients with diverse clinical presentations, symptom severity, and comorbid disorders [7, 44, 45].

Table 1. Dietary patterns, vitamins and minerals, ω -3 PUFA, and microbiota-targeted interventions discussed in relation to ADHD management

DIETARY PATTERNS				
Factor	Examples / intervention	Proposed mechanism	Effect on ADHD symptoms	Strength of evidence / limitations
Mediterranean diet	High intake of fruit, vegetables, legumes, fish, nuts, olive oil	Anti-inflammatory and neuroprotective effects	Higher adherence associated with approximately 51% lower odds of ADHD [23]	Case-control design; association only, no intervention trial
DASH diet	Vegetables, fruit, low-fat dairy, fish, nuts, legumes, whole-grain products; restriction of salt, saturated fat, processed food and simple sugars	Reduction of blood pressure and systemic inflammation; possible modulation of neuroinflammation	12-week RCT: significant reduction in symptom severity, greatest for concentration and attention [24]	Single RCT; short intervention period; limited generalizability
Western dietary pattern	Processed red meat and cold cuts, refined grains, hardened fats, sweetened beverages, desserts	Pro-inflammatory profile; low micronutrient density	Associated with approximately 92% higher risk of ADHD; healthy dietary patterns were associated with up to 37% lower risk in the same meta-analysis [22]	Observational data; recall and reporting bias possible
Elimination diets	Removal of eggs, milk, soy, nuts, fish/seafood, simple sugars, artificial colorings and preservatives	Removal of potential immunogenic or pro-inflammatory dietary triggers	Significant symptom reduction in approximately 35% of children after approximately 5 weeks [25, 26]	Effect transient and adherence-dependent; in the source trial, a standard healthy-diet comparator arm showed an even higher response rate (approximately 51%) than the elimination diet itself; risk of nutritional deficiencies; requires specialist supervision
Few Foods Diet (FFD)	Highly restrictive elimination protocol additionally excluding gluten, dairy, and most fruits and vegetables	Removal of potential immunogenic or pro-inflammatory dietary triggers, with more extensive elimination than standard elimination diets	Symptom reduction reported in children following restrictive elimination protocols [25, 26]	Greater risk of nutritional deficiency; limited long-term feasibility
Carbohydrate quality / added sugars / highly processed foods	High-glycemic-index, low-fiber foods and high intake of added sugars	Abrupt blood-glucose fluctuations affecting emotional regulation	Associated with higher ADHD symptom severity and greater ADHD prevalence in observational studies [19, 20]	Mechanistic and observational evidence; no dedicated RCTs cited
Vitamin and mineral supplementation				
Iron	80 mg/day orally for 12 weeks (in iron-deficient patients)	Cofactor in dopamine and noradrenaline synthesis	Improvement in ADHD symptom severity, particularly impulsivity-related symptoms [29, 30]	Single RCT; benefit limited to iron-deficient subgroup
Zinc	22 mg zinc sulfate (one capsule/day) as an adjunct to methylphenidate, for 8 weeks (Salehi et al., 2016)	Modulation of the dopaminergic system; reduction of oxidative stress	Significant improvement in Conners' scale scores versus control, specifically in the inattentive-subtype subgroup of ADHD [31]	Single RCT; benefit specific to the inattentive subtype
Magnesium	6 mg/kg/day for 8 weeks (combined with vitamin D)	Modulation of neurotransmitter release and neuronal excitability	Reduced severity of emotional and behavioral symptoms in some children [32, 33]	Combined protocol with vitamin D; effect of magnesium alone unclear

Vitamin D	50,000 IU weekly for 8 weeks (combined with magnesium)	Neuroprotective effects; modulation of neurotransmission	Reduced severity of emotional and behavioral symptoms in some children (same combined 8-week trial as magnesium, above) [32, 33]	Combined protocol with magnesium; effect of vitamin D alone unclear
(PUFA)				
ω-3 PUFAs (general)	Dietary sources: fatty marine fish, seafood, vegetable oils	Anti-inflammatory effects; structural component of neuronal membranes and myelin	Lower ω-3 PUFA concentrations reported in patients with ADHD [37]	Mostly mechanistic and observational evidence
EPA + DHA + GLA (Döpfner et al., 2021)	EPA 372 mg/day + DHA 116 mg/day + GLA 40 mg/day for 4 months, 40 preschool children	Modulation of serotonin and dopamine transmission	Reduced internalizing and externalizing problems; improvements in attention-related outcomes [38]	Small sample; preschool-specific population
EPA + DHA (San Mauro Martín et al., 2022)	EPA 550 mg/day + DHA 225 mg/day for 8 weeks, 60 children	Modulation of serotonin and dopamine transmission	Reduced impulsivity; improved behavioral control [39]	Short duration; combined with a Mediterranean-diet arm in the original study
Microbiota-targeted interventions				
Probiotic - Bifidobacterium bifidum Bf-688 (Wang et al., 2022)	2 sachets/day (5×10^9 CFU/day) for 8 weeks, 30 children	Modulation of gut microbiota composition and gut-brain axis signaling	Reduced ADHD symptom severity (attention, hyperactivity, impulsivity) [44]	Small sample; single bacterial strain
Multi-strain probiotic (Levy Schwartz et al., 2024)	2 capsules/day (8×10^9 CFU per strain) for 3 months, 67 university students (34 in the probiotic group, 33 in the placebo group); multi-strain preparation containing Lactobacillus helveticus, Bifidobacterium animalis ssp. lactis, Enterococcus faecium, Bifidobacterium longum, and Bacillus subtilis	Modification of gut microbiota structure and diversity	Improved cognitive and behavioral functioning; reduced hyperactivity [45]	No clearly identified changes in individual taxa
Fermented foods / kefir	125 mL of kefir daily for 6 weeks	Provision of diverse microbiota (bacteria and yeast)	Improved sleep continuity: reduced wake-after-sleep-onset time, less sleep fragmentation [7]	Single study; sleep-related outcome only

RCT - randomized controlled trial; CFU - colony-forming units; EPA - eicosapentaenoic acid; DHA - docosahexaenoic acid; GLA - gamma-linolenic acid.

Source: own elaboration based on references [7, 19-26, 29-33, 37-39, 44, 45].

Physical activity

Physical activity is considered an important factor complementing ADHD therapy, as it significantly improves patients' daily functioning. It increases cerebral blood flow and regulates the dopaminergic and noradrenergic systems, thereby influencing the functioning of the prefrontal cortex. This results in better control of impulsive behaviors and an increase in concentration and working memory [46].

Scientific reports indicate that a single, 30-minute moderate-intensity aerobic training session, compared with no activity, can significantly improve control of impulsive reactions and automatic behaviors. Both single moderate-intensity aerobic training sessions lasting approximately 30 minutes and regular, long-term exercise lead to improved executive functions in patients with ADHD [47, 48]. A meta-analysis found that moderate- to high-intensity exercise, including aerobic training and coordination activities used in children and adolescents with ADHD, lasting 6 to 12 weeks, with a frequency of 1–6 sessions of 5–90 minutes daily led to increased inhibitory control and cognitive flexibility [49]. In addition, a randomized clinical trial demonstrated that an 8-week intervention based on physical activity combined with elements of active games, conducted at home with a frequency of 3 sessions per week of 30 minutes each, resulted in significant improvement in selected executive functions, including reaction times and attention control, as well as improved motor functioning [50]. The main characteristics of the studies evaluating physical activity interventions in individuals with ADHD are summarized in Table 2.

Table 2. Characteristics of studies evaluating the effects of physical activity on cognitive and behavioral functioning in individuals with ADHD

STUDY (DESIGN)	POPULATION	TYPE OF ACTIVITY / DURATION	COMPARATOR / CONTROL	OUTCOME MEASURES	LIMITATIONS / INTERPRETATION
Christiansen et al., 2019 [47] - review of mechanisms and evidence-based recommendations	Children and adolescents with ADHD	Exercise interventions broadly (mechanisms and recommendations reviewed, not a single empirical protocol)	Not applicable (mechanism-focused review, not an empirical study)	Executive functions, attention, and cognitive performance (mechanism-focused overview)	Synthesizes mechanisms and recommendations rather than presenting a single empirical protocol
Yu et al., 2020 [48] - experimental study	Children with ADHD	Single bout of acute aerobic exercise	Video-watching condition (30-minute neutral nature video, within-subjects crossover design)	Inhibitory control and cognitive flexibility (executive functions)	Small sample; acute, short-term outcome only
Liang et al., 2021 [49] - systematic review and meta-analysis	Children and adolescents with ADHD	Moderate- to high-intensity aerobic training and coordination activities, 6–12 weeks (1–6 sessions/week, 5–90 min/session)	Varied across included studies (meta-analysis; not a single specified comparator)	Self-control and cognitive flexibility (executive functions)	Meta-analytic synthesis; comparator and heterogeneity of included studies not detailed in the source text
Benzing & Schmidt, 2019 [50] - randomized controlled trial	Children with ADHD	Home-based active games (exergaming), 8 weeks (3 sessions/week, 30 min/session)	Waiting-list control group	Executive functions (inhibition, cognitive flexibility, reaction time)	Single trial; home-based setting may limit supervision of adherence

Source: own elaboration based on references [47–50].

DISCUSSION

This narrative review summarizes and integrates published evidence on the role of diet, nutritional supplementation, the gut microbiota, and physical activity in the management of ADHD. This Discussion focuses on critically weighing the relative strength of the evidence across these areas and identifying the interventions that are best supported versus those that remain preliminary.

Among the reviewed interventions, evidence for ω -3 PUFA supplementation, particularly EPA and DHA, is the most internally consistent, with several randomized trials reporting reductions in symptom severity and a plausible mechanistic basis related to neuronal membrane composition and dopaminergic/serotonergic modulation [36, 37, 38, 39, 41]. Structured dietary patterns, especially the DASH diet, are supported by trial-level evidence, although this rests on a single randomized trial of short duration [24], while the Mediterranean diet and Western dietary pattern are supported mainly by observational, association-level data rather than intervention trials [20, 21, 22, 23]. By contrast, evidence for micronutrient supplementation (iron, zinc, magnesium, vitamin D) and for microbiota-targeted interventions (probiotics, fermented foods) remains preliminary: it is based on single, small-sample trials with heterogeneous protocols, and the effects appear to depend on patients' baseline nutritional or microbiota status, which limits generalizability [7, 9, 12, 27, 28, 29, 30, 31, 32, 33, 42, 43, 44, 45]. Evidence on physical activity is directionally consistent, showing benefit for executive function and impulse control across both acute and long-term interventions, but the included studies vary considerably in intervention protocols, intensity, and duration, which restricts firm conclusions about optimal dosing [46, 47, 48, 49, 50].

Taken together, these findings suggest a gradient of evidentiary strength rather than a uniform level of support: ω -3 PUFA supplementation and structured dietary patterns currently have the most consistent backing, physical activity shows a directionally consistent but methodologically heterogeneous evidence base, and micronutrient and microbiota-targeted interventions remain promising but preliminary. This gradient should inform how these strategies are prioritized in clinical practice and in future research, rather than treating diet, supplementation, microbiota modulation, and physical activity as equally validated options [9, 18, 27].

An individualized approach to the patient remains of key importance, taking into account the variable response of patients to non-pharmacological interventions, as well as their nutritional status and comorbidities [9, 19, 27]. Consequently, although diet

and lifestyle appear to be important factors supporting ADHD management, they should not be regarded as substitutes for standard pharmacotherapy and psychotherapy but rather as complementary interventions [9, 13, 17].

In summary, diet and lifestyle represent potential supportive components of ADHD management rather than standalone therapeutic approaches. Dietary and lifestyle interventions appear best positioned as adjunctive, individually tailored strategies that may enhance symptom control and overall patient functioning when integrated within a broader, multidisciplinary treatment plan [9, 18, 27, 37].

Limitations

This narrative review has several limitations. The literature search was restricted to a single database (PubMed), which may have led to the omission of relevant studies indexed elsewhere. Only publications written in English and available in full text were considered, which may have introduced language and availability bias and excluded potentially relevant non-English or abstract-only reports. As a narrative rather than a systematic review, this work did not include a meta-analysis or a formal, quantitative assessment of the quality or certainty of evidence, and the selection and interpretation of studies therefore retain an inherent degree of subjectivity. Finally, the included studies differed substantially in design, study populations, type and duration of intervention, and outcome measures, which limits direct comparability across studies and precludes firm, generalizable conclusions.

CONCLUSIONS

ADHD is a neurodevelopmental disorder with an unclear pathophysiology, the symptoms of which may persist throughout life and significantly impair functioning in family, occupational, and social life. Despite the availability of effective pharmacological and psychotherapeutic methods, full symptom control is not achieved in all patients. The use of conventional treatment methods may be associated with adverse effects and substantial costs.

For this reason, increasing attention has been devoted in recent years to alternative methods of treating the disorder. This review has shown that dietary interventions and lifestyle modifications may be considered as complementary strategies supporting standard ADHD therapy, rather than as a replacement for pharmacological and psychotherapeutic treatment.

Meeting the requirements for vitamins, minerals, and polyunsaturated fatty acids, as well as an overall approach to nutrition and regular physical activity of moderate to high intensity, may be of significance. Microbiota targeted interventions, including probiotics and fermented foods, also represent a promising but still preliminary area and require confirmation in larger randomized studies.

These interventions may contribute to improved cognitive and behavioral function, facilitating the patient's daily functioning. Despite promising results, the efficacy of individual strategies is not unequivocal and depends on the individual clinical presentation and comorbid conditions. Due to the complex etiology of the disorder, the development of universal recommendations that would benefit all patients with ADHD remains limited.

Further randomized clinical trials are needed to enable the development of more personalized therapeutic strategies. This could contribute to increased treatment efficacy, reduced therapy costs, and improved long term outcomes for individuals with ADHD.

DISCLOSURE

Author Contributions

All authors have made substantial intellectual contributions to this work. Conceptualization and methodology: Aleksandra Katarzyna Kłosowicz. Literature review and data extraction: Aleksandra Katarzyna Kłosowicz, Aleksandra Olga Pakulska, Natalia Rządzińska, Aleksandra Maria Błoch, Maria Anna Miller, Kornelia Julia Fimiarz, Aleksandra Jolanta Kamińska. Writing - original draft preparation: Aleksandra Katarzyna Kłosowicz, Aleksandra Olga Pakulska, Natalia Rządzińska, Aleksandra Maria Błoch, Maria Anna Miller, Kornelia Julia Fimiarz, Aleksandra Jolanta Kamińska. Writing - review and editing: Aleksandra Katarzyna Kłosowicz, Aleksandra Olga Pakulska, Natalia Rządzińska, Aleksandra Maria Błoch, Maria Anna Miller, Kornelia Julia Fimiarz, Aleksandra Jolanta Kamińska.

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Conflict of Interest

Authors declare no conflicts of interest.

Use of Artificial Intelligence

The authors declare that no artificial intelligence tools were used in the generation, writing, editing, or revision of this manuscript. All content was created solely by the authors.

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