

The Emerging Role of Omega-3 Fatty Acids in Psychiatry
Omega-3 fatty acid status in attention-deficit/hyperactivity disorder

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FROM ABSTRACT:

Lower levels of long-chain polyunsaturated fatty acids, particularly omega-3 fatty acids, in blood have repeatedly been associated with a variety of behavioral disorders including attention-deficit/hyperactivity disorder (ADHD).

We have studied children with ADHD who exhibited skin and thirst symptoms classically associated with essential fatty acid (EFA) deficiency, altered plasma and red blood cell fatty acid profiles, and dietary intake patterns that do not differ significantly from controls. This led us to focus on a potential metabolic insufficiency as the cause for the altered fatty acid phenotype.

The frequency of thirst and skin symptoms was greater in newly diagnosed individuals with ADHD (n=35) versus control individuals without behavioral problems (n=112) drawn from the Purdue student population.

A follow up case-control study with participants willing to provide a blood sample, a urine sample, a questionnaire about their general health, and dietary intake records was conducted with balancing based on gender, age, body mass index, smoking and ethnicity.

A number of biochemical measures were analyzed including status markers for several nutrients and antioxidants, markers of oxidative stress, inflammation markers, and fatty acid profiles in the blood.

The proportion of omega-3 fatty acids was found to be significantly lower in plasma phospholipids and erythrocytes in the ADHD group versus controls whereas saturated fatty acid proportions were higher.

Intake of saturated fat was 30% higher in the ADHD group, but intake of all other nutrients was not different.

THESE AUTHORS ALSO NOTE:

"Attention-deficit/hyperactivity disorder (ADHD) is the diagnosis used to describe children, adolescents, and adults who are inattentive, impulsive and overactive."

"ADHD is estimated to affect 5–10% of the school age population, and as many as 70% of children diagnosed with ADHD will continue to suffer from the disorder into adolescence and adulthood."

Among the symptoms that children with behavioral problems or ADHD have been reported to exhibit are several that occur in essential fatty acid (EFA) deficiency "including excessive thirst, frequent urination, dry skin, dry hair, dandruff, brittle nails and/or hyperfollicular keratoses (referred to herein as 'thirst/skin symptoms')."

Thirst/skin symptoms and/or blood EFA abnormalities have also been reported in patients suffering from learning or psychiatric disorders.

"The omega-3 fatty acids, particularly DHA, are concentrated in the brain and nervous system and are required for their proper development and function of these organs."

The actions of DHA in the brain range from regulation of gene transcription to effects on cell signaling.

"Animal studies have shown that induced omega-3 fatty acid deficiency is associated with behavioral abnormalities and repletion of DHA leads to recovery of normal behavior."

"Richardson found benefits of LC-PUFA supplementation rich in DHA and EPA as well as some omega-6 LC-PUFA on ADHD-like symptoms in a population of school children selected based on learning problems"

[The omega-6 used by Richardson was GLA or gamma-linolenic acid, which is found in borage, evening primrose or black current seed oils.]

In 2005, Richardson also found beneficial LC-PUFA supplementation of children with developmental coordination disorder in co-morbid ADHD symptoms. "The supplement in this study was richer in EPA than those previously used."

[The EPA / DHA ratio used was 3.2 / 1.]

In this study, the authors used Purdue University students who had been diagnosed with ADHD.

RESULTS

The ADHD group had more saturated fatty acids compared to controls.

Arachidonic acid was about 10% higher in ADHD versus controls.

DHA was 36% - 53% lower in the ADHD group versus controls.

The ratio of total omega-6 to omega-3 was higher in ADHD than in controls.

The ratio of AA to EPA was 36% higher in the ADHD versus controls.

Calories from saturated fat were 30% greater in the ADHD group versus controls.

DISCUSSION

"The frequency of skin/thirst symptoms was found to be higher in the ADHD group, and the omega-3 fatty acids were found to be lower in the [ADHD] cases versus the matched controls."

"Several essential nutrients play a role in the biosynthesis and/or metabolism of LC-PUFA and thus status of these nutrients may impact omega-3 fatty acid proportions in membranes. Additionally, suboptimal status of several of these same nutrients has been implicated as playing a role in ADHD, and these include magnesium, zinc, iron and vitamin B6."

The following points are made concerning magnesium:

- 1) Magnesium is a critical cofactor in the desaturase enzymes that convert short-chain omega-3s into the long-chain omega-3s.
- 2) Suboptimal levels of magnesium are implicated in hyperactive behavior.
- 3) Magnesium supplementation benefits behavioral problems in children with magnesium deficiency.

The following points are made concerning vitamin B6:

- 1) Vitamin B6 deficiency causes a depletion of erythrocyte membrane LC-PUFA.
- 2) Vitamin B6 is very important in the development and function of the brain and nervous system, and deficiency has been shown to result in neurological deficits.
- 3) The synthesis of the neurotransmitters dopamine, serotonin and GABA require decarboxylases that use vitamin B6 as a cofactor, and "altered dopamine signaling is implicated in ADHD."

The following points are made concerning zinc:

- 1) Zinc is a cofactor for hundreds of enzymes, including the delta-6 desaturase necessary for the metabolism of EFA and several enzymes involved in the metabolism of neurotransmitters, prostaglandins and melatonin.
- 2) Lower zinc status is found in children with ADHD, and they benefit with zinc supplementation.

Membrane composition of LC-PUFA can modulate immune cell function through production of eicosanoids.

Children with ADHD also have immune system problems, including more frequent stomachaches, antibiotic use, ear infections, surgical tubes in ears, asthma and sleep problems.

“The immune and nervous systems were once seen as completely separate, these systems have been linked with recent discoveries demonstrating the role of neurotransmitters in regulating immunity and the role of cytokines in regulating brain function and behavior.” **[Very Important]**

The following points are made concerning the neurotransmitter dopamine:

- 1) Dopamine is a catecholamine, as is norepinephrine from the sympathetic nervous system. Therefore, dopamine and norepinephrine are chemically related.
- 2) Dopamine is “centrally involved in ADHD.”
- 3) Dopamine has significant effects on T cells and other leukocytes because these cells express dopamine receptors.
- 4) Primary and secondary lymph organs are sympathetically innervated, and the sympathetic neurons use the catecholamine norepinephrine as a neurotransmitter. Therefore, behavioral disorders and immune system dysfunction are linked.
- 5) Dopamine “may also affect immune function through altering neuroendocrine pathways like the hypothalamic-pituitary-adrenal axis.”
- 6) The altered dopamine pathway has become a hallmark of ADHD and may also be responsible for symptoms of dysregulated immunity.
- 7) Long-chain polyunsaturated fatty acids affect dopamine neurotransmission.
- 8) Diets deficient in omega-3 fatty acid decrease brain dopamine.
- 9) It is “established that dopamine neurotransmission is likely regulated at least in part by intake of omega-3 PUFA.”
- 10) “Taken together, these studies establish a scenario in which intake of omega-3 PUFA modulates immune cell function directly by altering eicosanoid production and indirectly by influencing dopaminergic neurotransmission, which may also have an effect on immune cell function.”

"The work presented here extends our previous observations identifying suboptimal omega-3 fatty acid proportions in blood phospholipids and erythrocytes in ADHD to a young adult population in agreement with another report on adults with this disorder."

KEY POINTS FROM DAN MURPHY

- 1) "Attention-deficit/hyperactivity disorder (ADHD) is the diagnosis used to describe children, adolescents, and adults who are inattentive, impulsive, and overactive."
- 2) "ADHD is estimated to affect 5–10% of the school age population, and as many as 70% of children diagnosed with ADHD will continue to suffer from the disorder into adolescence and adulthood."
- 3) Lower levels of long-chain polyunsaturated fatty acids, particularly omega-3 fatty acids, in blood have repeatedly been associated with a variety of behavioral disorders including attention-deficit hyperactivity disorder (ADHD).
- 4) In this study of Purdue University students, the proportion of omega-3 fatty acids was found to be significantly lower.
- 5) ADHD students had a 30% higher intake of saturated fats versus controls.
- 6) Both ADHD patients and patients with essential fatty acid deficiency exhibit excessive thirst, frequent urination, dry skin, dry hair, dandruff, brittle nails and/or hyperfollicular keratoses (thirst/skin symptoms) at a greater frequency than controls.
- 7) "The omega-3 fatty acids, particularly DHA, are concentrated in the brain and nervous system and are required for their proper development and function of these organs."
- 8) "Omega-3 fatty acid deficiency is associated with behavioral abnormalities and repletion of DHA leads to recovery of normal behavior."
- 9) Optimum omega-3 fatty acid supplementation probably requires higher EPA to DHA ratio [Richardson used 3.2 EPA to 1 DHA] and inclusion of the omega-6 GLA.
[This is essentially the ratio formulated by Nutri-West Complete Omega-3 Essentials: 800-443-3333.]
- 10) Magnesium is required to convert short-chain omega-3s into the long-chain omega-3s.
- 11) Low magnesium levels are implicated in hyperactive behavior, and magnesium supplementation improves behavioral problems.

- 12) Vitamin B6 is very important in the development and function of the brain and nervous system, and deficiency has been shown to result in neurological deficits.
- 13) The synthesis of the neurotransmitters dopamine, serotonin and GABA require vitamin B6.
- 14) Zinc is required for the metabolism of EFA and several enzymes involved in the metabolism of neurotransmitters, prostaglandins and melatonin.
- 15) Lower zinc status is found in children with ADHD, and they benefit with zinc supplementation.
- 16) Children with ADHD also have immune system problems, including more frequent stomachaches, antibiotic use, ear infections, surgical tubes in ears, asthma, and sleep problems.
- 17) "The immune and nervous systems are functionally linked. **[Very Important]**"
- 18) "Altered dopamine signaling is implicated in ADHD."
- 19) Dopamine is "centrally involved in ADHD."
- 20) Primary and secondary lymph organs are sympathetically innervated, and the sympathetic neurons use the catecholamine norepinephrine as a neurotransmitter.
- 21) Dopamine is a catecholamine, as is norepinephrine from the sympathetic nervous system. Therefore, dopamine and norepinephrine are chemically related. Therefore, behavioral disorders and immune system dysfunction are linked.
- 22) Omega-3 fatty acids affect dopamine neurotransmission.
- 23) Diets deficient in omega-3 fatty acid decrease brain dopamine.
- 24) It is "established that dopamine neurotransmission is likely regulated at least in part by intake of omega-3 PUFA."
- 25) "Taken together, these studies establish a scenario in which intake of omega-3 PUFA modulates immune cell function directly by altering eicosanoid production and indirectly by influencing dopaminergic neurotransmission, which may also have an effect on immune cell function."
- 26) Those with ADHD have "suboptimal omega-3 fatty acid proportions."