NUTRITIONAL TREATMENT OF ADHD

The information explosion in the science of nutrition very often creates the impression that available information is contradictory. Consequently, it is no longer easy to distinguish between fact, misinformation and fiction. The Division of Human Nutrition, Faculty of Medicine and Health Sciences, Stellenbosch University act as a reliable and independent source of nutrition information.

Parenting a child with attention-deficit/hyperactivity disorder, or any disability can be overwhelming at times. All parents sometimes feel anger, fear, grief, frustration and fatigue while struggling to help their child. However, parents needn't waste limited emotional energy on self-blame. Attention-deficit hyperactivity disorder (ADHD) is a hereditary disorder and is not caused by poor parenting or a chaotic environment.

Although life with a child with ADHD may at times seem challenging, it is important to remember that such children can, and do, succeed. As a parent, one can help create home and school environments that improve the child's opportunities for success. The earlier one addresses the child's difficulties, the better one can prevent school and social failure and other associated ills such as conduct disorder, delinquency, mood disorders, drug and alcohol abuse and anxiety disorders. Early intervention is the key to maximizing positive outcomes for one’s child. ADHD was long perceived as a disorder of children, but it is now recognised as a chronic condition persisting into adulthood.

What is attention-deficit hyperactivity disorder (ADHD)?

ADHD is a condition of the brain that makes it hard for those affected to control their behaviour. ADHD is distinguished by inattention, impulsivity, and hyperactivity symptoms. It is one of the most common chronic conditions of childhood. ADHD can present as three different subtypes: the inattentive subtype, the hyperactive-impulsive subtype and the combined subtype where at least six symptoms need to be present for a period of six months to be labelled as ADHD. According to the American National Institute of Mental Health, two to three times more boys than girls are affected by this disorder and the reason for this difference is unclear. Although all children have behavioural difficulties at times, children with ADHD have frequent, and often severe, difficulties, which interfere with their ability to live normal lives. Attention-deficit hyperactivity disorder (ADHD) affects around 5% of children worldwide.

What causes ADHD?

At present, there is no single, clear cause identified for ADHD. Experts are investigating a number of genetic, biological and environmental predisposing / causative factors in ADHD. The causes of

ADHD might thus likely be multifactorial ADHD is very likely caused by unknown biological factors, which influence neurotransmitter activity (nerve communication and transport) in certain parts of the brain, which have a strong genetic basis. If one person in a family is diagnosed with ADHD there is a 25 - 35% probability that another family member also has ADHD, compared with a 4 - 6% probability for someone in the general population who has no family history of ADHD. Recent studies do not neglect the influence of maternal intake of food and drink additives, alcohol consumption and smoking during pregnancy, soil contamination, and low birth weight.

One of the environmental risk factors which play a pivotal role in ADHD is nutrition and diet. In the literature, there was a direct association between the western diet and low adherence to a Mediterranean diet with ADHD symptoms. Various nutrients have been proposed to have a contribution to neurodevelopment. Zinc and Iron are considered to have a potential role via their capacity in metabolic pathways of neurotransmitter production, and a deficiency of them is linked to ADHD symptoms. Omega-3 fatty acids may also impact on neurotransmission and signalling. A meta-analysis indicated that omega-3 supplementation results in the improvement of ADHD symptoms. Furthermore, processed foods, soft drinks, and sugar-sweetened beverages (SSBs) may be associated with the risk of the disorder.

How can it be treated?

Clinical experience has shown that the most effective treatment for ADHD is a combination of:

- medication (when necessary) and
- therapy or counselling to learn coping skills and adaptive behaviours

Medication, as prescribed by a medical doctor, is often used to help “normalize” brain activity. Stimulant medications, also known as psychostimulants, (e.g. Ritalin, Dexedrine, and Adderall) are commonly used because they have been shown to be the most effective for the majority of people with ADHD. However, other medications, for example, antidepressants, may be deemed necessary and be used at the discretion of the doctor. The overall purpose of these medications is to increase attention and decrease impulsivity, hyperactivity and aggression. They are not addictive but occasionally have side effects such as headaches, insomnia, increased irritability, depression and rebound hyperactivity when the drug wears off. Side effects of a nutritional nature such as shorter stature and lower weight accretion as well as appetite suppression have also been reported. If a child with ADHD receives any such medication, then the parent should ensure that the child is regularly followed-up by a paediatrician not only for monitoring the need for dose adjustments of any medication, but also for the evaluation of the child's overall physical health and growth patterns.

The effectiveness of psychostimulant drugs and antidepressants to calm children with ADHD is thought to be around 75%. Medication for children with ADHD should never be used as the *only*

form of treatment. It is also important for parents to work together with teachers, counsellors, and other family members to manage the child's behaviour. These special parenting skills are often needed because children with ADHD may not be as responsive to “common” parenting practices, - especially “punishment” as the lone practice, since such measures do not address the root cause of ADHD. Cognitive behavioural skills may help one’s child monitor his / her behaviour, introduce problem-solving strategies and coping skills, deal with the emotional effects of ADHD and self-reinforce positive behaviours. Therapeutic approaches, such as nutritional supplementation, might contribute to better management of patients.

Current dietary interventions for ADHD –

The hypothesis that dietary factors might play a role in the aetiology of ADHD was first proposed over 40 years ago, and it remains a controversial topic until the present day. ADHD is best managed with a whole diet approach. Like all children, children with ADHD need to eat well in order to have the nutrients they need to grow, learn and develop. Any diet recommended for the short or long term should be nutritionally sound, not harmful to the health or the environment, practical, affordable, and suit the child’s taste preferences and psychosocial environment. A healthy dietary pattern is associated with decreased ADHD chance in a recent meta-analysis. Previous systematic reviews in this area have also established that healthy dietary patterns may improve mental health. This dietary pattern should be high in vegetables, fruits, wholegrains, legumes, nuts, sea food; moderate in low- and fat-free dairy products; lower in red and processed meat; and low in sugar sweetened foods and beverages and refined grains. It should provide adequate amounts of polyunsaturated fatty acids (PUFAs), magnesium, zinc, iron and phytochemicals.

Dietary interventions which have been actively promoted for ADHD include:

- Omission of sugar
- Omission of artificial colours and food additives
- Allergy elimination diets
- Micronutrient Supplementation
- Essential Fatty Acid Supplementation

Omission of sugar

Several decades ago, the opinion of some parents made headline news that sugar caused hyperactivity. Tightly controlled research subsequently failed to show that children who consistently ate high levels of sugar were hyperactive. Nor did hyperactivity occur after children consumed single high doses of sugar.

A 2020 systematic review and meta-analysis concluded that there was a significant positive association between overall sugar intake and sugar sweetened beverages (SSBs) and symptoms of

ADHD, after adjusting for important potential confounders. The sub-group analysis revealed that dietary sugars alone did not increase the risk of developing ADHD symptoms, but higher SSBs consumption was associated with a 40% greater odds of ADHD symptoms in the study population compared with their lower intake counterparts. Due to the high sugar content, SSBs could lead to insulin secretion, incite the production of epinephrine and hyperactivity disorders stimulation. SSBs have been accounted as an important source of artificial food colorants and preservatives.

Evidence has therefore shown that sugar restriction per se has not been found to be helpful in improving ADHD symptoms, including hyperactivity. However, moderate replacement of refined sugars with more nutrient dense foods may help to achieve a well-balanced diet. SSBs is associated with an increased risk of symptoms and should be limited. Where parents are restricting sugar intake in children, weight and growth should be monitored to ensure there is adequate energy intake to support a positive energy balance.

Elimination diets

The available evidence suggests a relationship between allergy and hyperactivity. While 15-20% of the population has respiratory or cutaneous allergies, there is approximately a 70% prevalence of allergies in the hyperactive population. Three studies suggest that the most common foods found to cause allergic reactions were benzoic acid (preservative), tartrazine (food colouring), cow's milk, chocolate, wheat, oranges, eggs, tomatoes, peanuts, corn, fish and soy. Only foods with a **proven potential** allergenic reaction should however be avoided. IgE is implicated in typical food allergies. In reactions to food that are not mediated by IgE, assessment of IgG levels might be useful and IgG blood tests are offered with the aim of establishing a relation between foods and ADHD.

A very recent study. The Impact of Nutrition on Children with ADHD (INCA) found that a strictly supervised restricted elimination diet is a valuable instrument to assess whether ADHD symptoms is induced by food. The restricted elimination diet had a significant beneficial effect on ADHD symptoms in 64% of the children, and reintroducing foods led to a significant behavioural relapse in clinical responders. The study also concluded that the prescription of diets on the basis of IgG blood tests should be discouraged, since the challenge phase, after challenges with either high-IgG or low-IgG foods, relapse of ADHD symptoms occurred, independent of the IgG blood levels.

Artificial food colours and food additives (AFCA)

A food additive is any substance added to food primarily for preservation purposes and the consumer demands for a variety of safe and tasty, convenient and colourful foods. Additives and preservatives have been used for a very long time and contributed significantly to product development by the food industry. Despite the advances in the field of product development, some consumers have real concerns about additives in general for many possible reasons such as safety, misinformation;

misconceptions, self-reported or self-associated/experienced adverse reactions in themselves and their children or for a smaller segment of the of the consumer public diagnosed and confirmed allergies and intolerances to these substances.

It is important to realize, however, that food additives are extensively investigated and carefully regulated by various regulating bodies and various international organizations to ensure that their addition to foods is safe. Additionally, food products containing additives are labeled by law so as, in theory at least, to enable the consumer to avoid their consumption in case they experience any adverse effects.

A systematic review of intervention studies found that it was challenging to draw any firm conclusions concerning the effect of artificial colourants in children with ADHD. Four meta-analyses of randomized controlled trials (RCTs) in children with diagnosed ADHD concluded that, based on studies of limited quality, artificial food colours have a small statistically significant adverse effect on symptoms of ADHD **in some children**. An additional meta-analysis found a nonsignificant benefit of additive-free diets on hyperactivity-related symptoms. This evidence is limited due to the small sample sizes in studies to date, the age of the studies, and the heterogeneity of studies with a range of types and amounts of food colourants and preservatives tested. Large, randomized controlled studies of behavioural responses to challenge tests and elimination diets are needed.

The emerging evidence would appear to support, at least in part, individual experience(s) of adverse effects. It is important, however, to also note the ***variability in response*** reported in the current literature. As such, generalizations cannot be made and further conclusive research will be necessary in order to determine the type of dietary changes, if any, needed in order to treat children with ADHD.

Any decisions in the management of a ADHD child in the form of an additive free diet, i.e. free of colorants and preservatives, should only be taken by a health professional with due consideration to the necessary balance between the potential benefits of altering the child's diet and the harmful long-term educational impact of communicating to a child that his / her behaviour is controlled by what he / she eats, particularly when such an approach may not be effective or beneficial for ***all*** children. In this regard, it should also be borne in mind that the use of a "placebo" treatment does carry other risks, such as neglect of other beneficial treatments, loss of self-esteem, and the possibility that an ineffective diet may become a "punishment", since it 'deprives' the child of many foods enjoyed by peer groups and family.

NICUS, therefore, continues to advise that individuals who experience any adverse effects after consuming these or other substances in their diet should preferably seek professional advice or

alternatively avoid consuming foods containing such additives. NICUS also recommends that the food industry notes the emerging evidence in relation to their products and ensures that the labeling of their products is accurate and complies with current regulations.

Gluten-free diet

The idea for the gluten-free diet involves examination of the effects of removing all the food items containing gluten, a mixture of proteins found in wheat, oats, barley, or rye. A systematic review found that there is no conclusive evidence to support a relationship between ADHD and celiac disease (CD); therefore, routine screening for celiac disease and prescription of gluten-free diets is unnecessary in children and adults with ADHD.

Future research is necessary to establish the clinical utility of elimination diets in the treatment of children with ADHD, particularly considering the widespread use of these treatments. Ideally strict elimination diets should be managed and prescribed by registered dietitians to avoid possible nutrient deficiencies. Children who react favourably to an elimination diet should be diagnosed with food induced ADHD. A food challenge diet should be introduced to which foods the child reacts to and to increase the feasibility and to minimise the burden of a restricted diet. In children who do not show behavioural improvements after following an elimination diet, standard treatments such as drugs, behavioural treatments, or both should be considered.

Micronutrient supplementation therapy

In the past decades, some research regarding the role of micronutrients in the aetiology of ADHD had been conducted. Most notable among the studies are the ones particularly examining the relationship between zinc and ADHD. There is evidence to suggest that ADHD may be associated with low mineral status, specifically magnesium, zinc and iron. This is of considerable interest given the fact that iron and zinc, as well as copper, are essential cofactors in the production of dopamine and norepinephrine; two neurotransmitters that play an essential role in the aetiology of ADHD. Magnesium deficiency is linked to disturbances in cognitive capability, leading to symptoms such as: fatigue, lack of concentration, nervousness, mood swings and aggression. Vitamin D plays a diverse role in the central nervous system and the integrity of it's functioning. Studies have shown that deficiency of vitamin D has been suggested to be critically involved in the pathogenesis of many neurobehavioral disorders.

Magnesium

Two recent reviews and meta-analyses on serum magnesium (Mg) levels concluded that children with ADHD have lower levels than those without ADHD. Since a lower intake of magnesium in ADHD has been reported many supplementation studies have been carried out to correct the magnesium status. Generally, these have been done in combination with omega-3 fatty acids, zinc and other

minerals. However, systematic reviews lead to the conclusion that evidence for efficacy of Mg supplementation in a non-Mg deficient ADHD population is lacking and therefore cannot be recommended without demonstrated Mg deficiency in the treatment of ADHD.

Iron

Many studies have investigated the relationship between iron status and ADHD. Most of the studies indicate lower serum ferritin levels in ADHD patients. Due to the low iron status found in most studies on ADHD patients, supplementation has been carried out with varying success. The effect of iron supplements on iron blood parameters and on behavioural and cognitive symptoms in ADHD children without iron-deficiency merits further investigations.
After a systematic review of 11 randomized controlled trials, the authors claimed that more evidence was needed for an indication of an effect of iron (as well as magnesium and zinc) on the treatment of ADHD.

Zinc

A 2021 systematic review and dose-response meta-analysis of randomized clinical trials concluded that zinc supplementation may have beneficial effects in improving ADHD symptoms in children with ADHD. This meta-analysis is the first to investigate the effects of zinc supplementation on ADHD total scores, hyperactivity scores, and inattention scores among patients with ADHD. The certainty of the evidence was graded moderate to very low for all outcomes. Therefore, future well-designed, large-scale randomized controlled trials are needed to establish the benefit of zinc supplementation for ADHD.

Vitamin D

Evidence drawing a clear link between ADHD and vitamin D appears to be lacking and further research to develop experimental grounds is required.

It is not clear whether low status of various micronutrients results from a decreased appetite as a consequence of ADHD medications. Another explanation of lower daily intake may be that patients with ADHD have an impaired ability to sit still during the meals, leave the table earlier and have decreased nutritional intake for various nutrients. Both the American Psychiatric Association and the American Academy of Paediatrics have concluded that the use of megavitamin and mineral supplements to treat behavioural and learning difficulties is not justified. Evidence and arguments for supplementation of these various elements (alone or in combination) is insufficient, **unless in a severe deficient status.**

Essential fatty acid supplementation

There are two main types of polyunsaturated fatty acids (PUFAs) in the human body, the omega-6 (n-6) PUFAs from the cis-linoleic acid (LA, 18:2n-6) and the n-3 PUFAs from the α-linolenic acid (ALA, 18:3n-3). Omega 3 ALA can be converted to eicosapentaenoic acid (EPA) and EPA can be converted to docosahexaenoic acid (DHA). Omega-3 polyunsaturated fatty acids (or omega-3 PUFAs, n-3 PUFAs) are essential nutrients throughout the life span. Recent studies have shown the importance of n-3 PUFAs supplementation during prenatal and perinatal period as a potential protective factor of neurodevelopmental disorders. Omega-3 PUFAs have been reported to be lower in children with ADHD. Omega-3 PUFAs play a central role in the brain function and structure of the neuronal cell membranes, and also in the development of myelin sheath and retina. In particular, Docosahexaenoic acid (DHA) constitutes 70% of the n-3 PUFAs in the human brain and about 10–20% of total lipids, being associated with a number of positive effects on maternal and infant health. Higher DHA intake appears to reduce the risk of schizophrenia, bipolar disorder, depression, anxiety, and behaviour disorders, while suboptimal DHA levels seem to be a potentially risk factor for mental illness.

Omega-3 PUFAs supplementation, with its safety profile and anti-inflammatory effects, have been of great interest as a potential treatment for ADHD. Preliminary evidence suggests that supplements containing both eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) might be effective in treating ADHD symptoms. The findings from clinical trials of n-3 PUFAs in children with ADHD however have been controversial. Some clinical trials with n-3 PUFAs supplementation in ADHD have shown improvement in clinical symptoms and cognitive performances, but others have found no beneficial effects. A recent meta-analysis showed that omega-3 PUFAs have an improvement in both inattention and total ADHD scores and cognitive function. In addition, the sub analysis also showed that omega-3 PUFAs supplementation with EPA ＞ 500 mg/d improved clinical hyperactivity/impulsivity symptoms.

It appears from the reported studies that, although a link seems to exist between low long chain-PUFA status and the occurrence of ADHD, the beneficial effects of nutritional supplementation have not yet been clearly demonstrated.

Recommendations

The successful treatment of ADHD very much depends on the adoption of a holistic approach, including medication when necessary, which addresses the known cause of the disorder. Parents who are caught up in the enthusiasm for dietary intervention may overlook the other forms of intervention to the detriment of the child. Children with ADHD need to:

♦ Follow a healthy balanced diet *(for more detailed information contact NICUS or a registered dietitian).*

♦ Have consistent discipline, structure and routine.

♦ A strict elimination diet may be helpful for some children. Children who react favourably to an elimination diet should be diagnosed with food induced ADHD. A food challenge diet should be introduced to which foods the child reacts to and to increase the feasibility and to minimise the burden of a restricted diet, such diets should be implemented under expert supervision at all times.

♦ Children with ADHD are active and often experience difficulty sitting down for meals. Nutrition interventions such as added snacks, adjusted mealtimes and an increase in energy intake can prevent a low weight accretion. *(for more detailed information contact NICUS or a registered dietitian)*

♦ Medication may cause a lack of appetite in more than 60% of cases with most of the catecholamine-based medications used for ADHD (i.e., stimulant and non-stimulant medications). It is very important to monitor the growth of such children carefully with the standard growth charts available. Nutritional supplements such as balanced meal replacement drinks can be used as snacks to promote weight gain and growth. More frequent meals throughout the day may be useful, especially in the evening when the child may be more relaxed and in the home environment.

♦ Adequate intake of at least the RDA (Recommended Daily Allowance) of all micronutrients (vitamins and minerals) is recommended.

♦ A multivitamin and mineral supplement may be beneficial to improve iron, zinc, magnesium and Vit D status and to prevent vitamin and mineral deficiencies. Therapeutic doses of iron, magnesium and or zinc may be indicated in confirmed deficiencies (low serum levels).

♦ Children with ADHD should ideally eat oily fish regularly to increase the intake of omega 3 fatty acids in the diet. Substitute red meat with salmon, mackerel, snoek, trout, sardines, pilchards and shellfish at least three times per week.

♦ An omega 3 supplement that contains EPA and DHA may be beneficial for children who do not eat 3 portions of fatty types of fish per week.

♦ NICUS advises that individuals who experience any adverse effects after consuming AFCA or other substances in their diet should preferably seek professional advice or alternatively avoid consuming foods containing such additives.

Finally, parents should realise that ADHD does not necessarily limit one's horizons. Many individuals with ADHD, for instance:

- Became the inventors, innovators, and entrepreneurs of the world (Henry Ford)
- Could view things from a different perspective (Albert Einstein)
- Possessed imaginations par excellence (Walt Disney)

The following links can provide additional help and support:

- Attention Deficit and Hyperactivity Association of South Africa (ADHDASA)
  - http://www.adhdsupport.co.za
- Children and Adults with Attention-Deficit/Hyperactivity Disorder (CHADD)
  - http://www.chadd.org
- The National Attention-Deficit Disorder Association (ADDA)
  - http://www.add.org
- Learning Disabilities Association of America (LDA)
  - http://www.ldanatl.org

For further, personalized and more detailed information, please contact a dietitian registered with the Health Professions Council of South Africa.

References from the scientific literature used to compile this document are available on request.

Human Nutrition | Menslike Voeding
Fakulteit Geneeskunde en Gesondheidswetenskappe /
Faculty of Medicine and Health Sciences
Universiteit Stellenbosch University
Francie van Zijl Rylaan / Drive; Tygerberg; Kaapstad / Cape Town
Posbus / PO Box 241; Kaapstad / Cape Town; 8000
Suid-Afrika / South Africa
Tel: +27 21 938-9259
e-pos / e-mail: nicus@sun.ac.za
www.sun.ac.za

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT
forward together
sonke siya phambili
saam vorentoe