Low Iron Stores May Contribute To ADHD Symptoms

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Introduction

Attention Deficit/Hyperactivity disorder (ADHD) affects between 5% to 10% of school children, and may persist into adulthood. Symptoms include inappropriate impulsivity, overactivity, inattention and altered executive functions. As the latter are possibly modulated by the dopaminergic mesocortical pathways, and as ADHD patients have increased dopamine transporter-binding potential and genetic polymorphisms in the dopamine receptor, the symptoms of ADHD could be caused by dopamine dysfunction. Iron is a coenzyme of dopamine synthesis. Studies have shown that iron deficiency alters dopamine receptor density and activity in animals. Therefore iron stores within the brain may influence dopamine-dependent functions.

In the brain, iron is stored bound to ferritin. In childhood, low ferritin levels have been reported to affect the development of the central nervous system, leading to mental retardation and behavioural disorders. Therefore the researchers assessed whether iron deficiency contributes to ADHD symptoms compared to children without ADHD.

Who Participated in the Study?

During May 2002 to June 2003, 110 children referred to a paediatrics hospital because of school related problems were interviewed and examined. Fifty-three of the children (45 boys and 8 girls) aged 4 to 14 met the diagnostic criteria for ADHD. All the children diagnosed with ADHD as well as the controls had been drug-free for at least two months prior to the study.

What Did the Participants Do?

The Conners' Parent Rating Scale (CPRS) was completed to evaluate the severity of ADHD symptoms. Sub-scales to assess the severity of hyperactivity, cognitive impairment and oppositional behaviour were included. Serum ferritin levels were measured, along with blood haemoglobin, haematocrit and iron levels.

Results of the Study

The mean serum ferritin level in the children diagnosed with ADHD was 23 ng/mL, and lower than the mean serum ferritin level of 44 ng/mL in the control group. Additionally, 42 (84%) of the children who were diagnosed with ADHD had serum ferritin levels below 30 ng/mL, which is abnormally low.

Only 5 (18%) of the control group had a serum ferritin level below 30 ng/mL. Seventeen (32%) of the children with ADHD had a serum ferritin level below 15 ng/mL, compared to only one (3%) of the control group.

An important result was the matching of serum ferritin levels to the severity of ADHD symptoms:

- Serum ferritin levels were correlated with ADHD symptoms severity measured with CPRS.
- Serum ferritin levels also correlated with the cognitive subscore and tended toward a correlation with the hyperactivity subscore but did not correlate with the oppositional subscore.

In contrast, the serum ferritin levels of controls were not correlated with CPRS score. Serum iron, haemoglobin and haematocrit levels were within normal ranges for both groups, with no differences between the groups.

Conclusion of the Researchers

The researchers concluded that:

A major finding was that serum ferritin levels were inversely correlated with the severity of ADHD. The children with the most severe iron deficiency were the most inattentive, impulsive and hyperactive. These results suggest that low iron stores may explain as much as 30% of ADHD severity.

The cognitive subscore significantly correlated with low serum ferritin levels. This suggested that iron-deficient children are mainly inattentive and distractible and suffer from learning disabilities.

Children with the more severe iron deficiency also experienced increased motor restlessness.

If low serum ferritin levels were reflected in decreased ferritin levels in cerebrospinal fluid, then this would suggest that a brain iron deficiency may underlie the symptoms of ADHD. The authors consequently hypothesised that because dopamine neurotransmission is affected by brain iron levels:

- low ferritin levels might alter brain dopaminergic activity in children and contribute to ADHD symptoms.

It was not apparent why the children diagnosed with ADHD had low serum ferritin levels, and there was no obvious evidence of malnutrition or intestinal malabsorption, but this needs further investigation.

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