Nutritional Influences on Illness
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The Influence on Minerals on Attention Deficit-Hyperactivity Disorder

Calcium Deficiency
A study of 50 hyperactive children aged four to 13 years found that, compared to normals, their average plasma, erythrocyte, urine, and hair calcium levels were lower, with hair showing the greatest deficit. Moreover, there is evidence that hyperactivity caused by hypocalcemia without hypercalciuria may respond to calcium supplementation.

Copper Toxicity
Copper excess directly influences neurotransmitter systems and may be associated with irritability, although its role in hyperkinesis is poorly understood. In vitro, it inhibits the enzyme 5-hydroxytryptophan decarboxylase, which is necessary for the production of serotonin. However, both increased and decreased blood serotonin levels have been reported in hyperkinesis.

Excess copper may also affect the disorder by other mechanisms. Copper is part of the metalloenzyme dopamine ß hydroxylase, which is necessary for the production of noradrenaline, and increased levels of this enzyme have been reported in hyperkinesis. Also, excess copper inhibits the NMDA receptor, probably leading to a deficit in glutamergic transmission to produce neurological dysfunction.

Deficiency
Results of an epidemiological study of 50 hyperactive children suggest that insufficient copper nutriture may contribute to hyperkinesis. Further studies are needed for confirmation.

Iron Deficiency
Iron deficiency is common in our society, and most but not all studies have found evidence that iron nutriture in children with attention deficit hyperactivity disorder (ADHD) may be reduced. This inconsistency appears to be due to the combined effect of comorbidity with other behavioral disorders as, in a study of 151 children and adolescents with ADHD, total scores on the Conners Parent and Teacher Rating Scales were significantly negatively correlated with ferritin levels. Yet when only the 106 pure ADHD subjects were evaluated, the correlations no longer reached statistical significance. Moreover, the 45 subjects with both ADHD and other comorbid behavioral disorders had lower scores for mean hemoglobin and mean corpuscular volume.

To examine the effects of iron supplementation, 23 nonanemic children aged five to eight with ADHD and serum ferritin levels <30 ng/ml randomly received either ferrous sulfate 80 mg daily or placebo for 12 weeks. There was a progressive significant decrease in the ADHD Rating Scale on iron but not on placebo. Similarly, the mean Clinical Global Impression-Severity significantly decreased at 12 weeks with iron but was unchanged in the placebo group.

Magnesium Deficiency
Children with magnesium deficits may present with a hyperkinetic syndrome that is characterized by excessive fidgeting, anxious restlessness, psychomotor instability, and learning difficulties. Conversely, among children continued on page 159
specifically diagnosed with ADHD, magnesium deficiency appears to be quite common. For example, in one group of 94 boys and 20 girls aged nine to 12 years old, 95% had evidence of deficiency based on levels in the hair (78%), red blood cells (59%), or blood serum (34%).

Repletion of a chronic borderline magnesium deficiency appears to be an effective treatment. In one study, 50 children aged seven to 12 with ADHD who were found to have a magnesium deficiency received 200 mg magnesium daily for six months. Compared to both untreated, matched controls and their own clinical state before supplementation, treated children demonstrated a significant decrease in hyperactivity on standard psychometric scales.

Another study concerned 31 children aged six to 12 with attention deficiency and hyperactivity syndrome who were compared with 20 matched controls. The treatment group received magnesium along with vitamin B6, while the controls received a poly-vitamin complex. On the 30th day, the magnesium and vitamin B6 supplement was associated with improved behavior, decreased anxiety and aggression, improvement in both large- and small-scale mobility, decreased synkinesis, and increased attention. Significant differences (p < 0.01 or 0.001) were found between the test and control groups in the degree of expression of their disorder. In addition, the supplement normalized magnesium homeostasis and favored normalization of blood electrolytes.

**Manganese Toxicity**

Studies of hair manganese levels in hyperactive children have found them to be elevated. Moreover, manganese concentrations in drinking water have been directly correlated with both hyperactive and oppositional behaviors. Elevated manganese levels could theoretically cause increased locomotor activity by decreasing dopamine turnover. Also, chronic manganese exposure appears to increase copper concentrations in the basal ganglia and — similar to the effect of excess copper — excess manganese inhibits the NMDA receptor, probably producing neurological dysfunction by causing deficient glutamatergic transmission.

**Zinc Deficiency**

Zinc deficiency may be associated with irritability, and hyperactive children may have lower zinc levels in serum, urine, hair, and fingernails than normals. Tartrazine, sunset yellow, and perhaps other food additives may increase both abnormal behavior and urinary zinc excretion; this suggests that reactions to food additives may be mediated by a further lowering of already low zinc levels. Also, zinc and copper each reduce the other’s absorption; thus zinc supplementation would help to counteract the adverse effects of elevated copper.

In a double-blind study, 400 patients (mean age 9.6 years) randomly received zinc sulfate 150 mg daily or placebo. Zinc was found to be statistically superior to placebo in reducing hyperactive, impulsive, and impaired socialization symptoms, but not in reducing attention deficiency symptoms. The best results were in older children who had both low zinc and free fatty acid levels.

Dr. Werbach cautions that the nutritional treatment of illness should be supervised by physicians or practitioners whose training prepares them to recognize serious illness and to integrate nutritional interventions safely into the treatment plan.

If you treat patients with psychological symptoms, you will want a copy of Dr. Werbach’s thoroughly revised and expanded second edition of *Nutritional Influences on Mental Illness*. For more information on his books, see the Third Line Press webpage (www.third-line.com) or contact Third Line Press directly (4751 Viviana Drive, Tarzana, California 91356, USA; 818-996-0076; FAX: 818-774-1575; tlp@third-line.com).

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