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Letter to the Editor

THE ROLE OF DIET IN ATTENTION DEFICIT HYPERACTIVITY DISORDER

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INTRODUCTION

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder that presents with symptoms of hyperactivity, impulsivity, and inattention, that interfere with functioning or development. It is one of the most common mental disorders diagnosed in childhood, affecting approximately 7% of children and adolescents (1). Children with this deficit may show alterations in the size of the frontal lobes and caudate nucleus and present differently in the performance of psychological tests, even if these tests are nonspecific (2). The diagnosis is based on behavioral symptoms since there are no specific laboratory tests, and therefore, pharmacological treatment needs to be used with attention. Several articles have reported that ADHD may depend on a lack of dietary factors (3-5). Therapeutic nutritional treatments have been carried out, such as the use of food supplements, additional vitamin D, vitamin D plus magnesium, and anti-inflammatory omega-3 fatty acid (6).

DISCUSSION

The topic of nutrition in the treatment of ADHD in children is addressed with great interest today, even if at the moment, there is not enough published data to truly clarify the effect of food supplements. The topic is important because if nutrition were to have a positive effect on ADHD, pharmacological treatment, which is currently on the rise, could be avoided. The effect of diet on this brain disorder is not easy to evaluate; however, there are several interesting publications that may justify an in-depth study on this topic. The difficulty in evaluating the therapeutic effects of the diet lies in analyzing which foods are effective and which are not.

It has been observed that some dietary elements such as additives, sugars, and carbohydrates in general, can be harmful to ADHD, while others such as vitamins, omega-3 fatty acids, and vegetables can be helpful. However, to date, there are no specific and effective treatments for ADHD symptoms. Drug therapy has proven to be unsatisfactory and increasingly indicates that the nutritional route may be the right one.

In children, diet is very important for brain development and correct nutrition and a healthy environment can deter the development of neurological disorders and impaired cognition. In order to avoid behavioral changes, it is important to find out which foods aggravate or cause illness and contribute to mental disorders. Eliminating some foods, for example,

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those that could cause allergic phenomena, and being careful not to cause food deficiencies, could help the disease (Table I). Treatment with some vitamins is also recommended to avoid deficiencies.

Table I. *List of some allergenic and hypoallergenic foods correlated with ADHD. Allergenic foods could potentially generate or trigger ADHD and should be eliminated from the diet. Hypoallergenic foods should be consumed in the diet.*

Allergenic foods:	• dairy products	• preservatives
	• wheat, barley, oats, rye	• artificial sweeteners
	• artificial flavors and coloring	
Hypoallergenic foods:	• poultry	• pears
	• cod fish	• apples
	• lettuce	• rice

Some studies attribute the disease to an inflammatory state, since there is often a difference in the expression of anti-inflammatory omega-3 fatty acids in the plasma and cellular membranes of the erythrocytes in patients with ADHD, when compared to normal individuals, with consequent alteration of levels of dopamine and serotonin (7,8). However, therapy with Omega-3 fatty acid supplementation has given unsatisfactory results (9). Some scientific evidence reported in the literature demonstrates that oxidative stress and chronic inflammation can develop in ADHD (10,11) and could be counteracted with an antioxidant dietary treatment. On the other hand, chronic inflammation and/or oxidative stress can lead to the onset of ADHD (12-14). The chronic neuroinflammation that develops in ADHD can be activated by immune cells such as T cells with neuronal damage and brain dysfunction. But microglial cells can also be activated by oxidative brain damage with the release of inflammatory mediators such as cytokines and chemokines. These effects demonstrate that the immune status in ADHD patients can be very important both in tissue protection and in brain damage due to inflammation, where immune cells are hyperactivated.

Therefore, the use of antioxidants could be of help in this disease and in others involving neurodegeneration. In addition, micronutrient and probiotic supplementations have been seen to have mild positive effects on ADHD (15,16), but dietary treatments require more scientific evidence to be used as therapeutics.

Several studies suggest the use of polyphenols as antioxidants and immunoregulators with beneficial functions in ADHD (17,18). Polyphenols are a vast group of plant organic substances widespread in nature such as flavonoids, tannins, and others. Polyphenols are also produced by bacteria, fungi, and animals and have beneficial properties with antioxidant and anti-inflammatory capabilities in all tissues, including the brain system. The dietary intake of polyphenols is well tolerated by the body and their use is considered safe, even if there is no data on high-dose intake of these beneficial substances.

Reactive oxygen species (ROS) are involved in brain oxidative damage which can be prevented by efficient tissue oxygen gradients, inhibiting intracellular free radicals. Nutritional foods containing vitamin C, a water-soluble molecule, and fat-soluble vitamin E, are antioxidant substances capable of crossing the blood-brain barrier (BBB) with a protective function for the entire organism, including the brain. In ADHD, these antioxidant substances protect cells from oxidative stress and have the property of controlling cholesterol levels in the peripheral blood. Antioxidants have an antibacterial, antiparasitic, and antitoxic action and are protective for neurons. Oxidative stress may be involved in ADHD by causing damage to neurotransmitter receptors, dopamine damage and subsequent neuronal deterioration. Damaged dopamine can be cytotoxic to the cortex and ganglia involved in activity and attention, two important functions in ADHD. In ADHD, chronic inflammation could lead to an increase in STAT6, a molecule involved in the transduction and transcription of proinflammatory cytokines. It has been reported that rodents deficient in STAT6 may exhibit increased physical activity comparable to that seen in ADHD (19).

CONCLUSIONS

In conclusion, it can be deduced that oxidative stress and inflammation produced by the hyperstimulation of the immune system in ADHD could contribute to neuronal damage with brain alterations. Beneficial effects, although mild, can be produced using antioxidant and anti-inflammatory substances, such as polyphenols, which reduce oxidative stress.

Conflict of interest

The author declares that they have no conflict of interest.

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