Testing & Treatment for Key Nutrients in ADHD

Dr. Kate Henry

What We'll Cover Today

1. **Food Sources, Dietary Assessment, Deficiency Risk, Testing, Treatment**
    a. Magnesium
    b. Zinc and Copper
    c. Iron / Lead interaction
    d. Omega 3's (bonus)
    e. OPCs
    f. Overall diet and glycemic control
2. **Herbal Medicines for ADHD**
3. **Case Study**
4. **Test Panels**

Why are we covering nutrients?

Research suggests that deficiencies may play a role in ADHD

- Vitamin D
- **Zinc / copper balance**
- Iron
- **Magnesium**
- Omega 3's
- **Dietary pattern (next slide)**

Review > Children (Basel). 2014 Sep 29;1(3):261-79. doi: 10.3390/children1030261.

Iron, Magnesium, Vitamin D, and Zinc Deficiencies in Children Presenting with Symptoms of Attention-Deficit/Hyperactivity Disorder

Amelia Villagomez [1], Ujjwal Ramtekkar [2]

Affiliations + expand

PMID: 27417479 PMCID: PMC4928738 DOI: 10.3390/children1030261

Free PMC article

Abstract

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder increasing in prevalence. Although there is limited evidence to support treating ADHD with mineral/vitamin supplements, research does exist showing that patients with ADHD may have reduced levels of vitamin D, zinc, ferritin, and magnesium. These nutrients have important roles in neurologic function, including involvement in neurotransmitter synthesis. The aim of this paper is to discuss the role of each of these nutrients in the brain, the possible altered levels of these nutrients in patients with ADHD, possible reasons for a differential level in children with ADHD, and safety and effect of supplementation. With this knowledge, clinicians may choose in certain patients at high risk of deficiency, to screen for possible deficiencies of magnesium, vitamin D, zinc, and iron by checking RBC-magnesium, 25-OH vitamin D, serum/plasma zinc, and ferritin. Although children with ADHD may be more likely to have lower levels of vitamin D, zinc, magnesium, and iron, it cannot be stated that these lower levels caused ADHD. However, supplementing areas of deficiency may be a safe and justified intervention.

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PMCID: PMC8949924
PMID: 35334788

Do Children with Attention-Deficit/Hyperactivity Disorder Follow a Different Dietary Pattern than That of Their Control Peers?

Associations between nutritional status and ADHD in children have also been analyzed. In this regard, dietary factors have been examined for their possible role in the etiology and treatment of this disorder. Some studies found altered levels of certain oligo elements such as magnesium, iron, and zinc in serum in children with ADHD [11,12,13,14,15]. For these reasons, several studies attempted to find a more natural, as opposed to pharmacological, treatment for ADHD; hence, various systematic reviews analyzed the effect of different nutritional interventions on behavioral symptomatology [13,16,17,18,19,20,21,22,23], but were unable to find clear supporting evidence. Furthermore, other authors studied the relationship between diet and ADHD versus non-ADHD. These studies used dietary patterns to evaluate the nutrition of children and adolescents with ADHD, and found relationships between ADHD and unhealthy diets [24,25], such as the fast food, sweet, and Western [26,27,28,29,30] patterns. This means that children and adolescents with ADHD prefer superfluous food with greater palatability and lower nutritional quality. They have a higher intake of unhealthy high-sugar and high-fat food, and a lower intake of fruits, vegetables, wholegrain cereals, and quality protein foods. This diet may contribute to the obesity risk found in samples of children with ADHD. A relationship was also found between obesity and ADHD, with obesity in children regarded as when the body mass index (BMI) is above the 95th percentile for age and sex [31,32], and in adults when the BMI is equal or greater than 30 kg/m^2 [33]. In Spain, two studies specifically explored the association between ADHD diagnosis and the Mediterranean diet, a healthy dietary pattern that includes great diversity and high frequency of fiber-rich food such as fruits and vegetables, healthy fatty acids, proteins, and cereals of high nutritional quality [34,35]. They found lower adherence to the Mediterranean diet in children and adolescents with ADHD than that in controls, and less healthy habits in the eating process. However, these and other studies either do not provide data in terms of age periods or subtypes of ADHD presentation (inattentive, hyperactive–impulsive (H–I), or combined), or the sample size was not large enough. In addition, they did not consider factors that may influence the diet, such as socioeconomic level [36], psychological comorbid (internalizing) problems with ADHD [37,38], sex differences [6], pharmacological treatment [39], intelligence quotient [40], and ASD comorbidity [38].

Magnesium

1. Deficiency Risk
2. Food Sources
3. Dietary Assessment
4. Nutrient Status Testing
5. Repletion Strategies

Magnesium ADHD

- People with ADHD **have lower serum levels of magnesium** compared to controls

Meta-Analysis > Psychiatry Res. 2019 Apr;274:228-234. doi: 10.1016/j.psychres.2019.02.043. Epub 2019 Feb 19.

Magnesium status and attention deficit hyperactivity disorder (ADHD): A meta-analysis

Mohammad Effatpanah[1], Mahdi Rezaei[1], Hosein Effatpanah[2], Zeynab Effatpanah[3], Hamed Kord Varkaneh[4], Seyed Mohammad Mousavi[5], Somaye Fatahi[6], Giulia Rinaldi[7], Rezvan Hashemi[8]

Affiliations + expand

PMID: 30807974 DOI: 10.1016/j.psychres.2019.02.043

Abstract

Current research suggests conflicting evidence surrounding the association between serum magnesium levels and the diagnosis of attention deficit hyperactivity disorder (ADHD). This systematic review and meta-analysis aims to explore, summarize and quantify the published literature addressing this topic. We conducted an exhaustive literature search on Scopus and PubMed for all the relevant observational studies published up to August 2018. A meta-analysis using a random-effects model was used to summarize the overall association between serum magnesium level and ADHD from the available data. We identified seven studies which reported the mean and standard deviation (SD) of magnesium concentration in both ADHD and control groups. The random-effects meta-analysis showed that subjects with ADHD had 0.105 mmol/l (95% CI: -0.188, -0.022; $P < 0.013$) lower serum magnesium levels compared with to their healthy controls. Moreover, we observed striking and statistically significant heterogeneity among the included studies ($I^2 = 96.2\%$, $P = 0.0103$). The evidence from this meta-analysis supports the theory that an inverse relationship between serum magnesium deficiency and ADHD exists. High heterogeneity amongst the included studies suggests that there is a residual need for observational and community-based studies to further investigate this issue.

RDI for Magnesium

Table 1: Recommended Dietary Allowances (RDAs) for Magnesium [1]

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months	30 mg*	30 mg*		
7–12 months	75 mg*	75 mg*		
1–3 years	80 mg	80 mg		
4–8 years	130 mg	130 mg		
9–13 years	240 mg	240 mg		
14–18 years	410 mg	360 mg	400 mg	360 mg
19–30 years	400 mg	310 mg	350 mg	310 mg
31–50 years	420 mg	320 mg	360 mg	320 mg
51+ years	420 mg	320 mg		

*Adequate Intake (AI)

Sources of Magnesium

Table 2: Magnesium Content of Selected Foods [10]

Food	Milligrams (mg) per serving	Percent DV*
Pumpkin seeds, roasted, 1 ounce	156	37
Chia seeds, 1 ounce	111	26
Almonds, dry roasted, 1 ounce	80	19
Spinach, boiled, ½ cup	78	19
Cashews, dry roasted, 1 ounce	74	18
Peanuts, oil roasted, ¼ cup	63	15
Cereal, shredded wheat, 2 large biscuits	61	15
Soymilk, plain or vanilla, 1 cup	61	15
Black beans, cooked, ½ cup	60	14
Edamame, shelled, cooked, ½ cup	50	12
Peanut butter, smooth, 2 tablespoons	49	12
Potato, baked with skin, 3.5 ounces	43	10
Rice, brown, cooked, ½ cup	42	10
Yogurt, plain, low fat, 8 ounces	42	10
Breakfast cereals, fortified with 10% of the DV for magnesium, 1 serving	42	10
Oatmeal, instant, 1 packet	36	9
Kidney beans, canned, ½ cup	35	8
Banana, 1 medium	32	8
Salmon, Atlantic, farmed, cooked, 3 ounces	26	6
Milk, 1 cup	24–27	6

Magnesium Works!

- Magnesium supplementation **improved** relative to **cognitive functions in those with ADHD**

Egyptian Journal of Medical Human Genetics

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Home / Archives / Vol. 17 No. 1 (2016) / Articles

Magnesium supplementation in children with attention deficit hyperactivity disorder

Abstract

Background: Attention deficit hyperactivity disorder (ADHD) is a common neurodevelopmental
disorder with associated mineral deficiency.
Aim: To assess magnesium level in ADHD children and compare it to the normal levels in children. Then, to detect the effect of magnesium supplementation as an add on therapy, on magnesium deficient patients.
Methods: The study was conducted on 25 patients with ADHD and 25 controls. All subjects had magnesium estimation in serum and hair. ADHD children were further assessed by Wechsler intelligence scale for children, Conners' parent rating scale, and Wisconsin card sorting test. Then magnesium deficient patients were assigned into 2 groups, those who received magnesium, and those who did not. The difference between the studied groups was assessed by Conners' parents rating scale and Wisconsin card sorting test.
Results: Magnesium deficiency was found in 18 (72%) of ADHD children. The magnesium supplemented group improved as regards cognitive functions as measured by the Wisconsin card sorting test and Conners' rating scale. The patients reported minor side effects from magnesium supplementation.
Conclusion: Magnesium supplementation in ADHD, proves its value and safety.

Magnesium Works!

- 8 weeks of supplementation with Magnesium & Vitamin D **reduced conduct problems, social problems, and anxiety in those with ADHD**

Int J Prev Med. 2020; 11: 4.
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PMID: 32089804

Effect of Vitamin D and Magnesium Supplementation on Behavior Problems in Children with Attention-Deficit Hyperactivity Disorder

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▸ Author information ▸ Article notes ▸ Copyright and License information Disclaimer

Abstract

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Background:

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by the three main symptom domains including inattention, hyperactivity, and impulsivity. Recent findings suggested that nutrients might play an important role in the pathology of ADHD. The present study aimed to examine the effects of Vitamin D and magnesium supplementation on behavior problems in children with ADHD.

Methods:

This double-blind, randomized controlled clinical trial study was conducted on 66 children with ADHD in Clinic of Noor and Ali Asghar Hospital in Isfahan, Iran, in 2016. Children were randomly allocated to receive both Vitamin D (50,000 IU/week) and magnesium (6 mg/kg/day) supplements (n = 33) or placebos (n = 33) for 8 weeks. Conners' Parent Rating Scale was used to evaluate children's behavior at baseline and at the end of the study.

Results:

After 8 weeks of Vitamin D consumption as well as magnesium, the serum levels of 25-hydroxy-Vitamin D3 and magnesium increased significantly in the intervention group compared with placebo group. Supplementation with Vitamin D and magnesium caused a significant decrease in conduct problems, social problems, and anxiety/shy scores; but it had no significant effect on psychosomatic problems score.

How do you test for

Magnesium

Serum magnesium

RBC Magnesium

Others (next slide)

An adult body contains approximately 25 g magnesium, with 50% to 60% present in the bones and most of the rest in soft tissues [4]. Less than 1% of total magnesium is in blood serum, and these levels are kept under tight control. Normal serum magnesium concentrations range between 0.75 and 0.95 millimoles (mmol)/L [1,5]. Hypomagnesemia is defined as a serum magnesium level less than 0.75 mmol/L [6]. Magnesium homeostasis is largely controlled by the kidney, which typically excretes about 120 mg magnesium into the urine each day [2]. Urinary excretion is reduced when magnesium status is low [1].

Assessing magnesium status is difficult because most magnesium is inside cells or in bone [3]. The most commonly used and readily available method for assessing magnesium status is measurement of serum magnesium concentration, even though serum levels have little correlation with total body magnesium levels or concentrations in specific tissues [6]. Other methods for assessing magnesium status include measuring magnesium concentrations in erythrocytes, saliva, and urine; measuring ionized magnesium concentrations in blood, plasma, or serum; and conducting a magnesium-loading (or "tolerance") test. No single method is considered satisfactory [7]. Some experts [4] but not others [3] consider the tolerance test (in which urinary magnesium is measured after parenteral infusion of a dose of magnesium) to be the best method to assess magnesium status in adults. To comprehensively evaluate magnesium status, both laboratory tests and a clinical assessment might be required [6].

Compare Lab Tests

Magnesium	RBC Magnesium	Magnesium, 24 Hour Urine
Access Medical Laboratories	BostonHeart Diagnostics	Access Medical Laboratories
Start Order – $1.50	Start Order – $6.00	Start Order – $8.00

LAB TEST INFORMATION

PRICE		
~~$3.50~~ $1.50	$6.00	~~$10.00~~ $8.00
ADDITIONAL FEES		
$15 shipping fee	--	$15 shipping fee
SAMPLE TYPE		
SERUM	RED BLOOD CELLS	URINE
PHLEBOTOMY		
Pricing varies, paid directly to the phlebotomist	Pricing varies, paid directly to the phlebotomist	--
SAMPLE REPORT		
--	View Report ↗	--
METHODS USED FOR PROCESSING		
Spectrophotometry	--	Calculation

PATIENT EXPERIENCE

COLLECTION INSTRUCTIONS		
View Instructions ↗	View Instructions ↗	View Instructions ↗
SHIPPING TIME		
1 - 6 days, UPS	1 - 7 days, FedEx	1 - 6 days, UPS
SHIPMENT TRACKING		
Provides Tracking Number	Provides Tracking Number	Provides Tracking Number
TURNAROUND TIME		
2 days	14 days	6 days
TEST PREPARATION STARTS		
No Test Prep is Required	No Test Prep is Required	No Test Prep is Required
NUMBER OF COLLECTION DAYS		
1 day	1 day	1 day

LAB COMPANY INFORMATION

LAB COMPANY		
Access Medical Laboratories	BostonHeart Diagnostics	Access Medical Laboratories
ABOUT LAB		
About Access Medical Labs ↗	About BostonHeart ↗	About Access Medical Labs ↗
CERTIFICATIONS		
CAP Certified, CLIA Certified	CAP Certified, CLIA Certified	CAP Certified, CLIA Certified

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%

Table 2: Magnesium Content of Selected Foods [10]

Food	Milligrams (mg) per serving	Percent DV*
Pumpkin seeds, roasted, 1 ounce	156	37
Chia seeds, 1 ounce	111	26
Almonds, dry roasted, 1 ounce	80	19
Spinach, boiled, ½ cup	78	19
Cashews, dry roasted, 1 ounce	74	18
Peanuts, oil roasted, ¼ cup	63	15
Cereal, shredded wheat, 2 large biscuits	61	15
Soymilk, plain or vanilla, 1 cup	61	15
Black beans, cooked, ½ cup	60	14
Edamame, shelled, cooked, ½ cup	50	12
Peanut butter, smooth, 2 tablespoons	49	12
Potato, baked with skin, 3.5 ounces	43	10
Rice, brown, cooked, ½ cup	42	10
Yogurt, plain, low fat, 8 ounces	42	10
Breakfast cereals, fortified with 10% of the DV for magnesium, 1 serving	42	10
Oatmeal, instant, 1 packet	36	9
Kidney beans, canned, ½ cup	35	8
Banana, 1 medium	32	8
Salmon, Atlantic, farmed, cooked, 3 ounces	26	6
Milk, 1 cup	24–27	6

Zinc

1. Deficiency Risk
2. Food Sources
3. Dietary Assessment
4. Nutrient Status Testing
5. Repletion Strategies

Zinc Deficiency

- Zinc is an essential mineral that plays a critical role in **brain health** and development.
- Zinc is involved in regulating neurotransmitters and is implicated in affecting learning, memory, emotion, and mood.

Biofactors. Author manuscript; available in PMC 2013 Aug 30.
Published in final edited form as:
Biofactors. 2012 May-Jun; 38(3): 186–193.
Published online 2012 Mar 31. doi: 10.1002/biof.1012

PMCID: PMC3757551
NIHMSID: NIHMS424122
PMID: 22473811

Zinc in the central nervous system: From molecules to behavior

Shannon D. Gower-Winter[1] and Cathy W. Levenson[1,2,*]

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Abstract

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The trace metal zinc is a biofactor that plays essential roles in the central nervous system across the lifespan from early neonatal brain development through the maintenance of brain function in adults. At the molecular level, zinc regulates gene expression through transcription factor activity and is responsible for the activity of dozens of key enzymes in neuronal metabolism. At the cellular level, zinc is a modulator of synaptic activity and neuronal plasticity in both development and adulthood. Given these key roles, it is not surprising that alterations in brain zinc status have been implicated in a wide array of neurological disorders including impaired brain development, neurodegenerative disorders such as Alzheimer's disease, and mood disorders including depression. Zinc has also been implicated in neuronal damage associated with traumatic brain injury, stroke, and seizure. Understanding the mechanisms that control brain zinc homeostasis is thus critical to the development of preventive and treatment strategies for these and other neurological disorders.

Table 1: Recommended Dietary Allowances (RDAs) for Zinc [1]

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months*	2 mg	2 mg		
7–12 months	3 mg	3 mg		
1–3 years	3 mg	3 mg		
4–8 years	5 mg	5 mg		
9–13 years	8 mg	8 mg		
14–18 years	11 mg	9 mg	12 mg	13 mg
19+ years	11 mg	8 mg	11 mg	12 mg

Table 2: Zinc Content of Selected Foods [11]

Food	mg per serving	Percent DV*
Oysters, Eastern, farmed, raw, 3 ounces	32	291
Oysters, Pacific, cooked, 3 ounces	28.2	256
Beef, bottom sirloin, roasted, 3 ounces	3.8	35
Blue crab, cooked, 3 ounces	3.2	29
Breakfast cereals, fortified with 25% of the DV for zinc, 1 serving	2.8	25
Cereals, oats, regular and quick, unenriched, cooked with water, 1 cup	2.3	21
Pumpkin seeds, roasted, 1 ounce	2.2	20
Pork, center loin (chops), bone-in, broiled, 3 ounces	1.9	17
Turkey breast, meat only, roasted, 3 ounces	1.5	14
Cheese, cheddar, 1.5 ounces	1.5	14
Shrimp, cooked, 3 ounces	1.4	13
Lentils, boiled, ½ cup	1.3	12
Sardines, canned in oil, drained solids with bone, 3 ounces	1.1	10
Greek yogurt, plain, 6 ounces	1.0	9
Milk, 1% milkfat, 1 cup	1.0	9
Peanuts, dry roasted, 1 ounce	0.8	7
Rice, brown, long-grain, cooked, ½ cup	0.7	6
Egg, large, 1 egg	0.6	5
Kidney beans, canned, ½ cup	0.6	5
Bread, whole-wheat, 1 slice	0.6	5
Fish, salmon, cooked, 3 ounces	0.5	5

Zinc Works!

- Zinc supplementation can reduce the need for ADHD medication in children who take it before initiating pharmacotherapy

Child Adolesc Psychiatr Clin N Am. Author manuscript; available in PMC 2015 Oct 1. PMCID: PMC4170184
Published in final edited form as: NIHMSID: NIHMS622217
Child Adolesc Psychiatr Clin N Am. 2014 Oct; 23(4): 883–897. PMID: 25220092
Published online 2014 Aug 12. doi: 10.1016/j.chc.2014.05.002

Nutritional Supplements for the Treatment of Attention-Deficit Hyperactivity Disorder

Dr. Michael H. Bloch, MD, MS and Ms. Jilian Mulqueen, BA

Randomized, placebo-controlled trials of zinc supplementation either as an adjunct to psychostimulant treatment or as monotherapy have provided conflicting evidence of efficacy. These discrepant results are likely related to differences in underlying study quality and prevalence of zinc deficiency in the study populations.[15] A completers analysis of 193 (out of 400 randomized) Turkish children with ADHD demonstrated a significant benefit of 150mg of zinc sulfate per day compared to placebo after 12 weeks of treatment.[47] However, these positive results need to be treated with an abundance of caution given the high-drop rate and the non-intention to treat analysis. A small, randomized placebo-controlled trial of Zinc sulfate 55mg/day demonstrated that zinc augmentation of methylphenidate (1mg/day) was more effective than placebo augmentation in 44 Iran children with ADHD after 6 weeks.[48] A more recent randomized, placebo-controlled trial examined the addition of zinc sulfate 10mg/day (compared to placebo) as an adjunct to methylphenidate (0.3mg/kg/d) in 40 Chilean children with ADHD.[49] This trial demonstrated no significant differences between zinc supplementation and placebo on attentional measures but did demonstrate a trend towards greater improvement with zinc supplementation on Connor's attentional measures that did not reach statistical significance. Zinc plasma levels were normal in the sample at baseline and decreased throughout the trial in both the placebo and zinc supplementation groups. A randomized, placebo-controlled trial examining the efficacy of zinc glycinate (15–30mg/day) monotherapy over 8 weeks in 52 American children with ADHD[50] failed to demonstrate any benefit of zinc supplementation over the 8 weeks of treatment on any ADHD rating scales. Additionally, measures of zinc were not appreciably affected by supplementation. However, when children were given d-amphetamine over the next 5 weeks of the trial lower doses of d-amphetamine (37% reduction compared to placebo) were needed to achieve the same clinical effects in the zinc supplementation group.

The processes that maintain zinc homeostasis are absorption of zinc from the diet, excretion into the gastrointestinal tract, and reabsorption in the gastrointestinal lumen [2,3]. In general, as zinc intakes rise, the amount of zinc absorbed also increases, but its fractional absorption drops [2,3].

Serum or plasma zinc levels are typically used in clinical practice to assess zinc status. In healthy people, the amount of zinc in serum or plasma is 80 to 120 mcg/dL (12 to 18 mcmol/L) [2]. Serum zinc levels below 70 mcg/dL in women and 74 mcg/dL in men indicate inadequate zinc status. However, both serum and plasma measures have important limitations. Zinc concentrations in serum are associated with the patient's sex and age as well as the time of the blood draw (morning vs. evening) and do not always correlate with dietary or supplemental zinc intakes [6]. Zinc levels also fluctuate in response to other factors, including infections, changes in steroid hormones, and muscle catabolism during weight loss or illness [1,3]. Clinicians consider risk factors (such as inadequate caloric intake, chronic alcohol use, and malabsorptive digestive diseases) and signs of zinc deficiency (such as impaired growth in infants and children) when they assess a patient's zinc status [1].

Compare Lab Tests

Copy Link to Comparison

Zinc	Zinc	Zinc RBC	Kryptopyrrole Quant.	
Vibrant America	DHA Laboratory	Access Medical Laboratories	DHA Laboratory	+ Add Test to Comparison
Start Order – $3.37	Start Order – $45.00	Start Order – $26.00	Start Order – $119.00	

LAB TEST INFORMATION

PRICE			
$3.37	~~$49.00~~ $45.00	~~$34.50~~ $26.00	~~$131.00~~ $119.00
ADDITIONAL FEES			
Small order fee (up to $99) for orders under $200	--	$15 shipping fee	--
SAMPLE TYPE			
SERUM	PLASMA	RED BLOOD CELLS	URINE
PHLEBOTOMY			
Pricing varies, paid directly to the phlebotomist	Pricing varies, paid directly to the phlebotomist	Pricing varies, paid directly to the phlebotomist	--
SAMPLE REPORT			
View Report ↗	View Report ↗	--	View Report ↗
METHODS USED FOR PROCESSING			
LC-MS	ICP-MS	ICP-MS	--

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%
Methionine	1.3 g	231%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%
Zinc	11.8 mg	147%

Copper

1. Cu/Zn Ratio in ADHD
2. Food Sources
3. Dietary Assessment
4. Nutrient Status Testing

Molecules. 2020 Oct; 25(19): 4440. PMCID: PMC7583976
Published online 2020 Sep 27. doi: 10.3390/molecules25194440 PMID: 32992575

Magnesium, Iron, Zinc, Copper and Selenium Status in Attention-Deficit/Hyperactivity Disorder (ADHD)

5. Copper (Cu)

Go to: ▸

Copper is involved in catecholamine metabolism via beta-hydroxylase and monoaminoxidase (MAO). Higher copper concentrations lead to lower dopamine levels in rats [144]. In children, no correlation could be observed between whole blood Cu concentration levels and ADHD scores [101], nor was serum or plasma copper concentration different from that of normal controls [32,54,145]. In one publication a statistically insignificant higher ($p > 0.05$) copper blood level, compared to this in the with ADHD was associated with a decreased serum Cu/Zn SOD (superoxide dismutase)-level [146]. Lower levels of copper, as found in an older publication [104], were confirmed by the group of Rucklidge [140,141]. However, the lower baseline Cu concentrations seem to have limited value for the identification of responders to treatment with a vitamin-mineral supplement, which was also demonstrated for a similar supplementation study on adults with ADHD [147]. The Cu/Zn ratio may be more important than the elemental concentrations separately, as Skalny and coworkers proved recently [127]. They claimed that an elevated Cu/Zn ratio may significantly contribute to the risk of ADHD or its severity and/or comorbidity. One publication mentioned a 19% reduction in the values of copper in hair of ADHD patients, compared to controls [48]. Analysis of food intake and nutrient status in children with ADHD shows lower Cu levels in children with a predisposition for ADHD [50]. No relation was observed between copper exposure during pregnancy and ADHD symptomatology at the age of 4 years [148]. As a consequence of these contradictory findings Cu supplementation studies have not been carried out or could not be found.

> J Trace Elem Med Biol. 2020 Mar;58:126445. doi: 10.1016/j.jtemb.2019.126445.
Epub 2019 Dec 6.

Serum zinc, copper, zinc-to-copper ratio, and other essential elements and minerals in children with attention deficit/hyperactivity disorder (ADHD)

Results: Serum Cr, Mg, and Zn levels in children with ADHD were 21 % (p = 0.010), 4 % (p = 0.005), and 7 % (p = 0. 001) lower as compared to the healthy controls, respectively. In turn, serum Cu/Zn values were 11 % higher than those in the control group. Age and gender had a significant impact on serum element levels in ADHD. Particularly, preschool children were characterized by significantly increased Cu (+8 %; p = 0.034), and Cu/Zn (+19 %; p < 0.001) values, whereas serum Zn (-9 %; p = 0.004) level was decreased. In primary school-aged children only 6 % (p = 0.007) lower Mg levels were observed. Both boys and girls with ADHD were characterized by 8 % (p = 0.016) lower serum Zn levels and 10 % (p = 0.049) higher Cu/Zn values when compared to neurotypical girls. Boys with ADHD also had significantly higher Cu/Zn, exceeding the respective control values by 12 % (p = 0.021), predominantly due to a 7 % (p = 0.035) decrease in serum Zn. Serum Mg levels were also found to be significantly lower than those in neurotypical children by 5 % (p = 0.007). In adjusted regression models serum Cr (β=-0.234; p = 0.009) and Cu/Zn (β = 0.245; p = 0.029) values were significantly associated with ADHD, respectively. Two-way ANOVA revealed a significant impact of ADHD on Cr, Mg, Zn, and Cu/Zn, whereas age was associated with Cu, I, Mg, Mo, and Cu/Zn, whereas gender accounted only for variability in serum Mn levels. Principal component analysis (PCA) also revealed significant contributions of Mg, Zn, and Cu/Zn values to ADHD variability.

Table 1: Recommended Dietary Allowances (RDAs) for Copper [3]

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months*	200 mcg	200 mcg		
7–12 months*	220 mcg	220 mcg		
1–3 years	340 mcg	340 mcg		
4–8 years	440 mcg	440 mcg		
9–13 years	700 mcg	700 mcg		
14–18 years	890 mcg	890 mcg	1,000 mcg	1,300 mcg
19+ years	900 mcg	900 mcg	1,000 mcg	1,300 mcg

Table 2: Copper Content of Selected Foods [12]

Food	Micrograms (mcg) per serving	Percent DV*
Beef, liver, pan fried (3 ounces)	12,400	1,378
Oysters, eastern, wild, cooked, 3 ounces	4,850	539
Baking chocolate, unsweetened, 1 ounce	938	104
Potatoes, cooked, flesh and skin, 1 medium potato	675	75
Mushrooms, shiitake, cooked, cut pieces, ½ cup	650	72
Cashew nuts, dry roasted, 1 ounce	629	70
Crab, Dungeness, cooked, 3 ounces	624	69
Sunflower seed kernels, toasted, ¼ cup	615	68
Turkey, giblets, simmered, 3 ounces	588	65
Chocolate, dark, 70%-85% cacao solids, 1 ounce	501	56
Tofu, raw, firm, ½ cup	476	53
Chickpeas, mature sees, ½ cup	289	32
Millet, cooked, 1 cup	280	31
Salmon, Atlantic, wild, cooked, 3 ounces	273	30

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%
Methionine	1.3 g	231%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%
Zinc	11.8 mg	147%

Iron

1. Deficiency Risk
2. Food Sources
3. Dietary Assessment
4. Nutrient Status Testing
5. Repletion Strategies

Zinc & Iron Deficiency

- Zinc and Iron are involved in regulating neurotransmitters and is implicated in affecting learning, memory, emotion, and mood.
- There is an association between **zinc and iron deficiency and ADHD in children.**

> Nutrients. 2021 Nov 13;13(11):4059. doi: 10.3390/nu13114059.

The Role of Iron and Zinc in the Treatment of ADHD among Children and Adolescents: A Systematic Review of Randomized Clinical Trials

Roser Granero [1 2 3], Alfred Pardo-Garrido [1], Ivonne Lorena Carpio-Toro [4 5], Andrés Alexis Ramírez-Coronel [4 6], Pedro Carlos Martínez-Suárez [4 6], Geovanny Genaro Reivan-Ortiz [3 4]

Affiliations + expand

PMID: 34836314 PMCID: PMC8618748 DOI: 10.3390/nu13114059

Free PMC article

Abstract

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder common from childhood to adulthood, affecting 5% to 12% among the general population in developed countries. Potential etiological factors have been identified, including genetic causes, environmental elements and epigenetic components. Nutrition is currently considered an influencing factor, and several studies have explored the contribution of restriction and dietary supplements in ADHD treatments. Iron is an essential cofactor required for a number of functions, such as transport of oxygen, immune function, cellular respiration, neurotransmitter metabolism (dopamine production), and DNA synthesis. Zinc is also an essential trace element, required for cellular functions related to the metabolism of neurotransmitters, melatonin, and prostaglandins. Epidemiological studies have found that iron and zinc deficiencies are common nutritional deficits worldwide, with important roles on neurologic functions (poor memory, inattentiveness, and impulsiveness), finicky appetite, and mood changes (sadness and irritability). Altered levels of iron and zinc have been related with the aggravation and progression of ADHD.

Low Iron

Plays a key role in neurotransmitter production

- **Iron deficiency has been linked to ADHD in children.**
- Ferritin (a protein that stores iron) levels are almost 50% lower in children with ADHD than in controls.

Review > J Mol Neurosci. 2019 May;68(1):1-10. doi: 10.1007/s12031-019-01276-1. Epub 2019 Feb 18.

Iron Deficiency, Cognitive Functions, and Neurobehavioral Disorders in Children

Lyudmila Pivina [1, 2], Yuliya Semenova [1, 2], Monica Daniela Doşa [3], Marzhan Dauletyarova [4], Geir Bjørklund [5]

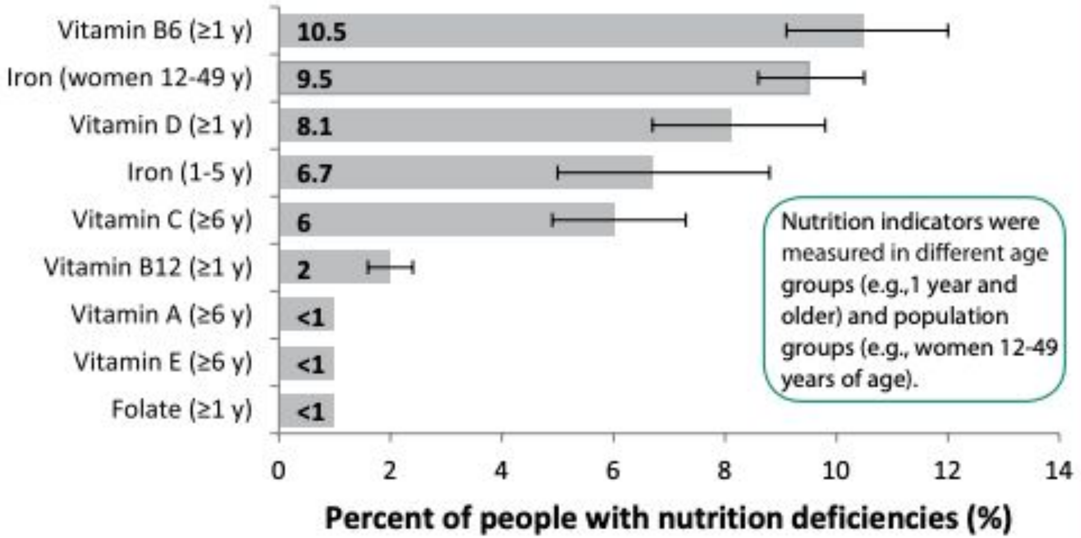
Affiliations + expand

PMID: 30778834 DOI: 10.1007/s12031-019-01276-1

Abstract

More than 25% of the world's population is affected by anemia, of which more than 50% suffers from iron deficiency anemia (IDA). Children below 7 years of age are the population group that is most vulnerable to iron deficiency. Iron is an essential element in brain metabolism. Iron deficiency can cause changes in neurotransmitter homeostasis, decrease myelin production, impair synaptogenesis, and decline the function of the basal ganglia. Therefore, IDA adversely affects cognitive functions and psychomotor development. Research has shown that iron deficiency is a frequent comorbidity in attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder. Iron deficiency may also induce or exacerbate deficiency of other essential nutrients, which may have a negative impact on the developing brain and other organs in infants. Many nations of the world have programs to control IDA based on the use of iron supplementation, intake of fortified food and drinks, improved food safety, and monitoring of dietary diversity. Based on the current recommendations of the World Health Organization on cost-effectiveness (WHO-CHOICE), iron fortification and iron supplementation programs can be considered cost-effective or even highly cost-effective in most countries of the world to averting cognitive impairment.

Nutrition deficiencies in the U.S. population



The graph shows prevalence estimates of nutrition deficiencies among people who live in the U.S. (NHANES 2003-2006). Of all the nutrients listed, the most people had vitamin B6, iron, and vitamin D deficiencies, and the fewest people had vitamin A, vitamin E, and folate deficiencies.

Table 1: Recommended Dietary Allowances (RDAs) for Iron [5]

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months	0.27 mg*	0.27 mg*		
7–12 months	11 mg	11 mg		
1–3 years	7 mg	7 mg		
4–8 years	10 mg	10 mg		
9–13 years	8 mg	8 mg		
14–18 years	11 mg	15 mg	27 mg	10 mg
19–50 years	8 mg	18 mg	27 mg	9 mg
51+ years	8 mg	8 mg		

Table 2: Iron Content of Selected Foods [25]

Food	Milligrams per serving	Percent DV*
Breakfast cereals, fortified with 100% of the DV for iron, 1 serving	18	100
Oysters, eastern, cooked with moist heat, 3 ounces	8	44
White beans, canned, 1 cup	8	44
Beef liver, pan fried, 3 ounces	5	28
Lentils, boiled and drained, ½ cup	3	17
Spinach, boiled and drained, ½ cup	3	17
Tofu, firm, ½ cup	3	17
Chocolate, dark, 45%–69% cacao solids, 1 ounce	2	11
Kidney beans, canned, ½ cup	2	11
Sardines, Atlantic, canned in oil, drained solids with bone, 3 ounces	2	11
Chickpeas, boiled and drained, ½ cup	2	11
Tomatoes, canned, stewed, ½ cup	2	11
Beef, braised bottom round, trimmed to 1/8" fat, 3 ounces	2	11
Potato, baked, flesh and skin, 1 medium potato	2	11
Cashew nuts, oil roasted, 1 ounce (18 nuts)	2	11
Green peas, boiled, ½ cup	1	6
Chicken, roasted, meat and skin, 3 ounces	1	6
Rice, white, long grain, enriched, parboiled, drained, ½ cup	1	6
Bread, whole wheat, 1 slice	1	6
Bread, white, 1 slice	1	6
Raisins, seedless, ¼ cup	1	6
Spaghetti, whole wheat, cooked, 1 cup	1	6

Iron Works!

iron supplementation plus methylphenidate improved scores of inattentiveness, hyperactivity, and impulsivity

Nutrients. 2021 Nov; 13(11): 4059.
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PMCID: PMC8618748
PMID: 34836314

The Role of Iron and Zinc in the Treatment of ADHD among Children and Adolescents: A Systematic Review of Randomized Clinical Trials

Roser Granero,[1,2,3,*] Alfred Pardo-Garrido,[1] Ivonne Lorena Carpio-Toro,[4,5] Andrés Alexis Ramírez-Coronel,[4,6] Pedro Carlos Martínez-Suárez,[4,6] and Geovanny Genaro Reivan-Ortiz[3,4]

The study by Konofal and colleagues aimed to examine the contribution of iron supplementation (ferrous sulfate, 80 mg/day) in a sample of $n = 23$ children who met the criteria for ADHD, which showed that the experimental group reported more improvement than the control group in different treatment outcomes [74]: ADHD symptom levels reported by patients, parents, and teachers (particularly marked for the inattention factor), and also the presence of restless leg syndrome. The authors did not find a correlation between the baseline levels of serum ferritin levels with endpoint ADHD measures, suggesting that children with the lowest pre-treatment ferritin values did not benefit more from iron supplementation therapy than other children. In their conclusions, these authors suggested that the effectiveness of ferrous sulfate could be associated with the ADHD pathophysiology, that the benefits of restless leg syndrome could be the consequence of the improvement in the ADHD motor activity in the evening, and that iron could enhance the action of pharmacological treatment with methylphenidate and amphetamine.

The study of Panahandeh et al. in a sample of $n = 42$ children with ADHD also obtained benefits for the use of ferrous sulfate (5 mg/kg/day) plus methylphenidate (1 mg/kg/day), in the inattentiveness, hyperactivity, and impulsive symptom levels reported by parents at 2 months of treatment [75]. In the conclusions section, these authors supported the hypothesis that the contribution of iron supplementation on the ADHD improvements could be explained by the capacity of this element in the dopamine transporter density and activity, which is consistent with other studies that observed decreased thalamic iron levels in children with ADHD compared to controls [77,78].

Molecules. 2020 Oct; 25(19): 4440. PMCID: PMC7583976
Published online 2020 Sep 27. doi: 10.3390/molecules25194440 PMID: 32992575

Magnesium, Iron, Zinc, Copper and Selenium Status in Attention-Deficit/Hyperactivity Disorder (ADHD)

Harry Robberecht,* Annelies A. J. Verlaet, Annelies Breynaert, Tess De Bruyne, and Nina Hermans

3.1.2. Hair and Urine Iron Levels Iron levels in hair [30,102] and in urine [30] were found to be lower in patients compared to healthy controls.

3.1.3. Brain Levels Low thalamic iron level may play a role in the pathophysiology of ADHD. Three studies could be found on brain-iron levels in ADHD by using magnetic resonance imaging (MRI). In one of these studies Cortese et al. [85] found that thalamic iron levels in an ADHD group was significantly lower than the healthy controls. There was no significant correlation observed between the brain-iron levels and the level of ferritin in serum. Two other studies [103,104] compared brain-iron indices of medication-naïve ADHD patients with these of psychostimulant-treated ADHD patients and completely healthy controls. Iron analysis in the striatal and thalamic region of the medication-naïve ADHD patients revealed significantly lower levels than those in the other groups. Brain iron seems not only to be a noninvasive diagnostic biomarker that responds to treatment [103], it also seems that brain-iron levels in ADHD normalize as a function of treatment duration [104].

3.1.4. Daily Intake Most publications mention lower intake of Fe in ADHD children [55,56,105]. The treatment with methylphenidate may result in reduced appetite, and hence a lower intake of nearly all food components [55,56]. However, it was quite remarkable that the intake of overweight ADHD children was significantly lower compared to the normal weight ADHD group [106]. Authors do not offer any explanation for this observation. Only one older publication mentioned higher Fe intake in Taiwanese ADHD children, resulting in high blood-iron levels [107].

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%
Methionine	1.3 g	231%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%
Zinc	11.8 mg	147%

Review > Korean J Pediatr. 2014 Aug;57(8):345-50. doi: 10.3345/kjp.2014.57.8.345.
Epub 2014 Aug 25.

Iron deficiency increases blood concentrations of neurotoxic metals in children

Yangho Kim [1], Sangkyu Park [2]

Affiliations + expand

PMID: 25210521 PMCID: PMC4155178 DOI: 10.3345/kjp.2014.57.8.345

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Full text links

Cite

Abstract

Iron deficiency affects approximately one-third of the world's population, occurring most frequently in children aged 6 months to 3 years. Mechanisms of iron absorption are similar to those of other divalent metals, particularly manganese, lead, and cadmium, and a diet deficient in iron can lead to excess absorption of manganese, lead, and cadmium. Iron deficiency may lead to cognitive impairments resulting from the deficiency itself or from increased metal concentrations caused by the deficiency. Iron deficiency combined with increased manganese or lead concentrations may further affect neurodevelopment. We recently showed that blood manganese and lead concentrations are elevated among iron-deficient infants. Increased blood manganese and lead levels are likely associated with prolonged breast-feeding, which is also a risk factor for iron deficiency. Thus, babies who are breast-fed for prolonged periods should be given plain, iron-fortified cereals or other good sources of dietary iron.

Lead Exposure

Environmental exposure to toxins such as heavy metals like lead and mercury **have been linked to an increased risk of ADHD**

The Role of Lead Exposure on Attention-Deficit/Hyperactivity Disorder in Children: A Systematic Review

Maryam Daneshparvar [1], Seyed-Ali Mostafavi [2], Maryam Zare Jeddi [3], Masud Yunesian [4], Alireza Mesdaghinia [3], Amir Hossein Mahvi [5], Shahin Akhondzadeh [6]

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PMID: 27252763 PMCID: PMC4888135

Free PMC article

Abstract

Objective: Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common behavioral disorders in children effecting the families and society. This systematic review examined the literature on the role of lead exposure in children with ADHD symptoms. Articles were analytically compared, focusing on the methodology used to assess exposure and adverse effects on children with ADHD.

Method: Using the search strategy from six databases (Pub Med, PsycINFO, Web of Science, SID, IRAN Medex, IRAN DOC), hand searching in key journals, list of references of selected articles and gray literature, without time and language limitation, articles up to May 2014 were entered into this review. In this review, 1,387 articles were acquired at the primary search. Study selection and quality assessment processes were done based on Cochrane library guidelines. After assessing the quality and inclusion and exclusion criteria, 18 articles were selected and entered into the data synthesis.

Results: Blood Lead level (BLL) of less than 10µg/dL in children has been attributed to at least one type of ADHD i.e., Combined / Inattentive / Hyperactive-Impulsive. The results of this study revealed that in 16 out of the 18 studies, a significant association was found between BLL and one of the types of ADHD.

Conclusion: Based on the findings of this study, even the BLL of less than the action level of 10µg/dL, chosen by Centers for Disease Control and Prevention (CDC), may affect children with ADHD..

Lead Exposure

- Important to remember that UNICEF estimated that globally ⅓ of children have blood lead level (BLL) >5. Children in SE Asia are at highest risk.
- Children have an more permeable blood brain barrier <36 months that makes them more vulnerable to neurologic consequences of lead + they crawl, have more hand-to-mouth behavior with soil and other potential sources of contamination and higher respiratory rates.
    - "...fetal brain vessels exhibit different, and in some respects increased, transport properties for amino acids and other metabolites, reflecting the higher demand for nutrients in the developing CNS (Ek et al., 2001, 2006; Johansson et al., 2006, 2008; Saunders et al., 2012)."
- Catching this early means you can change a child's entire life!

Lead Exposure in Children

- The American Academy of Pediatrics and the Centers for Disease Control and Prevention (CDC) state that **no safe or "nontoxic" blood lead level (BLL) exists.**
- Clinically levels **>3.5 mcg/dL** are reported to parents and recommended interventions.
- Children most at risk in the U.S. are
  - Children who live in urban areas in housing built before 1970s
  - Black children, children entering foster care in the U.S.
  - Refugee children entering the U.S.
  - Children who are anemic
    - “Mechanisms of iron absorption are similar to those of other divalent metals, particularly manganese, lead and cadmium. A diet deficient in iron can lead to excess absorption of manganese, lead, and cadmium.”

Elevated Blood Lead in Adults

- **Elevated BLL**: **≥5 mcg/dL** by the National Institute for Occupational Safety and Health (NIOSH)/CDC's Adult Blood Lead Epidemiology and Surveillance (ABLES) program.

- **Adult lead toxicity**: **≥10 mcg/dL**. Adult lead poisoning is defined as adult lead toxicity + symptoms.

- **Goal BLL**: **<10 mcg/dL**. US Department of Health and Human Services (HHS) recommends that BLLs among all adults be reduced to <10 mcg/dL, which is consistent with the current lower levels in the population as well as research concerning long-term effects of low level exposures [1,3,4].

B Vitamins

Are often found in high amino acid foods.

Vitamins B6, 9, 12 and their biochemical correlates are lower in children with ADHD compared to controls.

Treatment with these nutrients improves symptoms.

> Psychiatr Danub. 2018 Sep;30(3):310-316. doi: 10.24869/psyd.2018.310.

Homocysteine, Pyridoxine, Folate and Vitamin B12 Levels in Children with Attention Deficit Hyperactivity Disorder

Hatice Altun [1], Nilfer Şahin, Ergül Belge Kurutaş, Olcay Güngör

Affiliations + expand

PMID: 30267523 DOI: 10.24869/psyd.2018.310

Free article

Abstract

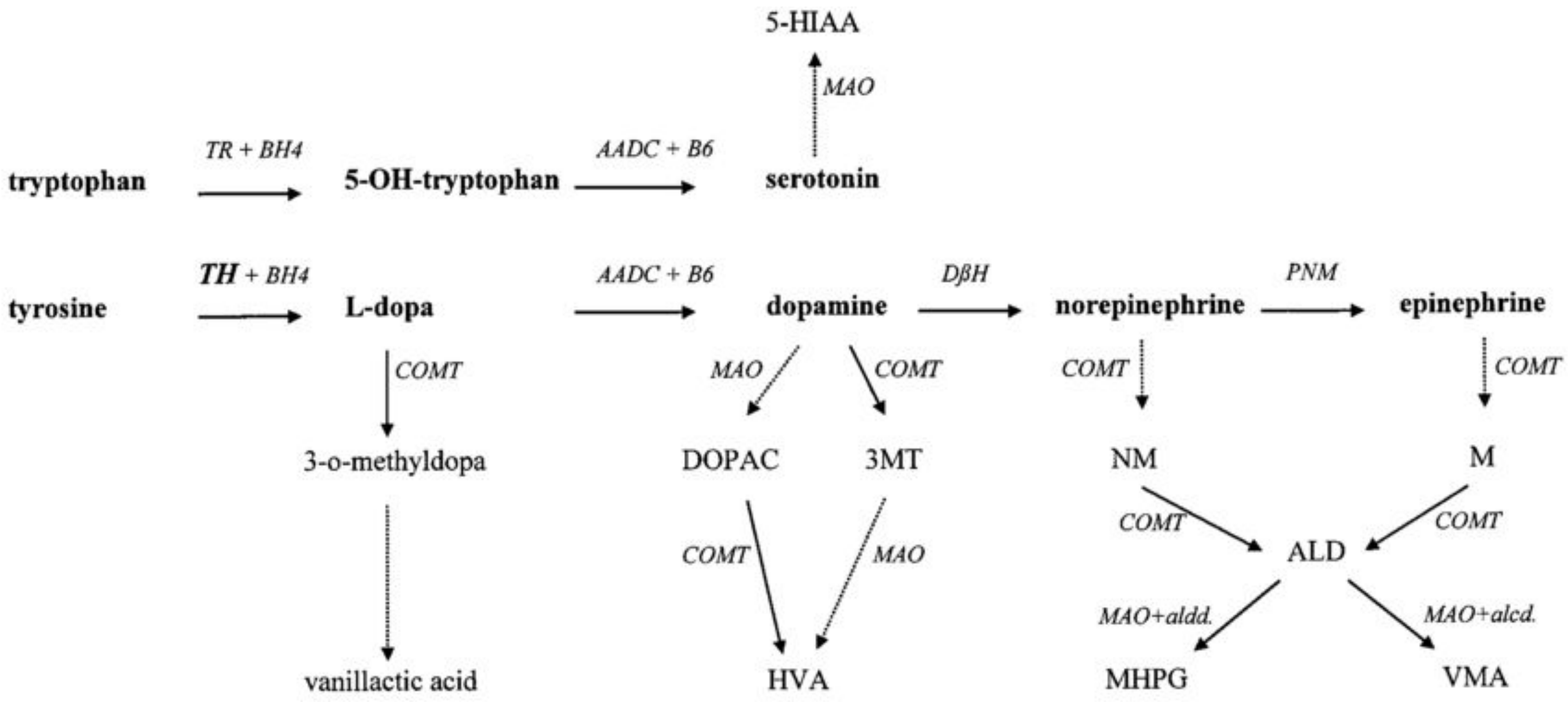
Background: In our study, we aimed to evaluate the serum homocysteine levels, pyridoxine, folate and vitamin B12 levels in children with attention deficit hyperactivity disorders (ADHD).

Subjects and methods: This study included 30 newly diagnosed drug-naive children with ADHD (23 males and 7 female, mean age 9.3±1.8 years) and 30 sex-and age matched healthy controls. The diagnosis of ADHD was made according to DSM-V criteria. Children and adolescents were administered the Schedule for Affective Disorders and Schizophrenia for School Aged Children, Present and Lifetime Version, the Conners' Parent Rating Scale-Revised, Long Form, the Conners' Teacher Rating Scale and the Wechsler Intelligence Scale for Children Revised (WISC-R) for all participants. Homocysteine, pyridoxine, folate and vitamin B12 levels were measured with enzyme-linked immunosorbent assay.

Results: Homocysteine, pyridoxine, folate and vitamin B12 levels were significantly lower in children with ADHD compared with their controls ($p<0.05$). A positive significant correlation was observed between the all WISC-R scores and vitamin B12 level in patients ($r=0.408$, $p=0.025$).

Conclusions: The results obtained in this study showed that reduced homocysteine, pyridoxine, folate and vitamin B12 levels could be a risk factor in the etiology of ADHD.

B Vitamins in ADHD Treatment



J Child Adolesc Psychopharmacol. 2015 Dec 1; 25(10): 783–798.
doi: 10.1089/cap.2015.0105

PMCID: PMC4702182
PMID: 26682999

Clinically Significant Symptom Reduction in Children with Attention-Deficit/Hyperactivity Disorder Treated with Micronutrients: An Open-Label Reversal Design Study

Heather A Gordon, PhD,[1] Julia J Rucklidge, PhD,[1] Neville M Blampied, MSc,[1] and Jeanette M Johnstone, PhD[2]

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Abstract

Go to: ▸

Objective: The purpose of this study was to investigate the clinical effect and safety of a broad spectrum, 36 ingredient micronutrient (vitamins and minerals) in treating children with attention-deficit/hyperactivity disorder (ADHD).

Methods: This open-label, on-off-on-off (reversal design) study followed 14 participants (8–12 years of age) with ADHD, diagnosed using standardized instruments, for 6 months with no dropouts. Following baseline assessment, including hematology and biochemistry screening, participants began an 8 week treatment phase with micronutrients titrated up to maximum dose (15 capsules/day). Treatment was withdrawn for 4 weeks, reinstated for a further 8 weeks, and then withdrawn for 4 weeks. Primary outcomes included the Conners' Parent Rating Scale, the Clinical Global Impressions Scale (CGI), and the Strengths and Difficulties Questionnaire – Parent version (SDQ). Secondary outcomes were mood and global functioning.

Results: Modified Brinley plots revealed a reduction in ADHD symptoms, improved mood, and improved overall functioning during intervention phases, and deterioration in ADHD symptoms, mood, and overall functioning during the withdrawal phases. Reliable change analyses, Cohen's d and percent superiority effect sizes, 95% confidence intervals and t tests confirmed clinically and statistically significant change between the intervention and withdrawal phases, with large effect sizes observed pre- to post-exposure of micronutrients ($d = 1.2–2.2$) on ADHD symptoms during intervention phases. Seventy-one percent of participants showed at least a 30% decrease in ADHD symptoms by the end of the second treatment phase, and 79% were identified as "much improved" or "very much improved" at the end of the second phase (5 months) based on the clinician-rated CGI when considering functioning generally. The SDQ showed that these benefits occurred across other areas of functioning including emotional symptoms, conduct problems, and prosocial behaviours. The children's self-reports confirmed the improvements. Excellent adherence to treatment occurred throughout, side effects were mild and transitory, and no safety issues were identified through blood analyses.

TABLE 1.

EMPOWERPLUS CAPSULE INGREDIENT LIST

	1 capsule	*4 capsules*	*8 capsules*	*15 capsules*
Vitamin A	384.0 IM	1536.0 IM	3072.0 IM	5760 IM
Vitamin C	40.0 mg	160.0 mg	320.0 mg	600 mg
Vitamin D	96.0 IM	384.0 IM	768.0 IM	1440 IM
Vitamin E	24.0 IM	96.0 IM	192.0 IM	360 IM
Vitamin B1	1.2 mg	4.8 mg	9.6 mg	18 mg
Vitamin B2	0.9 mg	3.6 mg	7.2 mg	13.5 mg
Vitamin B3	6.0 mg	24.0 mg	48.0 mg	90 mg
Vitamin B5	1.4 mg	5.8 mg	11.5 mg	21.6 mg
Vitamin B6	2.4 mg	9.6 mg	19.2 mg	36 mg
Vitamin B9	96.0 µg	384.0 µg	768.0 µg	1440 µg
Vitamin B12	60.0 µg	240.0 µg	480.0 µg	900 µg
Vitamin H	72.0 µg	288.0 µg	576.0 µg	1080 µg
Calcium	88.0 mg	352.0 mg	704.0 mg	1320 mg
Iron	0.9 mg	3.7 mg	7.3 mg	13.74 mg
Phosphorus	56.0 mg	224.0 mg	448.0 mg	840 mg
Iodine	13.6 µg	54.4 µg	108.8 µg	204 µg
Magnesium	40.0 mg	160.0 mg	320.0 mg	600 mg
Zinc	3.2 mg	12.8 mg	25.6 mg	48 mg
Selenium	13.6 µg	54.4 µg	108.8 µg	204 µg
Copper	0.5 mg	1.9 mg	3.8 mg	7.2 mg
Managnese	0.6 mg	2.6 mg	5.1 mg	9.6 mg
Chromium	41.6 µg	166.4 µg	332.8 µg	624 µg
Molybdenum	9.6 µg	38.4 µg	76.8 µg	144 µg
Potassium	16.0 mg	64.0 mg	128.0 mg	240 mg

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Plus a proprietary blend of: dl-phenylalanine, glutamine, citrus bioflavanoids, grape seed, choline bitartrate, inositol, ginkgo biloba, methionine, germanium sesquioxide, boron, nickel, and vanadium.

J Child Adolesc Psychopharmacol. 2015 Dec 1; 25(10): 783–798. PMCID: PMC4702182
doi: 10.1089/cap.2015.0105 PMID: 26682999

Clinically Significant Symptom Reduction in Children with Attention-Deficit/Hyperactivity Disorder Treated with Micronutrients: An Open-Label Reversal Design Study

Heather A Gordon, PhD,[1] Julia J Rucklidge, PhD,[1] Neville M Blampied, MSc,[1] and Jeanette M Johnstone, PhD[2]

MEASURE OF THE CHILD-RATED MYMOP AT BASELINE COMPARED WITH SECOND TREATMENT (ON 2) PHASE OF TRIAL

	Baseline		*On 2*		*Comparing baseline with On 2 phase*				
MYMOP- Child Self-Report Subscales	*Mean*	*SEM*	*Mean*	*SEM*	*MD*	*MD 95% CI*	*ES*	*ES 95% CI*	t *test*
Hyperactivity	1.75	0.32	0.71	0.29	1.04	0.14–1.93	0.92	0.08–1.24	2.5*
Impulsivity	2.18	0.37	1.07	0.27	1.11	0.34–1.88	0.92	0.21–1.43	3.11**
Inattention	2.42	0.20	1.61	0.32	0.82	0.01–1.63	0.81	0.005–1.14	2.18*
Sleep	2.00	0.39	1.14	0.33	0.86	0.15–1.57	0.63	0.10–1.27	2.60*
Low Mood	1.5	0.39	0.39	0.22	1.11	0.27–1.94	0.94	0.16–1.36	2.87**

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KH Kate Henry

Create Blood Panel

Choose multiple biomarkers, compare custom panels from our various labs, and save them as a custom blood panel for easy one-click ordering from your Favorites.

Search for individual biomarkers or common biomarker groupings (CBC, CMP, etc.)

MMA | MTHFR | Folate

Vibrant America	3 of 3 Biomarkers	$170.09 fee not included	Details	Create Panel
Access Medical Laboratories	3 of 3 Biomarkers	$194.00 fee not included	Details	Create Panel
Labcorp by AML	3 of 3 Biomarkers	$232.50 Includes fee	Details	Create Panel
BostonHeart Diagnostics	2 of 3 Biomarkers	$40.00 fee not included	Details	Create Panel

Omega 3's

1. Deficiency Risk
2. Food Sources
3. Dietary Assessment
4. Nutrient Status Testing
5. Repletion Strategies

Omega-3s

Omega-3s are important for neurological health

- including cellular membrane fluidity, function and neurotransmitter release

Lower intakes increase the risk for ADHD

Review > Nutrients. 2020 Aug 4;12(8):2333. doi: 10.3390/nu12082333.

The Importance of Marine Omega-3s for Brain Development and the Prevention and Treatment of Behavior, Mood, and Other Brain Disorders

James J DiNicolantonio [1], James H O'Keefe [1]

Affiliations + expand

PMID: 32759851 PMCID: PMC7468918 DOI: 10.3390/nu12082333

Free PMC article

Abstract

Most of the global population is deficient in long-chain marine omega-3s. In particular, docosahexaenoic acid (DHA), a long-chain omega-3 fatty acid, is important for brain and eye development. Additionally, DHA plays a significant role in mental health throughout early childhood and even into adulthood. In the brain, DHA is important for cellular membrane fluidity, function and neurotransmitter release. Evidence indicates that a low intake of marine omega-3s increases the risk for numerous mental health issues, including Attention Deficit Hyperactivity Disorder (ADHD), autism, bipolar disorder, depression and suicidal ideation. Studies giving supplemental marine omega-3s have shown promise for improving numerous mental health conditions. This paper will review the evidence surrounding marine omega-3s and mental health conditions.

Omega-3s
ADHD

Studies have shown that there is a **positive correlation between omega-3 deficiency severity and ADHD symptoms**

- Omega-3s have been suggested to be involved in a number of biological mechanisms that influence symptoms including inflammation

ELSEVIER

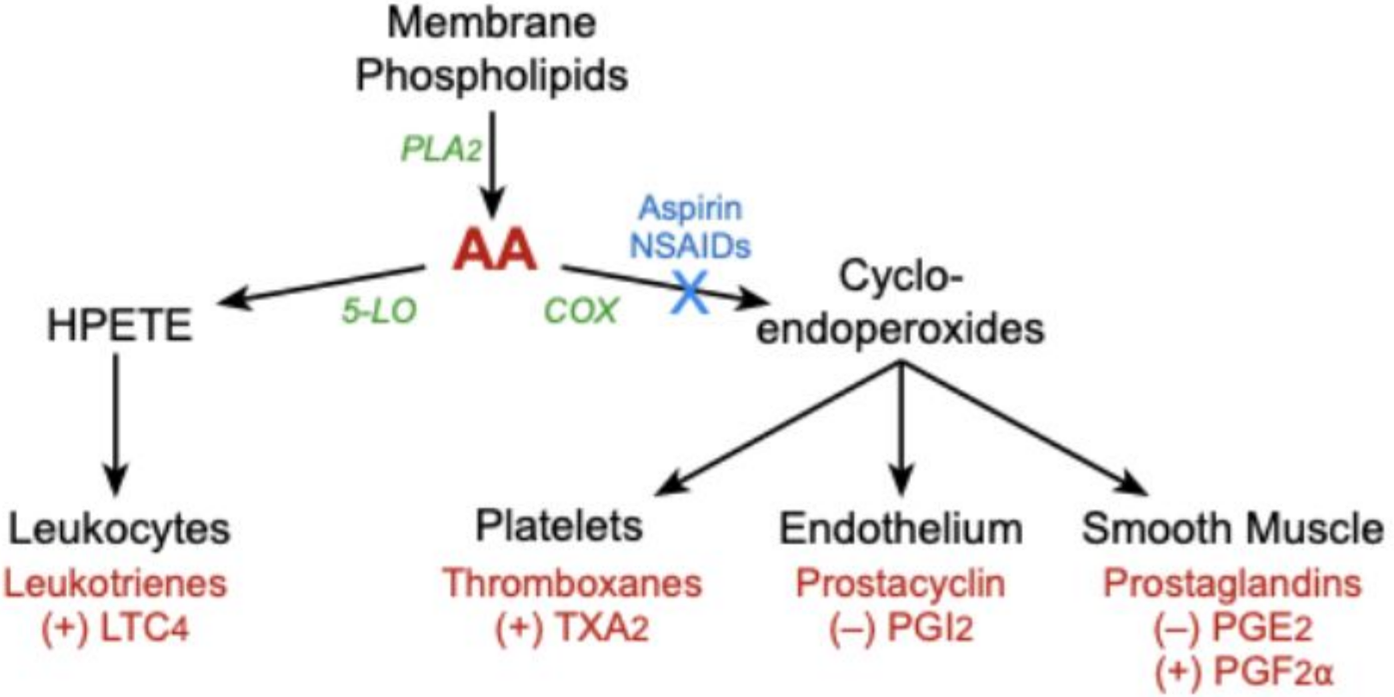
Brain, Behavior, & Immunity - Health
Volume 16, October 2021, 100310

Personalised medicine in child and Adolescent Psychiatry: Focus on omega-3 polyunsaturated fatty acids and ADHD

Jane Pei-Chen Chang [a b c]

Abstract

Attention deficit hyperactivity disorder, or ADHD, is a common childhood disorder with a prevalence rate of 5–10%. There have been many theories proposed to explain ADHD, and one of them focuses on the deficiency of essential fatty acids (EFA), particularly omega-3 polyunsaturated fatty acids (n-3 PUFAs) including docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Studies have shown that there is a positive correlation between EFA deficiency severity and ADHD symptoms, and a negative association between blood PUFAs levels and ADHD symptoms. Moreover, clinical studies have shown a promising effect of n-3 PUFAs in the treatment of both clinical and cognitive symptoms in children with ADHD. In addition, with the more relatively safe and tolerable properties of n-3 PUFAs when comparing with the standard pharmacotherapy, n-3 PUFAs may be a potential treatment option for children with ADHD. Of note, the association between n-3 PUFAs deficiency and ADHD has been suggested to involve several biological systems, including inflammation, dysregulation of the hypothalamus-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS), and an imbalanced gut-microbiota axis (GBA). Thus, the biomarkers from these biological systems may serve as possible treatment response predictors of n-3 PUFAs in children with ADHD.



Membrane Phospholipids
PLA2
AA
5-LO
COX
Aspirin
NSAIDs
HPETE
Cyclo-endoperoxides
Leukocytes
Leukotrienes
(+) LTC4
Platelets
Thromboxanes
(+) TXA2
Endothelium
Prostacyclin
(–) PGI2
Smooth Muscle
Prostaglandins
(–) PGE2
(+) PGF2α

Sources of Omega-3s

Table 2: ALA, EPA, and DHA Content of Selected Foods [29]

Food	Grams per serving		
	ALA	DHA	EPA
Flaxseed oil, 1 tbsp	7.26		
Chia seeds, 1 ounce	5.06		
English walnuts, 1 ounce	2.57		
Flaxseed, whole, 1 tbsp	2.35		
Salmon, Atlantic, farmed cooked, 3 ounces		1.24	0.59
Salmon, Atlantic, wild, cooked, 3 ounces		1.22	0.35
Herring, Atlantic, cooked, 3 ounces*		0.94	0.77
Canola oil, 1 tbsp	1.28		
Sardines, canned in tomato sauce, drained, 3 ounces*		0.74	0.45
Mackerel, Atlantic, cooked, 3 ounces*		0.59	0.43
Salmon, pink, canned, drained, 3 ounces*	0.04	0.63	0.28
Soybean oil, 1 tbsp	0.92		
Trout, rainbow, wild, cooked, 3 ounces		0.44	0.40
Black walnuts, 1 ounce	0.76		
Mayonnaise, 1 tbsp	0.74		
Oysters, eastern, wild, cooked, 3 ounces	0.14	0.23	0.30
Sea bass, cooked, 3 ounces*		0.47	0.18
Edamame, frozen, prepared, ½ cup	0.28		
Shrimp, cooked, 3 ounces*		0.12	0.12
Refried beans, canned, vegetarian, ½ cup	0.21		
Lobster, cooked, 3 ounces*	0.04	0.07	0.10

Clin Psychol Rev. 2014 Aug; 34(6): 496–505. PMID: 25181335
Published online 2014 Jun 2. doi: 10.1016/j.cpr.2014.05.005

Omega—3 fatty acid and ADHD: Blood level analysis and meta-analytic extension of supplementation trials

Elizabeth Hawkey[a] and Joel T. Nigg[a,b,*]

Omega 3's

- Children with ADHD are more likely to have lower blood levels of omega's
- ADHD symptoms are improved by Omega 3 supplementation per parent and teacher report

Abstract

Go to:

Interest in the value of Omega—3 (n—3) fatty acid supplementation for treatment of ADHD remains high. No prior meta-analysis has examined whether ADHD is associated with alterations in blood lipid levels and meta-analyses of supplementation have reached conflicting conclusions.

Methods

We report two new meta-analyses. Study 1 examined blood levels of Omega—3 fatty acids in relation to ADHD. Study 2 examined a larger sample of randomized intervention trials than previously reported.

Results

Study 1 included 9 studies ($n = 586$) and found lower overall blood levels of n—3 in individuals with ADHD versus controls ($g = 0.42$, 95% CI = 0.26–0.59; $p < .001$). Study 2 included 16 studies ($n = 1408$) and found that n—3 supplementation improved ADHD composite symptoms; using the best available rating and reporter ($g = 0.26$, 95% CI = 0.15–0.37; $p < .001$). Supplementation showed reliable effects on hyperactivity by parent and teacher report, but reliable effects for inattention only by parent report.

Conclusions

Omega—3 levels are reduced in children with ADHD. Dietary supplementation appears to create modest improvements in symptoms. There is sufficient evidence to consider Omega—3 fatty acids as a possible supplement to established therapies. However it remains unclear whether such intervention should be confined to children with below normal blood levels.

Omega-3s

A systematic review of 16 randomized controlled trials including 1514 children and young adults with ADHD

- In comparison to the placebo, 13 of 16 studies **showed improvements in hyperactivity, impulsivity, learning, reading and short term memory**

J Lipids. 2017; 2017: 6285218.
Published online 2017 Aug 30. doi: 10.1155/2017/6285218
PMCID: PMC5603098
PMID: 28951787

Do Omega-3/6 Fatty Acids Have a Therapeutic Role in Children and Young People with ADHD?

E. Derbyshire *

Abstract

Go to: ▸

Background

Attention deficit hyperactivity disorder (ADHD) is a debilitating behavioural disorder affecting daily ability to function, learn, and interact with peers. This publication assesses the role of omega-3/6 fatty acids in the treatment and management of ADHD.

Methods

A systematic review of 16 randomised controlled trials was undertaken. Trials included a total of 1,514 children and young people with ADHD who were allocated to take an omega-3/6 intervention, or a placebo.

Results

Of the studies identified, 13 reported favourable benefits on ADHD symptoms including improvements in hyperactivity, impulsivity, attention, visual learning, word reading, and working/short-term memory. Four studies used supplements containing a 9 : 3 : 1 ratio of eicosapentaenoic acid : docosahexaenoic acid : gamma linolenic acid which appeared effective at improving erythrocyte levels. Supplementation with this ratio of fatty acids also showed promise as an adjunctive therapy to traditional medications, lowering the dose and improving the compliance with medications such as methylphenidate.

Omega-3s play important roles in the body as components of the phospholipids that form the structures of cell membranes [5]. DHA, in particular, is especially high in the retina, brain, and sperm [3,5,6]. In addition to their structural role in cell membranes, omega-3s (along with omega-6s) provide energy for the body and are used to form eicosanoids. Eicosanoids are signaling molecules that have similar chemical structures to the fatty acids from which they are derived; they have wide-ranging functions in the body's cardiovascular, pulmonary, immune, and endocrine systems [1,2].

The eicosanoids made from omega-6s are generally more potent mediators of inflammation, vasoconstriction, and platelet aggregation than those made from omega-3s, although there are some exceptions [3,7]. Because both classes of fatty acids compete for the same desaturation enzymes, ALA is a competitive inhibitor of linoleic acid metabolism and vice versa [8]. Similarly, EPA and DHA can compete with arachidonic acid for the synthesis of eicosanoids. Thus, higher concentrations of EPA and DHA than arachidonic acid tip the eicosanoid balance toward less inflammatory activity [9].

Some researchers propose that the relative intakes of omega-6s and omega-3s—the omega-6/omega-3 ratio—may have important implications for the pathogenesis of many chronic diseases, such as cardiovascular disease and cancer [8], but the optimal ratio—if any—has not been defined [10]. Others have concluded that such ratios are too non-specific and are insensitive to individual fatty acid levels [11-13]. Most agree that raising EPA and DHA blood levels is far more important than lowering linoleic acid or arachidonic acid levels.

Currently, most clinicians do not assess omega-3 status, but it can be done by measuring individual omega-3s in plasma or serum phospholipids and expressing them as the percentage of total phospholipid fatty acids by weight [14-16]. Experts have not established normal ranges, but mean values for serum or plasma phospholipid EPA plus DHA among U.S. adults not taking omega-3 supplements are about 3%–4% [14-16]. Plasma and serum fatty acid values, however, can vary substantially based on an individual's most recent meal, so they do not reflect long-term dietary consumption [3,17].

It is also possible to assess omega-3 status via analysis of erythrocyte fatty acids, a measurement that reflects longer-term intakes over approximately the previous 120 days [18,19]. The "omega-3 index" proposed by Harris and von Schacky reflects the content of EPA plus DHA in erythrocyte membranes expressed as a percentage of total erythrocyte fatty acids [20,21]. This index can be used as a surrogate for assessing tissue levels of EPA plus DHA [16,22,23]. EPA and DHA typically comprise about 3%–5% of erythrocyte fatty acids in Western populations with low fish intakes. In Japan, where fish consumption is high, erythrocyte EPA and DHA levels are about twice those of Western populations [3].

Compare Lab Tests

Copy Link to Comparison

Fatty Acids, Omega-3 & 6 Vibrant America Start Order – $60.00	Omega-3 Index Complete Ayumetrix Start Order – $59.00	Omega-3 Index Complete Mosaic Diagnostics (formerly Gre... Start Order – $155.00	Omega-3 and -6 Fatty Acids Access Medical Laboratories Start Order – $69.00	Omega-3 and -6 Fatty Acids Labcorp by AML Start Order – $69.00	RBC Omega Fatty Acids Vibrant America Start Order – $60.00
~~AA/EPA Ratio~~	AA/EPA Ratio	AA/EPA Ratio	AA/EPA Ratio	AA/EPA Ratio	~~AA/EPA Ratio~~
~~Alpha-Linolenic Acid~~	Alpha-Linolenic Acid	Alpha-Linolenic Acid	~~Alpha-Linolenic Acid~~	~~Alpha-Linolenic Acid~~	~~Alpha-Linolenic Acid~~
~~Arachidic Acid~~	Arachidic Acid	Arachidic Acid	~~Arachidic Acid~~	~~Arachidic Acid~~	~~Arachidic Acid~~
Arachidonic Acid	Arachidonic Acid	Arachidonic Acid	~~Arachidonic Acid~~	Arachidonic Acid	Arachidonic Acid
~~Behenic Acid~~	Behenic Acid	Behenic Acid	~~Behenic Acid~~	~~Behenic Acid~~	~~Behenic Acid~~
~~Dihomo-Gamma-Linolenic Acid~~	Dihomo-Gamma-Linolenic Acid	Dihomo-Gamma-Linolenic Acid	~~Dihomo-Gamma-Linolenic Acid~~	~~Dihomo-Gamma-Linolenic Acid~~	~~Dihomo-Gamma-Linolenic Acid~~
Docosahexaenoic Acid	Docosahexaenoic Acid	Docosahexaenoic Acid	~~Docosahexaenoic Acid~~	Docosahexaenoic Acid	Docosahexaenoic Acid
Docosapentaenoic Acid	Docosapentaenoic Acid	Docosapentaenoic Acid	Docosapentaenoic Acid	Docosapentaenoic Acid	Docosapentaenoic Acid
~~Docosatetraenoic Acid~~	Docosatetraenoic Acid	Docosatetraenoic Acid	~~Docosatetraenoic Acid~~	~~Docosatetraenoic Acid~~	~~Docosatetraenoic Acid~~
~~Eicosadienoic Acid~~	Eicosadienoic Acid	Eicosadienoic Acid	~~Eicosadienoic Acid~~	~~Eicosadienoic Acid~~	~~Eicosadienoic Acid~~
Eicosapentaenoic Acid	Eicosapentaenoic Acid	Eicosapentaenoic Acid	Eicosapentaenoic Acid	Eicosapentaenoic Acid	Eicosapentaenoic Acid
~~Eicosenoic Acid~~	Eicosenoic Acid	Eicosenoic Acid	~~Eicosenoic Acid~~	~~Eicosenoic Acid~~	~~Eicosenoic Acid~~
~~Elaidic Acid~~	Elaidic Acid	Elaidic Acid	~~Elaidic Acid~~	~~Elaidic Acid~~	~~Elaidic Acid~~
~~Gamma-Linolenic Acid~~	Gamma-Linolenic Acid	Gamma-Linolenic Acid	~~Gamma-Linolenic Acid~~	~~Gamma-Linolenic Acid~~	~~Gamma-Linolenic Acid~~
~~Lignoceric Acid~~	Lignoceric Acid	Lignoceric Acid	~~Lignoceric Acid~~	~~Lignoceric Acid~~	~~Lignoceric Acid~~
~~Linoelaidic Acid~~	Linoelaidic Acid	Linoelaidic Acid	~~Linoelaidic Acid~~	~~Linoelaidic Acid~~	~~Linoelaidic Acid~~
Linoleic Acid	Linoleic Acid	Linoleic Acid	~~Linoleic Acid~~	Linoleic Acid	Linoleic Acid
~~Myristic Acid~~	Myristic Acid	Myristic Acid	~~Myristic Acid~~	~~Myristic Acid~~	~~Myristic Acid~~
~~Nervonic Acid~~	Nervonic Acid	Nervonic Acid	~~Nervonic Acid~~	~~Nervonic Acid~~	~~Nervonic Acid~~
~~Oleic Acid~~	Oleic Acid	Oleic Acid	~~Oleic Acid~~	~~Oleic Acid~~	~~Oleic Acid~~
Omega-3 Index	Omega-3 Index	Omega-3 Index	Omega-3 Index	~~Omega-3 Index~~	Omega-3 Index
~~Omega-6/Omega-3 Ratio~~	Omega-6/Omega-3 Ratio	Omega-6/Omega-3 Ratio	Omega-6/Omega-3 Ratio	Omega-6/Omega-3 Ratio	~~Omega-6/Omega-3 Ratio~~

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%
Methionine	1.3 g	231%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%
Zinc	11.8 mg	147%

Antioxidants

1. Deficiency Risk
2. Food Sources
3. Dietary Assessment
4. Nutrient Status Testing
5. Repletion Strategies

Antioxidants

ADHD has been associated with increased oxidative stress and immune dysregulation.

- Antioxidants, such as polyphenols and OPCs **may therefore have a supportive role in** ADHD

Review > Nutrients. 2018 Mar 24;10(4):405. doi: 10.3390/nu10040405.

Rationale for Dietary Antioxidant Treatment of ADHD

Annelies A J Verlaet [1], Carlijn M Maasakkers [2 3 4], Nina Hermans [5], Huub F J Savelkoul [6]

Affiliations + expand

PMID: 29587355 PMCID: PMC5946190 DOI: 10.3390/nu10040405
Free PMC article

Abstract

Increasing understanding arises regarding disadvantages of stimulant medication in children with ADHD (Attention-Deficit Hyperactivity Disorder). This review presents scientific findings supporting dietary antioxidant treatment of ADHD and describes substantial alterations in the immune system, epigenetic regulation of gene expression, and oxidative stress regulation in ADHD. As a result, chronic inflammation and oxidative stress could develop, which can lead to ADHD symptoms, for example by chronic T-cell-mediated neuroinflammation, as well as by neuronal oxidative damage and loss of normal cerebral functions. Therefore, modulation of immune system activity and oxidant-antioxidant balance using nutritional approaches might have potential in ADHD treatment. The use of natural antioxidants against oxidative conditions is an emerging field in the management of neurodegenerative diseases. Dietary polyphenols, for example, have antioxidant capacities as well as immunoregulatory effects and, therefore, appear appropriate in ADHD therapy. This review can stimulate the development and investigation of dietary antioxidant treatment in ADHD, which is highly desired.

Eur J Nutr. 2019; 58(7): 2911–2920. PMCID: PMC6768899
Published online 2018 Oct 16. doi: 10.1007/s00394-018-1843-6 PMID: 30327868

The effects of acute wild blueberry supplementation on the cognition of 7–10-year-old schoolchildren

Katie L. Barfoot,[1] Gabrielle May,[1,2] Daniel J. Lamport,[1] Jessie Ricketts,[2] Patricia M. Riddell,[1] and Claire M. Williams✉[1]

▸ Author information ▸ Article notes ▸ Copyright and License information Disclaimer

Abstract

Go to:

Purpose

Previous evidence suggests consumption of flavonoids, a sub-class of polyphenols, is associated with improved cognitive function across the lifespan. In particular, acute intervention of a flavonoid-rich wild blueberry (WBB) drink has been shown to boost executive function (EF), short-term memory and mood 2 6 h post-consumption in 7–10-year-old children. However, confirmation of the aspects of EF and memory susceptible to WBB ingestion is required, particularly during childhood, a critical period of neurological development. In addition, the child literature on berry flavonoid supplementation and cognition highlights the potential for such interventions to elicit positive benefits to real-world educational scenarios, such as reading, a complex ability which relies upon aspects of cognition already known to improve following WBB.

Methods

Here we examined which aspects of EF and memory are susceptible to acute WBB, as well as investigating whether acute WBB could further benefit reading ability. Fifty-four healthy children, aged 7–10 years, consumed a 200 ml WBB drink (253 mg anthocyanins) or a matched placebo according to a randomised, single-blind, parallel-groups design. Verbal memory (Auditory Verbal Learning Task; AVLT), EF (Modified Attention Network Task; MANT), and reading efficiency (Test of Word Reading Efficiency-2; TOWRE-2) were assessed at baseline and 2 h post-consumption.

Results

For the MANT, significantly quicker RTs were observed for WBB participants when compared to placebo participants on 120 ms trials, without cost to accuracy. Furthermore, WBB participants showed enhanced verbal memory performance on the AVLT, recalling more words than placebo participants on short delay and memory acquisition measures post-consumption. Despite these significant improvements in cognitive performance, no significant effects were observed for reading measures.

Conclusion

Consumption of WBB was found to significantly improve memory and attentional aspects of EF. This indicates that a flavonoid-rich blueberry product, equivalent to 240 g or 1½ cups of fresh blueberries can provide acute cognitive benefits in children. These findings support accumulating evidence that flavonoid-rich products are beneficial for healthy brain function, particularly during critical developmental periods. However, the lack of findings relating to reading ability suggested acute WBB may not be sufficient to elicit benefits to reading. Chronic supplementation and other more sensitive reading measures should be considered for examining the effects of WBB on such a complex skill in the future.

Fruits and Vegetables

Fruit and veggie intake is inversely associated with inattention

- **Keep fresh fruit and veggies out, kids will graze on them throughout the day**
- **Dried fruits and veggies may also help**

> Nutr Neurosci. 2023 Jun;26(6):572-581. doi: 10.1080/1028415X.2022.2071805.
Epub 2022 May 10.

Fruit and vegetable intake is inversely associated with severity of inattention in a pediatric population with ADHD symptoms: the MADDY Study

Lisa M Robinette [1], Irene E Hatsu [1 2], Jeanette M Johnstone [3 4], Gabriella Tost [3 4], Alisha M Bruton [3 4], Brenda M Y Leung [5], James B Odei [6], Tonya Orchard [1], Barbara L Gracious [7], L Eugene Arnold [8 9]

Affiliations + expand

PMID: 35535573 PMCID: PMC9646924 (available on 2024-06-01)
DOI: 10.1080/1028415X.2022.2071805

Abstract

Objectives: Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder with a U.S. pediatric prevalence of 8-10%. It presents with inattention and hyperactivity/impulsivity; frequently associated with emotional dysregulation (ED) symptoms common in Oppositional Defiant Disorder and Disruptive Mood Dysregulation Disorder. The etiology of ADHD is multi-factorial; symptom severity is associated with diet. This study examines the association of diet quality with ADHD and ED symptoms within a pediatric research cohort.

Methods: Baseline data were analyzed for 134 children aged 6-12 years with symptoms of ADHD and ED enrolled in an RCT of multinutrient supplementation. Diet quality was based on Healthy Eating Index-2015 (HEI-2015). ADHD and ED symptoms were assessed using Child and Adolescent Symptom Inventory-5 and Strengths and Difficulties Questionnaire. Linear regression models, adjusting for covariates when necessary, determined association.

Results: The mean HEI Total Score of 63.4 (SD = 8.8) was not significantly associated with any outcome symptoms. However, after adjusting for covariates, HEI component scores for total fruit intake ($\beta = -0.158$, $p = .037$) and total vegetable intake ($\beta = -0.118$, $p = .004$) were negatively associated with inattention.

Conclusions: The lack of association with total diet quality could be explained by the relatively good baseline diet quality and mild symptom severity in this sample, along with measurement error from dietary intake estimates and relatively small sample size. These findings suggest that dietary intake may impact inattention in children with ADHD and ED: those eating less fruits and vegetables were likely to have more severe symptoms of inattention. Causality is not established by this cross-sectional analysis.

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%
Methionine	1.3 g	231%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%
Zinc	11.8 mg	147%

Dietary Patterns

1. Food Sensitivities
2. Overall Diet
   a. Enough protein
   b. Fruits and vegetables
   c. Fluids

Remember to assess for food allergies

Food allergies can cause inflammatory responses in the brain and affect cognition and behavior

› Behav Brain Res. 2019 May 17;364:374-382. doi: 10.1016/j.bbr.2018.01.011. Epub 2018 Jan 12.

Food allergy induces alteration in brain inflammatory status and cognitive impairments

Liqing Zhou [1], Long Chen [1], Xiaohuan Li [1], Tingyu Li [1], Zhifang Dong [2], Yu Tian Wang [3]

Affiliations + expand

PMID: 29339006 DOI: 10.1016/j.bbr.2018.01.011

Abstract

Accumulating evidence supports an increase in emotional and behavioral problems in patients with food allergy, but the underlying mechanism remains poorly understood. Here we found that in addition to inducing an increase of allergic factors in serum, food allergy also increased levels of antigen-specific immunoglobulins and mast cell marker in the brain. In particular, food allergy increased the number of total microglia and the percentage of active microglia in the cerebral cortex and hippocampal CA1 areas, and induced the increase of TNF-α in the cerebral cortex. Importantly, these brain allergic responses were associated with behavioral impairments, including motor and learning deficits. Taken together, our study provides some evidence for profound effects of food allergy on brain functions, and thereby provides scientific basis for a better explanation of emotional and behavioral problems among patients with food allergy.

Food Allergies & Sensitivities

- Food intolerances can further contribute to symptoms of inflammation, exacerbate nutritional deficiencies, and alter gut bacteria balance
- **Individually adjusted nutrition significant improved ADHD symptomatology long term,** suggesting that this can be an effective treatment modality in ADHD.

Long-Term Effects of an Oligoantigenic Diet in Children with Attention-Deficit/Hyperactivity Disorder (ADHD) on Core Symptomatology

Greta Walz [1], Nicola Blazynski [1], Lukas Frey [1], Katja Schneider-Momm [1], Hans-Willi Clement [1], Reinhold Rauh [1], Eberhard Schulz [1], Monica Biscaldi [1], Christina Clement [1], Christian Fleischhaker [1]

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PMID: 36501141 PMCID: PMC9737158 DOI: 10.3390/nu14235111

Free PMC article

Abstract

In the early 1920s, it was discovered that nutrition is associated with what is known today as Attention-Deficit/Hyperactivity Disorder (ADHD) and that certain foods can worsen the symptoms. In previous studies, approximately 60% of the participants experience at least a 40% reduction in ADHD symptoms after an oligoantigenic diet (OD). The purpose of this study was to evaluate ADHD symptoms in children approximately 3.5 years after completing a 4-week oligoantigenic diet. Among 28 participants who completed the 4-week diet, 21 were re-assessed for this study after 3.5 years. The severity of ADHD symptoms was assessed with the ADHD-Rating-Scale-IV (ARS). Of 21 participants, 14 fulfilled the responder criterion, whereas 7 did not. At follow-up, 28% of the participants were taking medication. The mean ARS total score improved significantly from T1: M = 29.62 (SD = 9.80) to T2: M = 15.86 (SD = 8.56) between the time points before and after the diet (d = -1.91). There was also a lower ARS total score at the follow-up T5: M = 16.00 (SD = 10.52) compared to before the diet (d = -1.17). This study shows that individually adjusted nutrition significantly improved the ADHD symptomatology of the participants long-term. This suggests that an oligoantigenic diet with subsequent individual nutritional recommendations could become an additional treatment option for children with ADHD.

Randomized Controlled Trial > Lancet. 2011 Feb 5;377(9764):494-503.
doi: 10.1016/S0140-6736(10)62227-1.

Effects of a restricted elimination diet on the behaviour of children with attention-deficit hyperactivity disorder (INCA study): a randomised controlled trial

Lidy M Pelsser [1], Klaas Frankena, Jan Toorman, Huub F Savelkoul, Anthony E Dubois, Rob Rodrigues Pereira, Ton A Haagen, Nanda N Rommelse, Jan K Buitelaar

Affiliations + expand

PMID: 21296237 DOI: 10.1016/S0140-6736(10)62227-1

Abstract

Background: The effects of a restricted elimination diet in children with attention-deficit hyperactivity disorder (ADHD) have mainly been investigated in selected subgroups of patients. We aimed to investigate whether there is a connection between diet and behaviour in an unselected group of children.

Methods: The Impact of Nutrition on Children with ADHD (INCA) study was a randomised controlled trial that consisted of an open-label phase with masked measurements followed by a double-blind crossover phase. Patients in the Netherlands and Belgium were enrolled via announcements in medical health centres and through media announcements. Randomisation in both phases was individually done by random sampling. In the open-label phase (first phase), children aged 4-8 years who were diagnosed with ADHD were randomly assigned to 5 weeks of a restricted elimination diet (diet group) or to instructions for a healthy diet (control group). Thereafter, the clinical responders (those with an improvement of at least 40% on the ADHD rating scale [ARS]) from the diet group proceeded with a 4-week double-blind crossover food challenge phase (second phase), in which high-IgG or low-IgG foods (classified on the basis of every child's individual IgG blood test results) were added to the diet. During the first phase, only the assessing paediatrician was masked to group allocation. During the second phase (challenge phase), all persons involved were masked to challenge allocation. Primary endpoints were the change in ARS score between baseline and the end of the first phase (masked paediatrician) and between the end of the first phase and the second phase (double-blind), and the abbreviated Conners' scale (ACS) score (unmasked) between the same timepoints. Secondary endpoints included food-specific IgG levels at baseline related to the behaviour of the diet group responders after IgG-based food challenges. The primary analyses were intention to treat for the first phase and per protocol for the second phase. INCA is registered as an International Standard Randomised Controlled Trial, number ISRCTN 76063113.

Findings: Between Nov 4, 2008, and Sept 29, 2009, 100 children were enrolled and randomly assigned to the control group (n=50) or the diet group (n=50). Between baseline and the end of the first phase, the difference between the diet group and the control group in the mean ARS total score was 23·7 (95% CI 18·6-28·8; p<0·0001) according to the masked ratings. The difference between groups in the mean ACS score between the same timepoints was 11·8 (95% CI 9·2-14·5; p<0·0001). The ARS total score increased in clinical responders after the challenge by 20·8 (95% CI 14·3-27·3; p<0·0001) and the ACS score increased by 11·6 (7·7-15·4; p<0·0001). In the challenge phase, after challenges with either high-IgG or low-IgG foods, relapse of ADHD symptoms occurred in 19 of 30 (63%) children, independent of the IgG blood levels. There were no harms or adverse events reported in both phases.

Interpretation: A strictly supervised restricted elimination diet is a valuable instrument to assess whether ADHD is induced by food. The prescription of diets on the basis of IgG blood tests should be discouraged.

Dietary Patterns

Nutrients act like modulators, helping to support in reducing symptoms of ADHD.

- A whole-food, abundant fruits and vegetables, protein, fats, low-sugar, and minimally-processed diet is essential.
- A Mediterranean diet focuses on these areas, in addition to quality fatty acid content, which has been found to be beneficial for ADHD

> Clin Nutr ESPEN. 2022 Feb;47:346-350. doi: 10.1016/j.clnesp.2021.11.014. Epub 2021 Nov 15.

Adherence to Mediterranean diet and attention-deficit/hyperactivity disorder in children: A case control study

Zahra Darabi [1], Azam Ahmadi Vasmehjani [1], Mina Darand [2], Abbas Ali Sangouni [3], Mahdieh Hosseinzadeh [4]

Affiliations + expand

PMID: 35063225 DOI: 10.1016/j.clnesp.2021.11.014

Abstract

Objective: Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurodevelopmental disorders. The Mediterranean diet as a plant-based diet has a beneficial effect on mental health. The present study was designed to investigate the association between adherence to Mediterranean diet and odds of ADHD in Iranian children.

Results: After adjusting for potential confounders including energy intake, parents' educational level, economic status, family history ADHD and physical activity, the children in the highest tertile of adherence to Mediterranean diet had a lower odd of ADHD (odds ratio [OR]: 0.49; 95% Confidence Interval [CI]: 0.27-0.89) compared to the children in the lowest. In addition, an association was observed between increasing trend adherence to Mediterranean diet and decrease odds of ADHD after full adjustments (P for trend <0.001).

Conclusion: We found that higher adherence to Mediterranean diet containing vegetables, legumes, fruits and nuts, grains, and fish could decrease the odds of ADHD in primary school children. Further studies are suggested to approve our vision.

Nutritional Considerations

- Ensure the diet is nutrient replete, particularly in the vitamins and minerals mentioned today
    - B6, B12, B9
    - Vitamin D
    - Zinc
    - Copper
    - Iron
    - Magnesium
    - Omega 3’s
    - Total protein
    - Antioxidants, polyphenols
- Low allergen

Vitamins			
B1 (Thiamine)	4.0	mg	333%
B2 (Riboflavin)	2.9	mg	221%
B3 (Niacin)	305.9	mg	1912%
B5 (Pantothenic Acid)	35.2	mg	703%
B6 (Pyridoxine)	5.6	mg	433%
B12 (Cobalamin)	543.5	µg	22647%
Folate	752.6	µg	188%
Vitamin A	17568.0	IU	586%
Vitamin C	1250.8	mg	1390%
Vitamin D	5536.0	IU	923%
Vitamin E	27.3	mg	182%
Vitamin K	170.7	µg	142%

Minerals			
Calcium	1386.9	mg	139%
Copper	4.7	mg	524%
Iron	54.9	mg	686%
Magnesium	330.4	mg	79%
Manganese	5.2	mg	224%
Phosphorus	1218.1	mg	174%
Potassium	2807.5	mg	83%
Selenium	218.0	µg	396%
Sodium	2466.1	mg	164%
Zinc	128.6	mg	1169%

Example: 10 year old boy

Breakfast			186 kcal • 6 g protein • 31 g carbs • 4 g fat		
	Kellogg's, Special K Cereal, Red Berries	1	cup, whole pieces	112.01	kcal
	Milk, Whole	0.5	cup	74.42	kcal
Lunch			210 kcal • 8 g protein • 24 g carbs • 9 g fat		
	Pizza, Homemade or Restaurant, Cheese, Thin Crust	1	g	2.79	kcal
	Chocolate Milk, Whole	1	cup	207.5	kcal
Dinner			405 kcal • 17 g protein • 39 g carbs • 18 g fat		
	Spaghetti Sauce, Homemade	1	cup	145.75	kcal
	Spaghetti Noodles, White, Cooked in Unsalted Water	3	oz	134.38	kcal
	Meatballs, with Tomato Sauce	2	oz	125.24	kcal
Snacks			433 kcal • 4 g protein • 39 g carbs • 28 g fat		
	Apple, Fresh, With Skin	1	g	0.52	kcal
	Potato Chips, Salted	1	grab bag - each 2 7/8 oz	432.9	kcal

Example: 10 year old boy

General		
Energy	1235.5 kcal	92%
Alcohol	0.0 g	N/T
Caffeine	2.5 mg	N/T
Water	671.8 g	28%

Carbohydrates		
Carbs	149.6 g	115%
Fiber	15.9 g	51%
Starch	76.9 g	N/T
Sugars	51.6 g	N/T
Net Carbs	133.7 g	89%

Lipids		
Fat	58.7 g	130%
Monounsaturated	19.0 g	N/T
Polyunsaturated	20.7 g	N/T
Omega-3	1.9 g	158%
Omega-6	18.1 g	151%
Saturated	15.1 g	n/a
Trans-Fats	0.9 g	n/a
Cholesterol	84.6 mg	N/T

Protein		
Protein	34.6 g	41%
Cystine	0.4 g	71%
Histidine	1.0 g	106%
Isoleucine	1.5 g	131%
Leucine	2.7 g	104%
Lysine	2.2 g	94%
Methionine	0.7 g	123%
Phenylalanine	1.6 g	149%

Vitamins		
B1 (Thiamine)	1.8 mg	200%
B2 (Riboflavin)	1.3 mg	139%
B3 (Niacin)	11.5 mg	96%
B5 (Pantothenic Acid)	3.3 mg	83%
B6 (Pyridoxine)	1.5 mg	154%
B12 (Cobalamin)	2.7 µg	151%
Biotin	0.1 µg	1%
Choline	161.0 mg	43%
Folate	348.0 µg	116%
Vitamin A	201.6 µg	34%
Vitamin C	70.8 mg	157%
Vitamin D	264.9 IU	44%
Vitamin E	13.3 mg	121%
Vitamin K	45.6 µg	76%

Minerals		
Calcium	559.3 mg	43%
Chromium	- µg	0%
Copper	1.0 mg	141%
Iodine	41.8 µg	35%
Iron	14.6 mg	183%
Magnesium	176.5 mg	74%
Manganese	1.9 mg	100%
Molybdenum	- µg	0%
Phosphorus	737.6 mg	59%
Potassium	2446.1 mg	98%
Selenium	62.5 µg	156%
Sodium	2068.6 mg	172%
Zinc	5.3 mg	67%

N/T = No Target

Example: 10 year old boy

Minerals		
Calcium	559.3 mg	43%
Chromium	- µg	0%
Copper	1.0 mg	141%
Iodine	41.8 µg	35%
Iron	14.6 mg	183%
Magnesium	176.5 mg	74%
Manganese	1.9 mg	100%
Molybdenum	- µg	0%
Phosphorus	737.6 mg	59%
Potassium	2446.1 mg	98%
Selenium	62.5 µg	156%
Sodium	2068.6 mg	172%
Zinc	5.3 mg	67%

General		
Energy	1275.5 kcal	95%
Alcohol	0.0 g	N/T
Caffeine	2.5 mg	N/T
Water	671.8 g	28%

Carbohydrates		
Carbs	157.6 g	87%
Fiber	15.9 g	51%
Starch	76.9 g	N/T
Sugars	59.6 g	N/T
Net Carbs	141.7 g	94%

Lipids		
Fat	58.7 g	130%
Monounsaturated	19.0 g	N/T
Polyunsaturated	20.7 g	N/T
Omega-3	2.0 g	170%
Omega-6	18.1 g	151%
Saturated	15.1 g	n/a
Trans-Fats	0.9 g	n/a
Cholesterol	84.6 mg	N/T

Protein		
Protein	34.6 g	41%
Cystine	0.4 g	71%
Histidine	1.0 g	106%
Isoleucine	1.5 g	131%
Leucine	2.7 g	104%
Lysine	2.2 g	94%
Methionine	0.7 g	123%

Vitamins		
B1 (Thiamine)	1.8 mg	200%
B2 (Riboflavin)	1.3 mg	139%
B3 (Niacin)	11.5 mg	96%
B5 (Pantothenic Acid)	13.3 mg	333%
B6 (Pyridoxine)	3.5 mg	354%
B12 (Cobalamin)	8.7 µg	484%
Biotin	150.1 µg	751%
Choline	161.0 mg	43%
Folate	748.0 µg	249%
Vitamin A	1401.6 µg	234%
Vitamin C	130.8 mg	291%
Vitamin D	1464.9 IU	244%
Vitamin E	37.5 mg	341%
Vitamin K	45.6 µg	76%

Minerals		
Calcium	559.3 mg	43%
Chromium	- µg	0%
Copper	1.0 mg	142%
Iodine	101.8 µg	85%
Iron	14.6 mg	183%
Magnesium	176.5 mg	74%
Manganese	1.9 mg	99%
Molybdenum	- µg	0%
Phosphorus	737.6 mg	59%
Potassium	2446.1 mg	98%
Selenium	62.5 µg	156%
Sodium	2068.6 mg	172%
Zinc	10.3 mg	129%

Breakfast			186 kcal • 6 g protein • 31 g carbs • 4 g fat	
Kellogg's, Special K Cereal, Red Berries	1	cup, whole pieces	112.01	kcal
Milk, Whole	0.5	cup	74.42	kcal
Lunch			282 kcal • 11 g protein • 24 g carbs • 15 g fat	
Pizza, Homemade or Restaurant, Cheese, Thin Crust	1	g	2.79	kcal
Chocolate Milk, Whole	1	cup	207.5	kcal
Pepperoni	0.5	oz	71.44	kcal
Dinner			525 kcal • 33 g protein • 49 g carbs • 18 g fat	
Spaghetti Sauce, Homemade	1	cup	145.75	kcal
Meatballs, with Tomato Sauce	2	oz	125.24	kcal
Gluten Free Pasta, Lentil, Cooked in Salted Water	1.5	cup	253.65	kcal
Snacks			424 kcal • 24 g protein • 55 g carbs • 14 g fat	
Apple, Fresh, With Skin	1	g	0.52	kcal
Pumpkin or Squash Seeds, Shelled, Unsalted	4	tsp, whole pieces	56.44	kcal
Raisins, Uncooked	0.13	cup, whole pieces	54.19	kcal
Chocolate Chip Cookies, Homemade	1	each - approx 2 1/4" diameter	75.46	kcal
Power Bar, Protein Plus Bar, Vanilla	1	bar - each 2.1 oz	202.8	kcal
Smarty Pants, Kids Complete	1	× 4 gummies	35	kcal

Energy Summary

Macronutrient Targets

Energy — 1417 kcal / 1387 kcal — 102%

Protein — 74.2 g / 86.7 g — 86%

Net Carbs — 159.6 g / 156.0 g — 102%

Fat — 51.4 g / 46.2 g — 111%

Breakfast			186 kcal • 6 g protein • 31 g carbs • 4 g fat	
Kellogg's, Special K Cereal, Red Berries	1	cup, whole pieces	112.01	kcal
Milk, Whole	0.5	cup	74.42	kcal
Lunch			210 kcal • 8 g protein • 24 g carbs • 9 g fat	
Pizza, Homemade or Restaurant, Cheese, Thin Crust	1	g	2.79	kcal
Chocolate Milk, Whole	1	cup	207.5	kcal
Dinner			405 kcal • 17 g protein • 39 g carbs • 18 g fat	
Spaghetti Sauce, Homemade	1	cup	145.75	kcal
Spaghetti Noodles, White, Cooked in Unsalted Water	3	oz	134.38	kcal
Meatballs, with Tomato Sauce	2	oz	125.24	kcal
Snacks			433 kcal • 4 g protein • 39 g carbs • 28 g fat	
Apple, Fresh, With Skin	1	g	0.52	kcal
Potato Chips, Salted	1	grab bag - each 2 7/8 oz	432.9	kcal

Energy Summary

Consumed

Burned

Remaining

Macronutrient Targets

Energy	1236 kcal / 1341 kcal	92%
Protein	34.6 g / 83.8 g	41%
Net Carbs	133.7 g / 150.9 g	89%
Fat	58.7 g / 44.7 g	131%


Macronutrient Targets
Energy
1236 kcal / 1341 kcal
92%
Protein
34.6 g / 83.8 g
41%
Net Carbs
133.7 g / 150.9 g
89%
Fat
58.7 g / 44.7 g
131%


Macronutrient Targets
Energy
1417 kcal / 1387 kcal
102%
Protein
74.2 g / 86.7 g
86%
Net Carbs
159.6 g / 156.0 g
102%
Fat
51.4 g / 46.2 g
111%

General		
Energy	1235.5 kcal	92%
Alcohol	0.0 g	N/T
Caffeine	2.5 mg	N/T
Water	671.8 g	28%

Carbohydrates		
Carbs	149.6 g	82%
Fiber	15.9 g	51%
Starch	76.9 g	N/T
Sugars	51.6 g	N/T
Net Carbs	133.7 g	89%

Lipids		
Fat	58.7 g	130%
Monounsaturated	19.0 g	N/T
Polyunsaturated	20.7 g	N/T
Omega-3	1.9 g	158%
Omega-6	18.1 g	151%
Saturated	15.1 g	n/a
Trans-Fats	0.9 g	n/a
Cholesterol	84.6 mg	N/T

Protein		
Protein	34.6 g	41%
Cystine	0.4 g	71%
Histidine	1.0 g	106%
Isoleucine	1.5 g	131%
Leucine	2.7 g	104%
Lysine	2.2 g	94%
Methionine	0.7 g	123%

Vitamins		
B1 (Thiamine)	1.8 mg	200%
B2 (Riboflavin)	1.3 mg	139%
B3 (Niacin)	11.5 mg	96%
B5 (Pantothenic Acid)	3.3 mg	83%
B6 (Pyridoxine)	1.5 mg	154%
B12 (Cobalamin)	2.7 µg	151%
Biotin	0.1 µg	1%
Choline	161.0 mg	43%
Folate	348.0 µg	116%
Vitamin A	201.6 µg	34%
Vitamin C	70.8 mg	157%
Vitamin D	264.9 IU	44%
Vitamin E	13.3 mg	121%
Vitamin K	45.6 µg	76%

Minerals		
Calcium	559.3 mg	43%
Chromium	- µg	0%
Copper	1.0 mg	142%
Iodine	41.8 µg	35%
Iron	14.6 mg	183%
Magnesium	176.5 mg	74%
Manganese	1.9 mg	99%
Molybdenum	- µg	0%
Phosphorus	737.6 mg	59%
Potassium	2446.1 mg	98%
Selenium	62.5 µg	156%
Sodium	2068.6 mg	172%
Zinc	5.3 mg	67%

General		
Energy	1417.2 kcal	102%
Alcohol	0.0 g	N/T
Caffeine	5.3 mg	N/T
Water	774.9 g	32%

Carbohydrates		
Carbs	183.3 g	98%
Fiber	23.7 g	76%
Starch	54.4 g	N/T
Sugars	90.9 g	N/T
Net Carbs	159.6 g	102%

Lipids		
Fat	51.4 g	112%
Monounsaturated	15.8 g	N/T
Polyunsaturated	10.5 g	N/T
Omega-3	1.3 g	107%
Omega-6	8.4 g	70%
Saturated	20.7 g	n/a
Trans-Fats	1.1 g	n/a
Cholesterol	110.1 mg	N/T

Protein		
Protein	74.2 g	85%
Cystine	0.9 g	148%
Histidine	2.0 g	226%
Isoleucine	3.4 g	298%
Leucine	6.0 g	234%
Lysine	5.2 g	223%
Methionine	1.3 g	231%

Vitamins		
B1 (Thiamine)	1.9 mg	209%
B2 (Riboflavin)	1.6 mg	177%
B3 (Niacin)	9.9 mg	82%
B5 (Pantothenic Acid)	4.8 mg	121%
B6 (Pyridoxine)	2.8 mg	275%
B12 (Cobalamin)	69.9 µg	3886%
Biotin	30.2 µg	151%
Choline	250.4 mg	67%
Folate	779.0 µg	260%
Vitamin A	527.1 µg	88%
Vitamin C	59.9 mg	133%
Vitamin D	875.4 IU	146%
Vitamin E	19.3 mg	175%
Vitamin K	54.9 µg	91%

Minerals		
Calcium	677.9 mg	52%
Chromium	- µg	0%
Copper	1.5 mg	220%
Iodine	142.3 µg	119%
Iron	18.8 mg	235%
Magnesium	278.1 mg	116%
Manganese	3.2 mg	170%
Molybdenum	- µg	0%
Phosphorus	1168.1 mg	93%
Potassium	2519.6 mg	101%
Selenium	48.4 µg	121%
Sodium	2359.2 mg	197%
Zinc	11.8 mg	147%

What Did We Do?

1. Swap
    a. wheat → lentil pasta
    b. chips → powerbar
2. Add
    a. pepperoni
    b. trail mix snack
    c. multi gummy

RUPA HEALTH

- Dashboard
- Lab Catalog
- Learn About Labs
- Settings

PROGRAM

- LabShop

RESOURCES

- Promotions
- Phlebotomy Map
- Lab Ordering Access
- Food Plans BETA
- Support

kate henry

hello@doctorkatehenry.com Edit >

Dashboard / kate henry / Food Plan

Meal Frequency

3 meals, 2 snacks

Diet Plan Type

high protein, anti-inflammatory

Preferences

blueberries, high fiber

Dietary Restrictions

gluten free, dairy free, egg free, peanut free

Calorie & Nutrient Intake

Daily Calories

1500

Daily Nutrients

3g omega 3s, 100 grams protein

Include Ingredients

Layout

Table | List

Generate Food Plan

Generate a Food Plan Draft with Rupa AI BETA

Save time and streamline meal planning with Rupa AI, our HIPAA compliant assistant.

Watch Tutorial

RUPA HEALTH

- Dashboard
- Lab Catalog
- Learn About Labs
- Settings

PROGRAM

- LabShop

RESOURCES

- Promotions
- Phlebotomy Map
- Lab Ordering Access
- Food Plans BETA
- Support

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Dashboard / kate henry / Food Plan

Restart

Are there any changes you'd like Rupa AI to make? E.g. Use whole-grains, no seafood, more Thai food etc.

Layout

Table List

Update Food Plan

kate's Food Plan

Edited: September 3, 2023

Download PDF Save & Close

Please take a moment to review the draft and make any necessary adjustments.

B I U

Dear Kate, welcome to your personalized 7-day high protein, anti-inflammatory meal plan tailored to your preferences and dietary restrictions!

Day	Breakfast	Lunch	Dinner	Snack 1	Snack 2
1	**Blueberry Almond Smoothie** (300-350 cal) 1 cup almond milk 1 cup frozen blueberries 1 scoop vegan protein powder 1 tbsp chia seeds 1 tbsp almond butter	**Grilled Chicken Salad** (350-400 cal) 4 oz grilled chicken breast 2 cups mixed greens 1/2 cup cherry tomatoes 1/4 cup cucumber slices 1/4 cup sliced red onion 1 tbsp olive oil 1 tbsp apple cider vinegar	**Salmon with Quinoa and Steamed Vegetables** (400-450 cal) 4 oz grilled salmon 1/2 cup cooked quinoa 1 cup steamed broccoli 1 cup steamed carrots 1 tbsp olive oil 1 tbsp lemon juice	**Apple and Almond Butter** (150-200 cal) 1 medium apple 1 tbsp almond butter	**Hummus and Veggie Sticks** (150-200 cal) 1/4 cup hummus 1/2 cup baby carrots 1/2 cup cucumber slices
2	**Chia Pudding with Blueberries** (300-350 cal) 1/4 cup chia seeds 1 cup almond milk 1/2 cup blueberries 1 tbsp maple syrup 1 tbsp flaxseed meal	**Turkey and Avocado Lettuce Wraps** (350-400 cal) 4 oz sliced turkey breast 1/2 avocado, sliced 4 large lettuce leaves 1/4 cup shredded carrots 1/4 cup cucumber slices 1 tbsp mustard	**Shrimp Stir-Fry** (400-450 cal) 4 oz cooked shrimp 1 cup mixed bell peppers 1/2 cup snap peas 1/2 cup cooked brown rice 1 tbsp coconut aminos 1 tbsp sesame oil	**Mixed Nuts and Dried Fruit** (150-200 cal) 1/4 cup mixed nuts 1/4 cup dried fruit	**Roasted Chickpeas** (150-200 cal) 1/2 cup roasted chickpeas

Day	Breakfast	Lunch	Dinner	Snack 1	Snack 2
1	**Blueberry Almond Smoothie** (300-350 cal) 1 cup almond milk 1 cup frozen blueberries 1 scoop vegan protein powder 1 tbsp chia seeds 1 tbsp almond butter	**Grilled Chicken Salad** (350-400 cal) 4 oz grilled chicken breast 2 cups mixed greens 1/2 cup cherry tomatoes 1/4 cup cucumber slices 1/4 cup sliced red onion 1 tbsp olive oil 1 tbsp apple cider vinegar	**Salmon with Quinoa and Steamed Vegetables** (400-450 cal) 4 oz grilled salmon 1/2 cup cooked quinoa 1 cup steamed broccoli 1 cup steamed carrots 1 tbsp olive oil 1 tbsp lemon juice	**Apple and Almond Butter** (150-200 cal) 1 medium apple 1 tbsp almond butter	**Hummus and Veggie Sticks** (150-200 cal) 1/4 cup hummus 1/2 cup baby carrots 1/2 cup cucumber slices
2	**Chia Pudding with Blueberries** (300-350 cal) 1/4 cup chia seeds 1 cup almond milk 1/2 cup blueberries 1 tbsp maple syrup 1 tbsp flaxseed meal	**Turkey and Avocado Lettuce Wraps** (350-400 cal) 4 oz sliced turkey breast 1/2 avocado, sliced 4 large lettuce leaves 1/4 cup shredded carrots 1/4 cup cucumber slices 1 tbsp mustard	**Shrimp Stir-Fry** (400-450 cal) 4 oz cooked shrimp 1 cup mixed bell peppers 1/2 cup snap peas 1/2 cup cooked brown rice 1 tbsp coconut aminos 1 tbsp sesame oil	**Mixed Nuts and Dried Fruit** (150-200 cal) 1/4 cup mixed nuts 1/4 cup dried fruit	**Roasted Chickpeas** (150-200 cal) 1/2 cup roasted chickpeas
3	**Blueberry and Spinach Smoothie** (300-350 cal) 1 cup almond milk 1 cup frozen blueberries 1 cup spinach 1 scoop vegan protein powder 1 tbsp flaxseed meal	**Tuna Salad Stuffed Bell Peppers** (350-400 cal) 4 oz canned tuna in water 1/4 cup diced celery 1/4 cup diced red onion 1 tbsp olive oil 1 tbsp lemon juice 1 large bell pepper, halved	**Baked Chicken with Sweet Potato and Green Beans** (400-450 cal) 4 oz baked chicken breast 1 medium sweet potato, baked 1 cup steamed green beans 1 tbsp olive oil 1 tbsp lemon juice	**Celery and Sunflower Seed Butter** (150-200 cal) 2 large celery stalks 1 tbsp sunflower seed butter	**Kale Chips** (150-200 cal) 1 cup kale chips
4	**Blueberry and Almond Overnight Oats** (300-350 cal) 1/2 cup gluten-free rolled oats 1 cup almond milk 1/2 cup blueberries 1 tbsp almond butter 1 tbsp chia seeds	**Grilled Chicken and Avocado Salad** (350-400 cal) 4 oz grilled chicken breast 2 cups mixed greens 1/2 avocado, sliced 1/4 cup cherry tomatoes 1/4 cup cucumber slices 1 tbsp olive oil 1 tbsp apple cider vinegar	**Beef and Vegetable Stir-Fry** (400-450 cal) 4 oz cooked lean beef 1 cup mixed bell peppers 1/2 cup snap peas 1/2 cup cooked brown rice 1 tbsp coconut aminos 1 tbsp sesame oil	**Cucumber and Hummus** (150-200 cal) 1/2 cup cucumber slices 1/4 cup hummus	**Almonds and Blueberries** (150-200 cal) 1/4 cup almonds 1/2 cup blueberries
5	**Blueberry and Flaxseed Smoothie** (300-350 cal) 1 cup almond milk 1 cup frozen blueberries 1 scoop vegan protein powder 1 tbsp ground flaxseed 1 tbsp almond butter	**Turkey and Veggie Lettuce Wraps** (350-400 cal) 4 oz sliced turkey breast 4 large lettuce leaves 1/4 cup shredded carrots 1/4 cup cucumber slices 1/4 cup diced red bell pepper 1 tbsp mustard	**Salmon with Brown Rice and Steamed Vegetables** (400-450 cal) 4 oz grilled salmon 1/2 cup cooked brown rice 1 cup steamed broccoli 1 cup steamed carrots 1 tbsp olive oil 1 tbsp lemon juice	**Carrots and Sunflower Seed Butter** (150-200 cal) 1/2 cup baby carrots 1 tbsp sunflower seed butter	**Roasted Seaweed Snacks** (150-200 cal) 1 package roasted seaweed snacks
6	**Blueberry and Spinach Chia Pudding** (300-350 cal) 1/4 cup chia seeds 1 cup almond milk 1/2 cup blueberries 1 cup spinach 1 tbsp maple syrup	**Grilled Chicken and Veggie Skewers** (350-400 cal) 4 oz grilled chicken breast 1/2 cup bell pepper chunks 1/2 cup zucchini chunks 1/4 cup red onion chunks 1 tbsp olive oil 1 tbsp lemon juice	**Shrimp and Vegetable Curry** (400-450 cal) 4 oz cooked shrimp 1 cup mixed bell peppers 1/2 cup snap peas 1/2 cup cooked brown rice 1/4 cup coconut milk 1 tbsp curry powder	**Apple and Sunflower Seed Butter** (150-200 cal) 1 medium apple 1 tbsp sunflower seed butter	**Mixed Nuts and Blueberries** (150-200 cal) 1/4 cup mixed nuts 1/2 cup blueberries

Herbal Medicines

for ADHD

Ginseng, Gingko, Pycnogenol, Saffron, Bacopa, Valerian

Ginseng combined with **ginkgo biloba**

has been shown to improve ADHD symptoms.

- [PMID: 11394191]
- After 2 weeks of treatment, 31% - 67% subjects significantly improved in psychosomatic attribute.
- AFter 4 weeks, 44% experienced improvement in social functioning
- 74% DSM-IV hyperactive-impulsive attribute

> J Psychiatry Neurosci. 2001 May;26(3):221-8.

Effect of the herbal extract combination Panax quinquefolium and Ginkgo biloba on attention-deficit hyperactivity disorder: a pilot study

M R Lyon [1], J C Cline, J Totosy de Zepetnek, J J Shan, P Pang, C Benishin

Affiliations + expand

PMID: 11394191 PMCID: PMC1408291

Free PMC article

Abstract

Objective: A combination herbal product containing American ginseng extract, Panax quinquefolium, (200 mg) and Ginkgo biloba extract (50 mg) (AD-FX; CV Technologies, Edmonton, Alta.) was tested for its ability to improve the symptoms of attention-deficit hyperactivity disorder (ADHD).

Design: Open study.

Patients: 36 children ranging in age from 3 to 17 years who fit the diagnostic criteria for ADHD.

Interventions: AD-FX capsules were taken twice a day on an empty stomach for 4 weeks. Patients were instructed not to change any other medications during the study.

Outcome measures: At the beginning of the study, after 2 weeks, and then at the end of the 4-week trial, parents completed the Conners' Parent Rating Scale--revised, long version, a questionnaire that assesses a broad range of problem behaviours (and was used as an indication of ADHD symptom severity).

Results: After 2 weeks of treatment, the proportion of the subjects exhibiting improvement (i.e., decrease in T-score of at least 5 points) ranged from 31% for the anxious-shy attribute to 67% for the psychosomatic attribute. After 4 weeks of treatment, the proportion of subjects exhibiting improvement ranged from 44% for the social problems attribute to 74% for the Conners' ADHD index and the DSM-IV hyperactive-impulsive attribute. Five (14%) of 36 subjects reported adverse events, only 2 of which were considered related to the study medication.

Conclusions: These preliminary results suggest AD-FX treatment may improve symptoms of ADHD and should encourage further research on the use of ginseng and Ginkgo biloba extracts to treat ADHD symptoms.

Pycnogenol (pine bark)

- 1 month of 1mg/kg/day supplementation can improve hyperactive behavior, attention and visual-motor coordination, and concentration.
  - [PMID: 16699814](https://pubmed.ncbi.nlm.nih.gov/16699814)

PubMed ID zed Controlled Trial > Eur Child Adolesc Psychiatry. 2006 Sep;15(6):329-35.
doi: 10.1007/s00787-006-0538-3. Epub 2006 May 13.

Treatment of ADHD with French maritime pine bark extract, Pycnogenol

Jana Trebatická [1], Sona Kopasová, Zuzana Hradecná, Kamil Cinovský, Igor Skodácek, Ján Suba, Jana Muchová, Ingrid Zitnanová, Iweta Waczulíková, Peter Rohdewald, Zdenka Duracková

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PMID: 16699814 DOI: 10.1007/s00787-006-0538-3

Abstract

Attention Deficit/Hyperactivity Disorder (ADHD) is the most common psychiatric disorder in children. Pycnogenol, an extract from the bark of the French maritime pine, consisting of phenolic acids, catechin, taxifolin and procyanidins, has shown improvement of ADHD in case reports and in an open study. Aim of the present study was to evaluate the effect of Pycnogenol on ADHD symptoms. Sixty-one children were supplemented with 1 mg/kg/day Pycnogenol or placebo over a period of 4 weeks in a randomised, placebo-controlled, doubleblind study. Patients were examined at start of trial, 1 month after treatment and 1 month after end of treatment period by standard questionnaires: CAP (Child Attention Problems) teacher rating scale, Conner's Teacher Rating Scale (CTRS), the Conner's Parent Rating Scale (CPRS) and a modified Wechsler Intelligence Scale for children. Results show that 1-month Pycnogenol administration caused a significant reduction of hyperactivity, improves attention and visual-motoric coordination and concentration of children with ADHD. In the placebo group no positive effects were found. One month after termination of Pycnogenol administration a relapse of symptoms was noted. Our results point to an option to use Pycnogenol as a natural supplement to relieve ADHD symptoms of children.

Saffron therapy

20-30mg per day has similar efficacy to methylphenidate in the treatment of ADHD.
PMID: 30741567

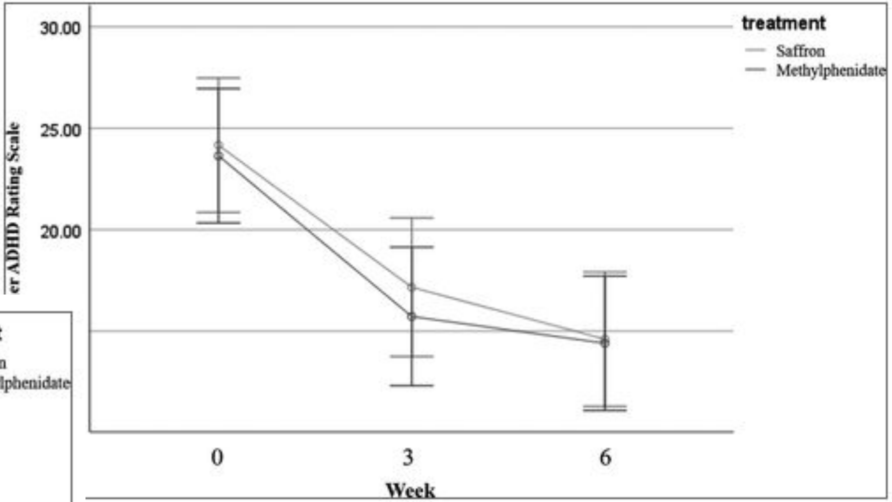
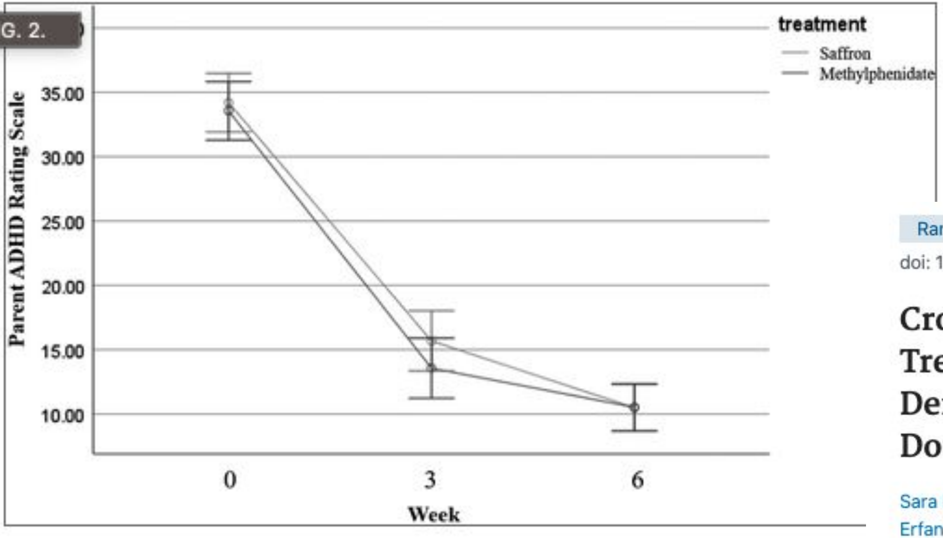


FIG. 2.



Randomized Controlled Trial > J Child Adolesc Psychopharmacol. 2019 Apr;29(3):205-212.
doi: 10.1089/cap.2018.0146. Epub 2019 Feb 11.

Crocus sativus L. Versus Methylphenidate in Treatment of Children with Attention-Deficit/Hyperactivity Disorder: A Randomized, Double-Blind Pilot Study

Sara Baziar [1], Ali Aqamolaei [1], Ebrahim Khadem [2], Seyyed Hosein Mortazavi [1], Sina Naderi [1], Erfan Sahebolzamani [1], Amirhosein Mortezaei [1], Shakiba Jalilevand [1], Mohammad-Reza Mohammadi [1], Mahsa Shahmirzadi [1], Shahin Akhondzadeh [1]

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PMID: 30741567 DOI: 10.1089/cap.2018.0146

Bacopa monnieri (also known as Brahmi) reduces symptoms of restlessness, lack of self-control, attention-deficit symptoms, learning problems, impulsivity, and psychiatric problems in people with ADHD.

[PMID: 24682000]

Clinical Trial > Adv Mind Body Med. 2014 Spring;28(2):10-5.

An open-label study to elucidate the effects of standardized Bacopa monnieri extract in the management of symptoms of attention-deficit hyperactivity disorder in children

Usha Pinakin Dave, Sunila Rajeev Dingankar, Vinod Swaroop Saxena, Joshua Allan Joseph, Bharathi Bethapudi, Amit Agarwal, Venkateshwarlu Kudiganti

PMID: 24682000

Abstract

Context: Attention-deficit hyperactivity disorder (ADHD) is a clinically heterogeneous disorder of inattention, hyperactivity, and impulsivity or difficulty in controlling behavior. Psychostimulant medications remain the mainline treatment for children with ADHD; however, the average response rate to these medications is 70%, and up to 30% of children do not respond to these medications or are unable to tolerate such potential adverse effects as nausea, insomnia, and weight loss.

Objective: The study investigated the effectiveness of standardized Bacopa monnieri extract (SBME) in ameliorating the severity of the symptoms of ADHD in children.

Design: The clinical trial was conducted as an open-label study.

Setting: The study was conducted at the Center for Research in Mental Retardation (CREMERE) in Mumbai, India, from 2008 to 2010.

Participants: Thirty-one children were participants in the trial. They were 6-12 y of age, with an age of onset of ADHD before 7 y of age, as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for ADHD.

Intervention: The children received SBME at a dose of 225 mg/d for a period of 6 mo. The specific SBME used in the study was BacoMind (M/s Natural Remedies, Bangalore, India).

Outcome measures: Subsequent to the screening of participants, the research team administered the Parent Rating Scale to assess the ADHD symptom scores at baseline, and the team administered it again at the end of the 6 mo of treatment.

Results: SBME significantly reduced the subtests scores of ADHD symptoms, except for social problems. The symptom scores for restlessness were reduced in 93% of children, whereas improvement in self-control was observed in 89% of the children. The attention-deficit symptoms were reduced in 85% of children. Similarly, symptom scores for learning problems, impulsivity, and psychiatric problems were reduced for 78%, 67%, and 52% of children, respectively. It was observed that 74% of the children exhibited up to a 20% reduction, while 26% of children showed between a 21% and a 50% reduction in the total subtests scores.

Conclusion: Standardized extract of B monnieri was found to be effective in alleviating the symptoms of ADHD and was well-tolerated by the children.

Valerian

Razlog *et al*	Randomised, double-blind, Placebo-controlled clinical trial	N = 30; age. (5–11 y) gender: 18/9 (m/f).	exp.grp. 1.: *Valeriana officinalis* (mother tincture) 10 drops/3times per day experimental groups 2: *Valeriana officinalis* (homeopathic 3×potency) 10 drops/3 times per day	Placebo tincture in the same dosage	Efficacy was assessed by the Barkley and DuPaul teacher rating scale, the children's checking task and the parent symptom questionnaire scores at baseline, first and the second week of the treatment period and 1 week after the treatment period	Significant improvements of both treatment groups in nearly all subscales of PSQ but after 2 weeks of treatment	The scores of teacher's assessment revealed that the treatment group showed a decrease in symptoms of ADHD	Valeriana officinalis MT and 3X may have benefits in the treatment of ADHD, according to findings

PMID: 35592415

Case Study

Seeing this in action

How Mike Used Diet And Nutrition To Reduce His ADHD Symptoms

by **Dr. Kate Henry** ND

Chief Complaint: ADHD, Brain Fog and Fatigue

Mike was a 29-year-old cis male who presented to our clinic with ADHD symptoms, including impulsivity, difficulty concentrating, and procrastination.

He reported that stimulant medication had improved his ADHD symptoms a bit, but he still struggled to focus during the day. He also experienced extreme brain fog and fatigue as his medications wore off (sometimes known as a medication "crash").

Mike was also experiencing issues with his digestion, insomnia, depression, and anxiety. Our shared goal was to help Mike live an energetic, active life filled with calm, peace, joy, and abundant focus.

We aimed to do that by giving him a food-as-medicine and lifestyle-focused plan that would allow him to control his ADHD symptoms and reduce the side effects of his medications naturally. Here's a bit more background.

Patient History

Mike always had an easy time with school and tested gifted throughout elementary, middle, and high school. He began to struggle academically in college and found that he

Baseline Nutrient Analysis

Mike's nutrient analysis revealed that he was low in the vitamins B1, B2, B3, B5, B12, B9, C, D, E, and K. Mike also under-consumed zinc, which is linked with poor symptom control and a need for higher doses of stimulant medication in people with ADHD.

Additionally, Mike did not consume enough protein (under 53% RDI), which also impacts ADHD by reducing the available tyrosine for conversion to dopamine. His diet was high in processed foods, sodium, and total calories.

General			
Energy	3071.3	kcal	119%
Alcohol	0.0	g	No Target
Caffeine	0.0	mg	No Target
Water	776.1	g	21%

Carbohydrates			
Carbs	355.1	g	120%
Fiber	37.4	g	98%
Starch	1.1	g	No Target
Sugars	109.3	g	No Target
Net Carbs	316.8	g	123%

Lipids			
Fat	145.5	g	169%
Monounsaturated	41.6	g	No Target
Polyunsaturated	52.8	g	No Target
Omega-3	8.9	g	557%
Omega-6	35.8	g	211%
Saturated	29.2	g	n/a
Trans-Fats	0.3	g	n/a
Cholesterol	535.6	mg	No Target

Protein			
Protein	101.3	g	52%
Alanine	3.4	g	No Target

Vitamins			
B1 (Thiamine)	1.0	mg	82%
B2 (Riboflavin)	1.0	mg	79%
B3 (Niacin)	15.0	mg	94%
B5 (Pantothenic Acid)	3.2	mg	63%
B6 (Pyridoxine)	1.8	mg	135%
B12 (Cobalamin)	1.8	µg	76%
Folate	137.4	µg	34%
Vitamin A	6182.8	IU	206%
Vitamin C	55.5	mg	62%
Vitamin D	88.0	IU	15%
Vitamin E	9.6	mg	64%
Vitamin K	91.7	µg	76%

Minerals			
Calcium	547.7	mg	55%
Copper	1.6	mg	178%
Iron	18.0	mg	225%
Magnesium	413.7	mg	99%
Manganese	2.8	mg	121%
Phosphorus	1039.2	mg	148%
Potassium	3182.3	mg	94%
Selenium	82.0	µg	149%
Sodium	4746.3	mg	316%
Zinc	9.0	mg	82%

Baseline Labs

Lab	Optimal Reference Range	Patients Starting Values
Testosterone	348-1197 ng/dL	666
TSH	0.45-4.50 uIU/mL	2.78
Vitamin D	30.0–100 ng/mL	29.6 (L)
Pertinent Normals: CBC, CMP and Lipid Panel were within normal limits		
Food Sensitivities: (3+) Gluten, Dairy, Peanuts		

Lab Analysis

Mike's lab work was mostly normal but pointed to a few issues that were reflective of abnormal endocrine function that was worsening his symptoms of brain fog, ADHD, and fatigue.

- Vitamin D level was low, which is linked to depression and ADHD symptoms.
- Food sensitivity results that were ordered by a previous provider indicated a high reactivity to Gluten, Dairy, and Peanuts
- Testosterone and TSH levels were normal, but you will see later in the article that they improve with his protocol, emphasizing the importance of a healthy diet and lifestyle.

Mike was prescribed mild time-restricted feeding (TRF) combined with chrononutrition. His eating window was reduced to 12 hours (7 am-7 pm) versus his original 16+ hours eating window.

This was done to increase the likelihood that his gut would heal and that he'd perform optimal autophagy during sleep, which is an essential factor for optimal brain health.

Food sensitivities were swapped out for whole foods products that provided him higher micronutrients, protein, fiber, and omega 3's.

There are currently many studies that suggest nutritional sensitivities can worsen ADHD symptoms.

Processed, canned, and frozen foods were swapped for meats, vegetables, legumes, fruits, nuts, and seeds.

His meal plan emphasized easy-to-prepare meals and snacks that he enjoyed to increase his likelihood of sticking with this meal plan. Many people with ADHD struggle to meal plan and cook consistently, so his plan also contained grab-and-go options for the days when he couldn't prepare meals.

Additionally, his new meal plan gave him enough tyrosine and vitamins to make dopamine each day.

Supplements

- He was prescribed a once-daily multivitamin that contained vitamins A-K, biotin, choline, iodine, zinc, selenium, manganese, chromium, molybdenum, boron, inositol, CoQ10, Alpha lipoic acid, lutein, zeaxanthin, lycopene. Zinc, in particular, is linked to improved outcomes in ADHD.
- Digestive enzymes with meals to increase nutrient absorption.
- DIM Detox supplement twice daily between meals to assist with methylation and phase I, phase II liver detoxification.
- Fish oil supplement at 2-4 grams of combined DHA/EPA daily. Red blood cell levels of omega 3 fatty acids are generally lower in people with ADHD, and supplementation can improve outcomes.

Follow Up Nutrient Analysis

General			
Energy	2956.9	kcal	99%
Alcohol	2.1	g	No Target
Caffeine	7.0	mg	No Target
Water	1211.2	g	33%

Carbohydrates			
Carbs	307.6	g	92%
Fiber	30.2	g	79%
Starch	87.0	g	No Target
Sugars	114.3	g	No Target
Net Carbs	277.4	g	93%

Lipids			
Fat	108.2	g	109%
Monounsaturated	27.6	g	No Target
Polyunsaturated	12.5	g	No Target
Omega-3	2.1	g	131%
Omega-6	6.7	g	39%
Saturated	29.2	g	n/a
Trans-Fats	0.9	g	n/a
Cholesterol	1901.3	mg	No Target

Protein			
Protein	188.8	g	85%
Alanine	8.9	g	No Target

Vitamins			
B1 (Thiamine)	4.0	mg	333%
B2 (Riboflavin)	2.9	mg	221%
B3 (Niacin)	305.9	mg	1912%
B5 (Pantothenic Acid)	35.2	mg	703%
B6 (Pyridoxine)	5.6	mg	433%
B12 (Cobalamin)	543.5	µg	22647%
Folate	752.6	µg	188%
Vitamin A	17568.0	IU	586%
Vitamin C	1250.8	mg	1390%
Vitamin D	5536.0	IU	923%
Vitamin E	27.3	mg	182%
Vitamin K	170.7	µg	142%

Minerals			
Calcium	1386.9	mg	139%
Copper	4.7	mg	524%
Iron	54.9	mg	686%
Magnesium	330.4	mg	79%
Manganese	5.2	mg	224%
Phosphorus	1218.1	mg	174%
Potassium	2807.5	mg	83%
Selenium	218.0	µg	396%
Sodium	2466.1	mg	164%
Zinc	128.6	mg	1169%

Mike's individualized nutrition plan was designed to be healthy, easy to cook, and fun to eat. It was also designed to correct his inadequate intake of vitamins B1, B2, B3, B5, B12, B9, C, D, E, and K.

Follow Up Labs

- Vitamin D is now normal
- TSH, and testosterone levels improved naturally over time with this protocol.

Lab	Optimal Reference Range	Patients Values Before Program	Patient Values after 6 months	Patients values after 1.5 years of protocol
Testosterone	348-1197 ng/dL	666	835	1065 (Normal & Improved)
TSH	0.45-4.50 uIU/mL	2.78	2.02	1.82 (Normal & Improved)
Vitamin D	30.0–100 ng/mL	29.6 (L)	n/a	47.9 (Normal)

Results From a Functional Medicine ADHD Treatment Program

Over the course of a year and a half, Mike and I had three more follow-ups. At his third follow-up, he reported that he felt significantly better. His concentration had improved, and his daytime fatigue and brain fog were gone. He had lost fat and water weight and increased his muscle mass. He was no longer bloated and felt that he digested foods much more easily. As a result, his body image had improved, and he looked and felt better.

Mike also reported that he now slept through the night and no longer experienced daytime or nighttime anxiety. His daily caffeine intake had decreased by 50% without associated reductions in alertness, energy level, or focus. He noticed fewer side effects from his medications and was able to experience a noticeable increase in their clinical effectiveness at the same dose. He hadn’t had to pull over while driving in months.

Mike now felt that his ADHD symptoms were under control for the first time in years.

Thank You

Get In Touch:

drkate@rupahealth.com

References:

1. "ADHD Statistics: New ADD Facts and Research." *ADDitude*, 6 Oct. 2006, www.additudemag.com/statistics-of-adhd/#:~:text=ADHD%20Prevalence%20in%20Children,Control%20and%20Prevention%20(CDC). Accessed 29 Jan. 2022.
2. Adeyemo BO, Biederman J, Zafonte R, Kagan E, Spencer TJ, Uchida M, Kenworthy T, Spencer AE, Faraone SV. Mild traumatic brain injury and ADHD: a systematic review of the literature and meta-analysis. J Atten Disord. 2014 Oct;18(7):576-84. doi: 10.1177/1087054714543371. Epub 2014 Jul 21. PMID: 25047040.
3. Ahn, James, et al. "Natural Product-Derived Treatments for Attention-Deficit/Hyperactivity Disorder: Safety, Efficacy, and Therapeutic Potential of Combination Therapy." *Neural Plasticity*, vol. 2016, 2016, pp. 1–18, www.ncbi.nlm.nih.gov/pmc/articles/PMC4757677/, https://doi.org/10.1155/2016/1320423. Accessed 28 Nov. 2022.
4. Akhondzadeh, Shahin, et al. "Zinc Sulfate as an Adjunct to Methylphenidate for the Treatment of Attention Deficit Hyperactivity Disorder in Children: A Double Blind and Randomized Trial [ISRCTN64132371]." *BMC Psychiatry*, vol. 4, no. 1, 8 Apr. 2004, www.ncbi.nlm.nih.gov/pmc/articles/PMC400741/, https://doi.org/10.1186/1471-244x-4-9. Accessed 28 Nov. 2022.

5. Anheyer, Dennis, et al. “Herbal Medicines in Children with Attention Deficit Hyperactivity Disorder (ADHD): A Systematic Review.” *Complementary Therapies in Medicine*, vol. 30, Feb. 2017, pp. 14–23, www.sciencedirect.com/science/article/abs/pii/S0965229916303284?via%3Dihub, https://doi.org/10.1016/j.ctim.2016.11.004. Accessed 28 Nov. 2022.

6. Antalis, Caryl J., et al. “Omega-3 Fatty Acid Status in Attention-Deficit/Hyperactivity Disorder.” *Prostaglandins, Leukotrienes and Essential Fatty Acids*, vol. 75, no. 4-5, Oct. 2006, pp. 299–308, pubmed.ncbi.nlm.nih.gov/16962757/, https://doi.org/10.1016/j.plefa.2006.07.004. Accessed 30 Jan. 2022.

7. Arnold, L. Eugene, et al. “Zinc for Attention-Deficit/Hyperactivity Disorder: Placebo-Controlled Double-Blind Pilot Trial Alone and Combined with Amphetamine.” *Journal of Child and Adolescent Psychopharmacology*, vol. 21, no. 1, Feb. 2011, pp. 1–19, www.ncbi.nlm.nih.gov/pmc/articles/PMC3037197/, https://doi.org/10.1089/cap.2010.0073. Accessed 30 Jan. 2022.

8. “Attention-Deficit/Hyperactivity Disorder.” *National Institute of Mental Health (NIMH)*, 2021, www.nimh.nih.gov/health/topics/attention-deficit-hyperactivity-disorder-adhd. Accessed 28 Jan. 2022.

9. Avcil, Sibelnur. “Association between Altered Lipid Profiles and Attention Deficit Hyperactivity Disorder in Boys.” *Nordic Journal of Psychiatry*, vol. 72, no. 5, 24 Apr. 2018, pp. 361–366, pubmed.ncbi.nlm.nih.gov/29688116/, https://doi.org/10.1080/08039488.2018.1465591. Accessed 30 Jan. 2022.

10. Baziar, Sara, et al. “*Crocus Sativus* L. Versus Methylphenidate in Treatment of Children with Attention-Deficit/Hyperactivity Disorder: A Randomized, Double-Blind Pilot Study.” *Journal of Child and Adolescent Psychopharmacology*, vol. 29, no. 3, Apr. 2019, pp. 205–212, pubmed.ncbi.nlm.nih.gov/30741567/, https://doi.org/10.1089/cap.2018.0146. Accessed 28 Nov. 2022.

11. Becker SP. ADHD and sleep: recent advances and future directions. Curr Opin Psychol. 2020 Aug;34:50-56. doi: 10.1016/j.copsyc.2019.09.006. Epub 2019 Sep 20. PMID: 31629217; PMCID: PMC7082190.

12. Bilici, Mustafa, et al. “Double-Blind, Placebo-Controlled Study of Zinc Sulfate in the Treatment of Attention Deficit Hyperactivity Disorder.” *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, vol. 28, no. 1, Jan. 2004, pp. 181–190, pubmed.ncbi.nlm.nih.gov/14687872/, https://doi.org/10.1016/j.pnpbp.2003.09.034. Accessed 28 Nov. 2022.

13. Bloch, Michael H., and Jilian Mulqueen. “Nutritional Supplements for the Treatment of ADHD.” *Child and Adolescent Psychiatric Clinics of North America*, vol. 23, no. 4, Oct. 2014, pp. 883–897, www.ncbi.nlm.nih.gov/pmc/articles/PMC4170184/, https://doi.org/10.1016/j.chc.2014.05.002. Accessed 7 Feb. 2022.

14. Bonvicini C, Faraone SV, Scassellati C. Attention-deficit hyperactivity disorder in adults: A systematic review and meta-analysis of genetic, pharmacogenetic and biochemical studies. Mol Psychiatry. 2016 Jul;21(7):872-84. doi: 10.1038/mp.2016.74. Epub 2016 May 24. Erratum in: Mol Psychiatry. 2016 Nov;21(11):1643. PMID: 27217152; PMCID: PMC5414093.

15. Bos, Dienke J, et al. “Reduced Symptoms of Inattention after Dietary Omega-3 Fatty Acid Supplementation in Boys with and without Attention Deficit/Hyperactivity Disorder.” *Neuropsychopharmacology*, vol. 40, no. 10, 19 Mar. 2015, pp. 2298–2306, www.ncbi.nlm.nih.gov/pmc/articles/PMC4538345/, https://doi.org/10.1038/npp.2015.73. Accessed 22 Jan. 2022

16. Bosch, Annick, et al. “A Two Arm Randomized Controlled Trial Comparing the Short and Long Term Effects of an Elimination Diet and a Healthy Diet in Children with ADHD (TRACE Study). Rationale, Study Design and Methods.” *BMC Psychiatry*, vol. 20, no. 1, 27 May 2020, pubmed.ncbi.nlm.nih.gov/32460725/, https://doi.org/10.1186/s12888-020-02576-2.

Accessed 9 Feb.2022.

.

17. Cabral MDI, Liu S, Soares N. Attention-deficit/hyperactivity disorder: diagnostic criteria, epidemiology, risk factors and evaluation in youth. Transl Pediatr. 2020 Feb;9(Suppl 1):S104-S113. doi: 10.21037/tp.2019.09.08. PMID: 32206588; PMCID: PMC7082246.

18. Calarge, Chadi, et al. "Serum Ferritin and Amphetamine Response in Youth with Attention-Deficit/Hyperactivity Disorder." *Journal of Child and Adolescent Psychopharmacology*, vol. 20, no. 6, Dec. 2010, pp. 495–502, www.ncbi.nlm.nih.gov/pmc/articles/PMC3003494/, https://doi.org/10.1089/cap.2010.0053. Accessed 22 Jan. 2022.

19. CDC. "Data and Statistics about ADHD." *Centers for Disease Control and Prevention*, 16 Nov. 2020, www.cdc.gov/ncbddd/adhd/data.html. Accessed 20 Jan. 2022.

20. Centers for Disease Control and Prevention, et al. *CDC's Second Nutrition Report: A Comprehensive Biochemical Assessment of the Nutrition Status of the U.S. Population Report Measures 58 Indicators of Diet and Nutrition New Report Uses NHANES Results*. 2012.

21. Checa-Ros A, Jeréz-Calero A, Molina-Carballo A, Campoy C, Muñoz-Hoyos A. Current Evidence on the Role of the Gut Microbiome in ADHD Pathophysiology and Therapeutic Implications. *Nutrients*. 2021 Jan 16;13(1):249. doi: 10.3390/nu13010249. PMID: 33467150; PMCID: PMC7830868.

22. Chovanová, Zuzana, et al. “Effect of Polyphenolic Extract, Pycnogenol®, on the Level of 8-Oxoguanine in Children Suffering from Attention Deficit/Hyperactivity Disorder.” *Free Radical Research*, vol. 40, no. 9, Jan. 2006, pp. 1003–1010, pubmed.ncbi.nlm.nih.gov/17015282/, https://doi.org/10.1080/10715760600824902. Accessed 28 Nov. 2022.

23. Chung W, Jiang S, Paksarian D, et al. Trends in the Prevalence and Incidence of Attention-Deficit/Hyperactivity Disorder Among Adults and Children of Different Racial and Ethnic Groups. *JAMA Netw Open*. 2019;2(11):e1914344.

24. Colter, Ashley L, et al. “Fatty Acid Status and Behavioural Symptoms of Attention Deficit Hyperactivity Disorder in Adolescents: A Case-Control Study.” *Nutrition Journal*, vol. 7, no. 1, 14 Feb. 2008, pubmed.ncbi.nlm.nih.gov/18275609/, https://doi.org/10.1186/1475-2891-7-8. Accessed 30 Jan. 2022.

25. Demirci, Kadir, et al. “The Investigation of Symptoms and Diagnoses of Adult-Attention Deficit/ Hyperactivity Disorder in Women with Iron Deficiency Anemia.” *Noro Psikiyatri Arsivi*, vol. 54, no. 1, 8 May 2017, pp. 72–77, www.ncbi.nlm.nih.gov/pmc/articles/PMC5439476/, https://doi.org/10.5152/npa.2016.12464. Accessed 11 Mar. 2021.

26. Den Heijer AE, Groen Y, Tucha L, Fuermaier AB, Koerts J, Lange KW, Thome J, Tucha O. Sweat it out? The effects of pysical exercise on cognition and behavior in children and adults with ADHD: a systematic literature review. J Neural Transm (Vienna). 2017 Feb;124(Suppl 1):3-26. doi: 10.1007/s00702-016-1593-7. *Epub* 2016 Jul 11. PMID:

27. Dodig-Curković K;Dovhanj J;Curković M;Dodig-Radić J;Degmecić D. "[the Role of Zinc in the Treatment of Hyperactivity Disorder in Children]." *Acta Medica Croatica : Casopis Hravatske Akademije Medicinskih Znanosti*, vol. 63, no. 4, 2012, pubmed.ncbi.nlm.nih.gov/20034331/. Accessed 11 Mar. 2021.

28. Dutta, Tusheema, et al. "Phytotherapy for Attention Deficit Hyperactivity Disorder (ADHD): A Systematic Review and Meta-Analysis." *Frontiers in Pharmacology*, vol. 13, 3 May 2022, www.ncbi.nlm.nih.gov/pmc/articles/PMC9110892/, https://doi.org/10.3389/fphar.2022.827411. Accessed 28 Nov. 2022.

29. "Phytotherapy for Attention Deficit Hyperactivity Disorder (ADHD): A Systematic Review and Meta-Analysis." *Frontiers in Pharmacology*, vol. 13, 3 May 2022, pubmed.ncbi.nlm.nih.gov/35592415/, https://doi.org/10.3389/fphar.2022.827411. Accessed 28 Nov. 2022.

30. “Effects of Iron Supplementation Twice a Week on Attention Score and Haematologic Measures in Female High School Students | SMJ.” *Smj.org.sg*, 2014, www.smj.org.sg/article/effects-iron-supplementation-twice-week-attention-score-and-haematologic-measures-female. Accessed 10 Feb. 2022.

31. Faraone SV, Rostain AL, Blader J, Busch B, Childress AC, Connor DF, Newcorn JH. Practitioner Review: Emotional dysregulation in attention-deficit/hyperactivity disorder - implications for clinical recognition and intervention. J Child Psychol Psychiatry. 2019 Feb;60(2):133-150. doi: 10.1111/jcpp.12899. Epub 2018 Apr 6. PMID: 29624671.

32. Fageera W, Chaumette B, Fortier MÈ, Grizenko N, Labbe A, Sengupta SM, Joober R. Association between COMT methylation and response to treatment in children with ADHD. J Psychiatr Res. 2021 Mar;135:86-93. doi: 10.1016/j.jpsychires.2021.01.008. Epub 2021 Jan 7. PMID: 33453563.

33. “Fruit and Vegetable Intake Is Inversely Associated with Severity of Inattention in a Pediatric Population with ADHD Symptoms: The MADDY Study.” *Nutritional Neuroscience*, 2022, www.tandfonline.com/doi/full/10.1080/1028415X.2022.2071805. Accessed 5 June 2022.

34. Glenn, Jordan M., et al. “Dietary Protein and Amino Acid Intake: Links to the Maintenance of Cognitive Health.” *Nutrients*, vol. 11, no. 6, 12 June 2019, p. 1315, www.ncbi.nlm.nih.gov/pmc/articles/PMC6627761/, https://doi.org/10.3390/nu11061315. Accessed 28 Oct. 2021.

35. Gordon, Heather A, et al. “Clinically Significant Symptom Reduction in Children with Attention-Deficit/Hyperactivity Disorder

Treated with Micronutrients: An Open-Label Reversal Design Study.” *Journal of Child and Adolescent Psychopharmacology*, vol. 25, no. 10, Dec. 2015, pp. 783–798, www.ncbi.nlm.nih.gov/pmc/articles/PMC4702182/, https://doi.org/10.1089/cap.2015.0105. Accessed 28 Nov. 2022.

36. “Clinically Significant Symptom Reduction in Children with Attention-Deficit/Hyperactivity Disorder Treated with Micronutrients: An Open-Label Reversal Design Study.” *Journal of Child and Adolescent Psychopharmacology*, vol. 25, no. 10, Dec. 2015, pp. 783–798, www.ncbi.nlm.nih.gov/pmc/articles/PMC4702182/, https://doi.org/10.1089/cap.2015.0105. Accessed 28 Nov. 2022.

37. Gow, Rachel V., et al. “Total Red Blood Cell Concentrations of ω-3 Fatty Acids Are Associated with Emotion-Elicited Neural Activity in Adolescent Boys with Attention-Deficit Hyperactivity Disorder.” *Prostaglandins, Leukotrienes and Essential Fatty Acids*, vol. 80, no. 2-3, Feb. 2009, pp. 151–156, pubmed.ncbi.nlm.nih.gov/19230637/, https://doi.org/10.1016/j.plefa.2008.12.007. Accessed 30 Jan. 2022.

38. Hanly C, Shah H, Au PYB, Murias K. Description of neurodevelopmental phenotypes associated with 10 genetic neurodevelopmental disorders: A scoping review. C*lin Genet. 2021* Mar;99(3):335-346. doi: 10.1111/cge.13882. Epub 2020 Nov 18. PMID: 33179249.

39. Haimov-Kochman, Ronit, and Itai Berger. “Cognitive Functions of Regularly Cycling Women May Differ throughout the Month, Depending on Sex Hormone Status; a Possible Explanation to Conflicting Results of Studies of ADHD in Females.” *Frontiers in Human Neuroscience*, vol. 8, 1 Apr. 2014, www.ncbi.nlm.nih.gov/pmc/articles/PMC3978296/, https://doi.org/10.3389/fnhum.2014.00191. Accessed 7 Feb. 2022.

38. Hirayama, S., et al. “The Effect of Phosphatidylserine Administration on Memory and Symptoms of Attention‐Deficit Hyperactivity Disorder: A Randomised, Double‐Blind, Placebo‐Controlled Clinical Trial.” *Journal of Human Nutrition and Dietetics*, vol. 27, no. s2, 17 Mar. 2013, pp. 284–291, pubmed.ncbi.nlm.nih.gov/23495677/, https://doi.org/10.1111/jhn.12090. Accessed 28 Nov. 2022.

39. ---. “The Effect of Phosphatidylserine Administration on Memory and Symptoms of Attention‐Deficit Hyperactivity Disorder: A Randomised, Double‐Blind, Placebo‐Controlled Clinical Trial.” *Journal of Human Nutrition and Dietetics*, vol. 27, no. s2, 17 Mar. 2013, pp. 284–291, pubmed.ncbi.nlm.nih.gov/23495677/, https://doi.org/10.1111/jhn.12090. Accessed 28 Nov. 2022.

40. Holton, Kathleen F., et al. “Evaluation of Dietary Intake in Children and College Students with and without Attention-Deficit/Hyperactivity Disorder.” *Nutritional Neuroscience*, vol. 22, no. 9, 23 Jan. 2018, pp. 664–677, www.ncbi.nlm.nih.gov/pmc/articles/PMC6309508/, https://doi.org/10.1080/1028415x.2018.1427661. Accessed 28 Nov. 2022.

41. Huss, Michael, et al. “Supplementation of Polyunsaturated Fatty Acids, Magnesium and Zinc in Children Seeking Medical Advice for Attention-Deficit/Hyperactivity Problems - an Observational Cohort Study.” *Lipids in Health and Disease*, vol. 9, no. 1, 2010, p. 105, www.ncbi.nlm.nih.gov/pmc/articles/PMC2955638/, https://doi.org/10.1186/1476-511x-9-105. Accessed 11 Mar. 2021.

42. Hwang, Wu Jeong, et al. "The Role of Estrogen Receptors and Their Signaling across Psychiatric Disorders." *International Journal of Molecular Sciences*, vol. 22, no. 1, 31 Dec. 2020, p. 373, www.ncbi.nlm.nih.gov/pmc/articles/PMC7794990/, https://doi.org/10.3390/ijms22010373. Accessed 10 Feb. 2022.

43. Islam, Kamirul, et al. "A Study on Association of Iron Deficiency with Attention Deficit Hyperactivity Disorder in a Tertiary Care Center." *Indian Journal of Psychiatry*, vol. 60, no. 1, 2018, p. 131, pubmed.ncbi.nlm.nih.gov/29736076/, https://doi.org/10.4103/psychiatry.indianjpsychiatry_197_17. Accessed 11 Mar. 2021.

44. Kamal, Madeeha, et al. "Is High Prevalence of Vitamin D Deficiency a Correlate for Attention Deficit Hyperactivity Disorder?" *ADHD Attention Deficit and Hyperactivity Disorders*, vol. 6, no. 2, 9 Mar. 2014, pp. 73–78, pubmed.ncbi.nlm.nih.gov/24610453/, https://doi.org/10.1007/s12402-014-0130-5. Accessed 30 Jan. 2022.

45. Kelly, Daniel M, and T Hugh Jones. "Testosterone: A Metabolic Hormone in Health and Disease." *Journal of Endocrinology*, vol. 217, no. 3, 30 Jan. 2013, pp. R25–R45, pubmed.ncbi.nlm.nih.gov/23378050/, https://doi.org/10.1530/joe-12-0455. Accessed 30 Jan. 2022.

46. Khedr, Eman, et al. “Iron States and Cognitive Abilities in Young Adults: Neuropsychological and Neurophysiological Assessment.” *European Archives of Psychiatry and Clinical Neuroscience*, vol. 258, no. 8, 20 June 2008, pp. 489–496, pubmed.ncbi.nlm.nih.gov/18574611/, https://doi.org/10.1007/s00406-008-0822-y. Accessed 10 Feb. 2022.

47. Konikowska K;Regulska-Ilow B;Rózańska D. “The Influence of Components of Diet on the Symptoms of ADHD in Children.” *Roczniki Panstwowego Zakladu Higieny*, vol. 63, no. 2, 2012, pubmed.ncbi.nlm.nih.gov/22928358/. Accessed 27 Oct. 2021.

48. Konofal, Eric, and Samuele Cortese. “Lead and Neuroprotection by Iron in ADHD.” *Environmental Health Perspectives*, vol. 115, no. 8, Aug. 2007, www.ncbi.nlm.nih.gov/pmc/articles/PMC1940080/, https://doi.org/10.1289/ehp.10304. Accessed 10 Feb. 2022.

49. Kris-Etherton, Penny M, et al. “Nutrition and Behavioral Health Disorders: Depression and Anxiety.” *Nutrition Reviews*, vol. 79, no. 3, 24 May 2020, pp. 247–260, www.ncbi.nlm.nih.gov/pmc/articles/PMC8453603/, https://doi.org/10.1093/nutrit/nuaa025. Accessed 23 Feb. 2022.

50. Leeds PR, Yu F, Wang Z, Chiu CT, Zhang Y, Leng Y, Linares GR, Chuang DM. A new avenue for lithium: intervention in traumatic brain injury. ACS Chem Neurosci. 2014 Jun 18;5(6):422-33. doi: 10.1021/cn500040g. Epub 2014 Apr 11. PMID: 24697257; PMCID: PMC4063503

51. Leeds PR, Yu F, Wang Z, Chiu CT, Zhang Y, Leng Y, Linares GR, Chuang DM. A new avenue for lithium: intervention in traumatic brain injury. ACS Chem Neurosci. 2014 Jun 18;5(6):422-33. doi: 10.1021/cn500040g. Epub 2014 Apr 11. PMID: 24697257; PMCID: PMC4063503

52. Lepping, Peter, and Markus Huber. “Role of Zinc in the Pathogenesis of Attention-Deficit Hyperactivity Disorder.” *CNS Drugs*, July 2010, p. 1, pubmed.ncbi.nlm.nih.gov/20806985/, https://doi.org/10.2165/11537610-000000000-00000. Accessed 30 Jan. 2022.

53. Lindblad, Frank, et al. “Fasting Blood Glucose and HbA1c in Children with ADHD.” *Psychiatry Research*, vol. 226, no. 2-3, Apr. 2015, pp. 515–516, pubmed.ncbi.nlm.nih.gov/25747679/, https://doi.org/10.1016/j.psychres.2015.01.028. Accessed 30 Jan. 2022.

54. Ly V, Bottelier M, Hoekstra PJ, Arias Vasquez A, Buitelaar JK, Rommelse NN. Elimination diets' efficacy and mechanisms in attention deficit hyperactivity disorder and autism spectrum disorder. Eur Child Adolesc Psychiatry. 2017 Sep;26(9):1067-1079. doi: 10.1007/s00787-017-0959-1. Epub 2017 Feb 11. PMID: 28190137; PMCID: PMC5591346.

55. Lyon, M R, et al. “Effect of the Herbal Extract Combination Panax Quinquefolium and Ginkgo Biloba on Attention-Deficit Hyperactivity Disorder: A Pilot Study.” *Journal of Psychiatry & Neuroscience : JPN*, vol. 26, no. 3, 2001, pp. 221–8, www.ncbi.nlm.nih.gov/pmc/articles/PMC1408291/. Accessed 28 Nov. 2022.

56. Maier JAM, Locatelli L, Fedele G, Cazzaniga A, Mazur A. Magnesium and the Brain: A Focus on Neuroinflammation and Neurodegeneration. Int J Mol Sci. 2022 Dec 23;24(1):223. doi: 10.3390/ijms24010223. PMID: 36613667; PMCID: PMC9820677.

57. Manor, I., et al. “The Effect of Phosphatidylserine Containing Omega3 Fatty-Acids on Attention-Deficit Hyperactivity Disorder Symptoms in Children: A Double-Blind Placebo-Controlled Trial, Followed by an Open-Label Extension.” *European Psychiatry*, vol. 27, no. 5, July 2012, pp. 335–342, pubmed.ncbi.nlm.nih.gov/21807480/, https://doi.org/10.1016/j.eurpsy.2011.05.004. Accessed 28 Nov. 2022.

58. Mathee K, Cickovski T, Deoraj A, Stollstorff M, Narasimhan G. The gut microbiome and neuropsychiatric disorders: implications for attention deficit hyperactivity disorder (ADHD). J Med Microbiol. 2020 Jan;69(1):14-24. doi: 10.1099/jmm.0.001112. PMID: 31821133; PMCID: PMC7440676.

59. May, James M., et al. “Mechanisms of Ascorbic Acid Stimulation of Norepinephrine Synthesis in Neuronal Cells.” *Biochemical and Biophysical Research Communications*, vol. 426, no. 1, Sept. 2012, pp. 148–152, www.ncbi.nlm.nih.gov/pmc/articles/PMC3449284/, https://doi.org/10.1016/j.bbrc.2012.08.054. Accessed 11 Mar. 2021.

60.. Markiewcz R. The use of EEG Biofeedback/Neurofeedback in psychiatric rehabilitation. Psychiatr Pol. 2017 Dec 30;51(6):1095-1106. English, Polish. doi: 10.12740/PP/68919. Epub 2017 Dec 30. PMID: 29432505.

61. Mehren, Aylin, et al. “Physical Exercise in Attention Deficit Hyperactivity Disorder – Evidence and Implications for the Treatment of Borderline Personality Disorder.” *Borderline Personality Disorder and Emotion Dysregulation*, vol. 7, no. 1, 6 Jan. 2020, www.ncbi.nlm.nih.gov/pmc/articles/PMC6945516/, https://doi.org/10.1186/s40479-019-0115-2. Accessed 2 May 2023.

62.. Mousain-Bosc M;Roche M;Polge A;Pradal-Prat D;Rapin J;Bali JP. “Improvement of Neurobehavioral Disorders in Children Supplemented with Magnesium-Vitamin B6. I. Attention Deficit Hyperactivity Disorders.” *Magnesium Research*, vol. 19, no. 1, 2014, pubmed.ncbi.nlm.nih.gov/16846100/. Accessed 28 Nov. 2022.

63.. ---. “Improvement of Neurobehavioral Disorders in Children Supplemented with Magnesium-Vitamin B6. I. Attention Deficit Hyperactivity Disorders.” *Magnesium Research*, vol. 19, no. 1, 2014, pubmed.ncbi.nlm.nih.gov/16846100/. Accessed 1 Mar. 2023.

64. Murray-Kolb, Laura E, and John L Beard. “Iron Treatment Normalizes Cognitive Functioning in Young Women.” *The American Journal of Clinical Nutrition*, vol. 85, no. 3, 1 Mar. 2007, pp. 778–787, pubmed.ncbi.nlm.nih.gov/17344500/, https://doi.org/10.1093/ajcn/85.3.778. Accessed 10 Feb. 2022.

65. Nigg, Joel T., and Kathleen Holton. “Restriction and Elimination Diets in ADHD Treatment.” *Child and Adolescent Psychiatric Clinics of North America*, vol. 23, no. 4, Oct. 2014, pp. 937–953, www.ncbi.nlm.nih.gov/pmc/articles/PMC4322780/, https://doi.org/10.1016/j.chc.2014.05.010. Accessed 1 Mar. 2023.

66. “Office of Dietary Supplements - Vitamin D.” *Nih.gov*, 2015, ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/. Accessed 20 Jan. 2022. Parkman, Henry P., et al. “Dietary Intake and Nutritional Deficiencies in Patients with Diabetic or Idiopathic Gastroparesis.” *Gastroenterology*, vol. 141, no. 2, Aug. 2011, pp. 486-498.e7, pubmed.ncbi.nlm.nih.gov/21684286/, https://doi.org/10.1053/j.gastro.2011.04.045. Accessed 9 Feb. 2022.

67. Parletta, Natalie, et al. “Omega-3 and Omega-6 Polyunsaturated Fatty Acid Levels and Correlations with Symptoms in Children with Attention Deficit Hyperactivity Disorder, Autistic Spectrum Disorder and Typically Developing Controls.” *PLOS ONE*, vol. 11, no. 5, 27 May 2016, p. e0156432, pubmed.ncbi.nlm.nih.gov/27232999/, https://doi.org/10.1371/journal.pone.0156432. Accessed 30 Jan. 2022.

68. Placebo-Controlled Study of the Effects of Supplementation with Highly Unsaturated Fatty Acids on ADHD-Related Symptoms in Children with Specific Learning Difficulties." *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, vol. 26, no. 2, Feb. 2002, pp. 233–239, pubmed.ncbi.nlm.nih.gov/11817499/, https://doi.org/10.1016/s0278-5846(01)00254-8. Accessed 28 Nov. 2022.

69. Richardson, Alexandra J, and Basant K Puri. "A Randomized Double-Blind, Robberecht, Harry, et al. "Magnesium, Iron, Zinc, Copper and Selenium Status in Attention-Deficit/Hyperactivity Disorder (ADHD)." *Molecules*, vol. 25, no. 19, 27 Sept. 2020, p. 4440, www.ncbi.nlm.nih.gov/pmc/articles/PMC7583976/, https://doi.org/10.3390/molecules25194440. Accessed 28 Nov. 2022.

70. Roberts, Bethan, et al. "Reproductive Steroids and ADHD Symptoms across the Menstrual Cycle." *Psychoneuroendocrinology*, vol. 88, Feb. 2018, pp. 105–114, www.ncbi.nlm.nih.gov/pmc/articles/PMC5803442/, https://doi.org/10.1016/j.psyneuen.2017.11.015. Accessed 10 Feb. 2022.

71. Saccaro LF, Schilliger Z, Perroud N, Piguet C. Inflammation, Anxiety, and Stress in Attention-Deficit/Hyperactivity Disorder. *Biomedicines.* 2021 Sep 24;9(10):1313. doi: 10.3390/biomedicines9101313. PMID: 34680430; PMCID: PMC8533349.

72. Salvat, Habibeh, et al. “Nutrient Intake, Dietary Patterns, and Anthropometric Variables of Children with ADHD in Comparison to Healthy Controls: A Case-Control Study.” *BMC Pediatrics*, vol. 22, no. 1, 29 Jan. 2022, www.ncbi.nlm.nih.gov/pmc/articles/PMC8800296/, https://doi.org/10.1186/s12887-022-03123-6. Accessed 28 Nov. 2022.

73. Scassellati, Catia, et al. “Biomarkers and Attention-Deficit/Hyperactivity Disorder: A Systematic Review and Meta-Analyses.” *Journal of the American Academy of Child & Adolescent Psychiatry*, vol. 51, no. 10, Oct. 2012, pp. 1003-1019.e20, www.jaacap.org/article/S0890-8567(12)00605-3/fulltext, https://doi.org/10.1016/j.jaac.2012.08.015. Accessed 10 Feb. 2022.

74. Seyedi, Marzieh, et al. “The Effect of Vitamin D3 Supplementation on Serum BDNF, Dopamine, and Serotonin in Children with Attention-Deficit/Hyperactivity Disorder.” *CNS & Neurological Disorders - Drug Targets*, vol. 18, no. 6, 30 Aug. 2019, pp. 496–501, pubmed.ncbi.nlm.nih.gov/31269890/, https://doi.org/10.2174/1871527318666190703103709. Accessed 1 Mar. 2023.

75. Sharif, Mohammad Reza, et al. “The Relationship between Serum Vitamin D Level and Attention Deficit Hyperactivity Disorder.” *Iranian Journal of Child Neurology*, vol. 9, no. 4, 2015, pp. 48–53, www.ncbi.nlm.nih.gov/pmc/articles/PMC4670977/#:~:text=However%2C%20there%20was%20a%20statistically,vitamin%20D%20level%20below%20normal. Accessed 29 Jan. 2022. The remaining 78.4% children had serum vitamin D level below normal.

76. Sinn, N., et al. “Cognitive Effects of Polyunsaturated Fatty Acids in Children with Attention Deficit Hyperactivity Disorder Symptoms: A Randomised Controlled Trial.” *Prostaglandins, Leukotrienes and Essential Fatty Acids*, vol. 78, no. 4-5, Apr. 2008, pp. 311–326, pubmed.ncbi.nlm.nih.gov/18514501/, https://doi.org/10.1016/j.plefa.2008.04.004. Accessed 28 Nov. 2022.

77. Sinn, Natalie, and Janet Bryan. “Effect of Supplementation with Polyunsaturated Fatty Acids and Micronutrients on Learning and Behavior Problems Associated with Child ADHD.” *Journal of Developmental & Behavioral Pediatrics*, vol. 28, no. 2, Apr. 2007, pp. 82–91, pubmed.ncbi.nlm.nih.gov/17435458/, https://doi.org/10.1097/01.dbp.0000267558.88457.a5. Accessed 28 Nov. 2022.

78. Stevens, Laura, et al. “EFA Supplementation in Children with Inattention, Hyperactivity, and Other Disruptive Behaviors.” *Lipids*, vol. 38, no. 10, Oct. 2003, pp. 1007–1021, pubmed.ncbi.nlm.nih.gov/14669965/, https://doi.org/10.1007/s11745-006-1155-0. Accessed 28 Nov. 2022.

79.. Stevens, Laura J., et al. “Dietary Sensitivities and ADHD Symptoms: Thirty-Five Years of Research.” *Clinical Pediatrics*, vol. 50, no. 4, 2 Dec. 2010, pp. 279–293, pubmed.ncbi.nlm.nih.gov/21127082/, https://doi.org/10.1177/0009922810384728. Accessed 11 Mar. 2021.

80.. Surman, Craig, et al. “Does L-Methylfolate Supplement Methylphenidate Pharmacotherapy in Attention-Deficit/Hyperactivity Disorder?” *Journal of Clinical Psychopharmacology*, vol. 39, no. 1, Jan. 2019, pp. 28–38, pubmed.ncbi.nlm.nih.gov/30566416/, https://doi.org/10.1097/jcp.0000000000000990. Accessed 29 Jan. 2022.

81. Tian, Xiaoyi, et al. “Urinary Metabolomic Study in a Healthy Children Population and Metabolic Biomarker Discovery of Attention-Deficit/Hyperactivity Disorder (ADHD).” *Frontiers in Psychiatry*, vol. 13, 20 May 2022, www.ncbi.nlm.nih.gov/pmc/articles/PMC9163378/, https://doi.org/10.3389/fpsyt.2022.819498. Accessed 28 Nov. 2022.

82. ---. “Urinary Metabolomic Study in a Healthy Children Population and Metabolic Biomarker Discovery of Attention-Deficit/Hyperactivity Disorder (ADHD).” *Frontiers in Psychiatry*, vol. 13, 20 May 2022, www.ncbi.nlm.nih.gov/pmc/articles/PMC9163378/, https://doi.org/10.3389/fpsyt.2022.819498. Accessed 28 Nov. 2022.

83. Tolppanen, Anna-Maija, et al. “The Association of 25-Hydroxyvitamin D3 and D2 with Behavioural Problems in Childhood.” *PLoS ONE*, vol. 7, no. 7, 10 July 2012, p. e40097, www.ncbi.nlm.nih.gov/pmc/articles/PMC3393748/, https://doi.org/10.1371/journal.pone.0040097. Accessed 30 Jan. 2022.

84. Trebatická, Jana, et al. “Treatment of ADHD with French Maritime Pine Bark Extract, Pycnogenol®.” *European Child & Adolescent Psychiatry*, vol. 15, no. 6, 13 May 2006, pp. 329–335, pubmed.ncbi.nlm.nih.gov/16699814/, https://doi.org/10.1007/s00787-006-0538-3. Accessed 28 Nov. 2022.

86. UP;Dingankar, Dave. “An Open-Label Study to Elucidate the Effects of Standardized Bacopa Monnieri Extract in the Management of Symptoms of Attention-Deficit Hyperactivity Disorder in Children.” *Advances in Mind-Body Medicine*, vol. 28, no. 2, 2014, pubmed.ncbi.nlm.nih.gov/24682000/. Accessed 28 Nov. 2022.

87. Van Oudheusden LJ, Scholte HR. Efficacy of carnitine in the treatment of children with attention-deficit hyperactivity disorder. *Prostaglandins Leukot Essent Fatty Acids.* 2002 Jul;67(1):33-8. doi: 10.1054/plef.2002.0378. PMID: 12213433.

88. Verlaet AAJ, Maasakkers CM, Hermans N, Savelkoul HFJ. Rationale for Dietary Antioxidant Treatment of ADHD. Nutrients. 2018 Mar 24;10(4):405. doi: 10.3390/nu10040405. PMID: 29587355; PMCID: PMC5946190.

89. Villagomez, Amelia, and Ujjwal Ramtekkar. “Iron, Magnesium, Vitamin D, and Zinc Deficiencies in Children Presenting with Symptoms of Attention-Deficit/Hyperactivity Disorder.” *Children*, vol. 1, no. 3, 29 Sept. 2014, pp. 261–279, www.ncbi.nlm.nih.gov/pmc/articles/PMC4928738/, https://doi.org/10.3390/children1030261. Accessed 22 Jan. 2022.

90. Yadav SK, Bhat AA, Hashem S, Nisar S, Kamal M, Syed N, Temanni MR, Gupta RK, Kamran S, Azeem MW, Srivastava AK, Bagga P, Chawla S, Reddy R, Frenneaux MP, Fakhro K, Haris M. Genetic variations influence brain changes in patients with attention-deficit hyperactivity disorder. T*ransl Psychiatry.* 2021 Jun 5;11(1):349. doi: 10.1038/s41398-021-01473-w. PMID: 34091591; PMCID: PMC8179928.