Research Article

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COMPARISON OF SELECTED BIOCHEMICAL PARAMETERS OF ATTENTION DEFICIT HYPERACTIVITY DISORDER CHILDREN AND NORMAL CHILDREN

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ABSTRACT

ADHD is one of the most commonly diagnosed behavioural disorders of children, and it occurs in approximately 6-9 % of school-aged children. This study aimed to compare the selected biochemical parameters in blood plasma of Attention Deficit Hyperactivity Disorder (ADHD) children and normal children. A prospective study was conducted on ADHD children at Adhiparasakthi Annai Illam, Melmaruvathur, Kancheepuram district, Tamil Nadu, India, and normal children at Sothupakkam Secondary School, Melmaruvathur, Kancheepuram district, Tamil Nadu, India. After the written consent from the parents and head of the institution, a biochemical examination of the serum ferritin and serum zinc levels was performed. A total of 20 children between 6-12 years had been selected. Results reported that the mean serum ferritin levels of normal and ADHD boys were 22.94 and 13.17, respectively, and the mean serum ferritin levels of normal and ADHD girls were 18.53 and 8.93, respectively. The mean serum zinc levels of normal and ADHD boys were 87.89 and 30.99, respectively, and the mean serum zinc levels of normal and ADHD girls were 69.33 and 30.33, respectively. The study concludes that there might be a positive correlation between blood level of serum ferritin and serum zinc among ADHD children $r = 0.632$, $p = 0.050$. There was no correlation between blood level of serum ferritin and serum zinc among normal children $r = -0.384$, $p = 0.274$. The study suggested that serum iron and serum zinc levels among ADHD children were very low compared to normal children.

Keywords: Attention Deficit Hyperactivity Disorder, comparison, biochemical parameters, serum ferritin and serum zinc

INTRODUCTION

Attention Deficit Hyperactivity Disorder is characterized by inattention, hyperactivity and impulsivity. It is a most common childhood disorder. The worldwide prevalence rate was estimated at 5.29 %.[1] It is more common in boys. It will increase the risk of other psychiatric disorders, educational and occupational failure, criminality, social disability and addictions. No single factor is involved in the cause of ADHD. It arises from several genetic and environmental risk factors. ADHD was diagnosed by using rating scales and clinical interviews. There is no curative treatment for ADHD, but medications and nonpharmacological approaches are valuable for the management of ADHD.[2]

According to the Diagnostic Statistics Manual of Mental Disorders-5, inattention or hyperactive-impulsive symptoms are present before the age of 12 years. Based on the DSM-IV criteria, there are three subtypes of ADHD: ADHD, Predominantly Inattentive Type (ADHD-PI), Predominantly hyperactive-impulsive Type (ADHD-PHI) and Combined Type (ADHD-C). Iron plays a vital role in brain function. It is necessary for proper cognitive, emotional and motor development.[3] Iron deficiency impairs neurotransmitter regulation, including gamma-aminobutyric acid (GABA), dopamine, serotonin and norepinephrine.[4] Iron is a necessary co-factor for tyrosine hydroxylase and an enzyme that is a rate-limiting step in producing dopamine, nor-epinephrine and serotonin.[5] It is also needed in the brain for myelin protein formation, synaptic strengthening and energy generation.[6] Iron is necessary for the synthesis of catecholamine and dopamine. Ferritin is a marker of peripheral iron stores and can be used to estimate body iron stores.

Zinc is a co-factor for the metabolism of neurotransmitters and fatty acids, and it also regulates dopamine metabolism, which is involved in attention deficit hyperactivity disorder. Zinc helps in both the synthesis and regulation of melatonin. It also binds to and regulates the dopamine transporter, which is the site of action of psychostimulants used to treat ADHD. The research was conducted on the relationships between serum zinc levels and ADHD in children. A meta-analysis study was conducted between 2000 and 2015. A total of 17 studies showed that serum zinc levels in children with ADHD were lower than in normal children. The sensitivity indicated that the results were reliable.[7] Dopamine and noradrenaline play important roles in executive functions reported to be impaired in ADHD.[8]

A study reported iron deficiency status in ADHD children using serum ferritin levels. The role of iron is in the production of dopamine and noradrenalin in our body. The study group has 143 newly referred ADHD children aged 5-15. The results showed serum ferritin levels below 20 ng/ml in 67 children and above 20 ng/ml in 46 children. There was a very low inverse statistical correlation between Conner's rating scale scores and ferritin levels. It shows that low iron stores may be related to ADHD pathophysiology. Therefore, serum ferritin should be included in the overall evaluation of children with ADHD. [9]

A study was conducted on the use of zinc sulphate in the treatment of ADHD. This research was a double-blind, placebo-controlled study to assess the efficacy of zinc sulphate. A total of 400 ADHD

children were selected. Results reported that after 12 weeks of zinc treatment, the experimental group was statistically superior to the placebo group in reducing the symptoms of hyperactivity, impulsivity and impaired socialization but not in reducing inattention symptoms.[10]

Children with ADHD frequently have difficulty in organizing tasks, a short attention span, low academic performance, failure to do homework and poor relationships with their parents, siblings, teachers and peers. The study aims to compare and correlate the serum ferritin and serum zinc levels in the blood plasma of ADHD and normal children.

MATERIALS AND METHODS

Participants

Twenty children were selected: ten ADHD children were chosen from a special school, and ten normal children were selected from a government secondary school in Kancheepuram district. Permission was obtained from the special school and normal school authorities to conduct the study. The benefits of the study were explained to the teachers. Informed consent was obtained from the parents of the children for their participation, and the children were also informed about the study. This study has the approval of the Institutional Ethics Committee of Saveetha University, Tamil Nadu. (004/12/2014/IEC/SU, dated 18/12/2014).

Inclusion and Exclusion Criteria

Children of both sexes whose parents agreed to their children's participation in a special and normal school. Parents and children were not willing to participate, and they were excluded from the study.

Data collection procedure

Informed consent was obtained from each parent to participate in the study and make the child comfortable with their parents. 2 ml of venous blood from the antecubital vein was collected from 10 selected ADHD children and ten normal children in an EDTA vacutainer. On the same day, after withdrawing the blood container, it was appropriately labelled with the child's name, age, sex, serial number, and parameters and sent the specimen for lab investigation to check the level of serum ferritin and serum zinc.

Statistics

The data have been expressed in means of ± SE, frequency distribution, Pearson's correlation coefficient and paired t' test and were used. The analysis and plotting of graphs were carried out using Sigma Plat-12 (SYSTAT-USA)

RESULTS

Table 1 explained that the Mean serum ferritin levels of normal and ADHD boys were 22.94 and 13.17, respectively, and the Mean serum ferritin levels of normal and ADHD girls were 18.53 and 8.93, respectively. The mean serum zinc levels of normal and ADHD Boys were 87.89 and 30.99, respectively, and the Mean serum zinc levels of normal and ADHD girls were 69.33 and 30.33, respectively.

Table 2 explained that the correlation between the blood level of serum ferritin among normal and ADHD children was (r=0.632, p=0.50) and the blood level of serum zinc among normal and ADHD children was (r=-0.384, p=0.274).

Figure 1 illustrated that a comparison of blood serum ferritin levels among normal and ADHD children of boys reported that the blood serum ferritin level was marginally significant with normal children and ADHD children of boys. T=1.946, P=0.075. It also showed that the blood serum ferritin level was significant in normal children and ADHD children in girls. T=2.303, P=0.041.

Figure 2 reported that the comparison of blood serum zinc levels among normal and ADHD children among boys and girls was highly significant with normal children and ADHD children of boys and girls. (Boys T=6.388, P=0.001, Girls T=4.637, P=0.010).

Figure 3 illustrated that blood levels of serum ferritin among normal and ADHD children were positively correlated (r=0.632, p=0.50), and blood levels of serum zinc among normal and ADHD children were negatively correlated (r=-0.384, p=0.274).

Table 1: Comparison of serum ferritin and serum zinc among normal and ADHD children (boys and girls)

S.No	Parameter	Groups	Mean ±SE	t-test
1	Serum ferritin	Normal boys	22.94 ± 4.63	t =1.946
		ADHD boys	13.17 ± 1.94	P =0.075
2	Serum ferritin	Normal girls	18.53 ± 3.12	t =2.303
		ADHD girls	8.93 ± 2.76	P =0.041
3	Serum Zinc	Normal boys	87.89 ± 8.57	t =6.388
		ADHD boys	30.99 ± 2.42	P <0.001
4	Serum Zinc	Normal girls	69.33 ± 8.19	t =4.637
		ADHD girls	30.33 ± 1.91	P =0.010

Table 2: Correlation of serum ferritin and serum zinc among normal and ADHD children (boys and girls combined)

S.No.	Parameters	Serum zinc ADHD children	Serum zinc normal children
1	Serum ferritin ADHD children	r = 0.632 P=0.050	-
2	Serum ferritin Normal children	-	r =-0.384 P=0.274

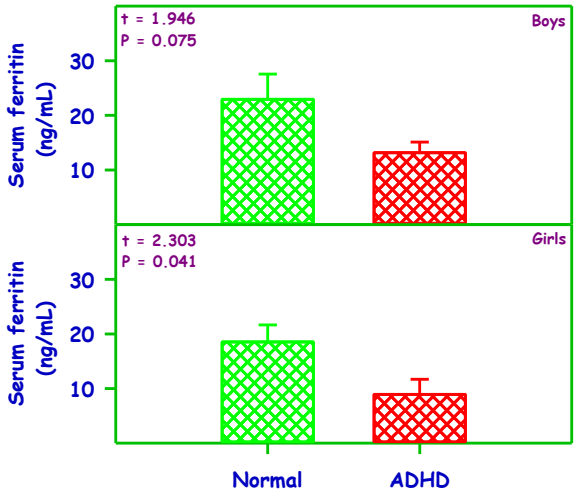

Figure 1: Comparison of serum ferritin levels among normal and ADHD children.

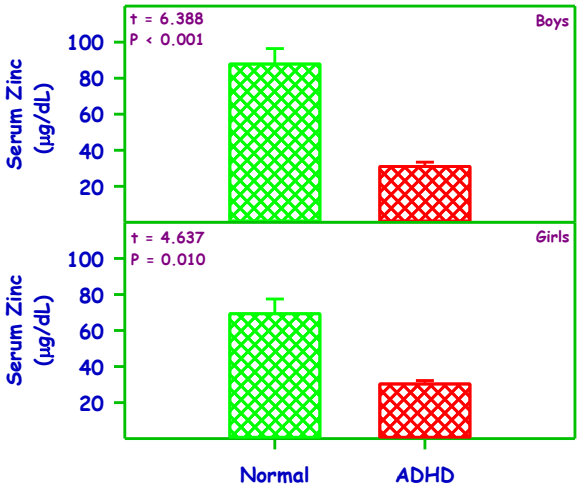

Figure 2: Comparison of serum zinc levels among normal and ADHD children.

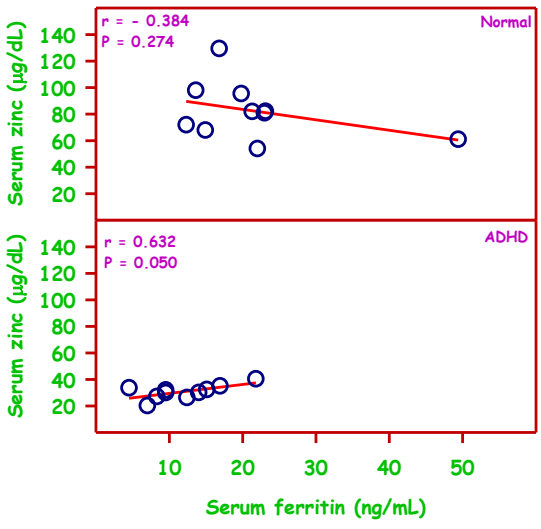

Figure 3: Correlation of serum ferritin and serum zinc levels among normal and ADHD children.

DISCUSSION

Iron is a common mineral for normal brain development and human behaviour. Iron is also necessary for the enzyme monoamine oxidase to break down the neurotransmitters. Imbalances in dopamine levels will cause muscle and behavioural problems. Several studies showed that children with ADHD had lower mean ferritin levels when compared with normal controls, and low serum ferritin levels are related to more severe symptoms of ADHD reported by teachers or parents.

A study was conducted on iron status in attention deficit hyperactivity disorder. It is a systematic review and meta-analysis study. Results reported that 11 studies were published before July 25, 2016. Of these, ten studies comprised 2191 participants, and 1196 ADHD cases reported low serum ferritin levels. Six studies comprised 671 participants, and 369 ADHD cases reported low serum iron levels. The study concluded that lower serum ferritin levels than serum iron levels were associated with ADHD in children.[11]

Children with low levels of zinc and ferritin showed higher symptom scores in attention deficit hyperactivity disorder, as per their parents and teachers. Children with low zinc and lower iron levels might have higher levels of parent-reported hyperactivity symptoms. The study concluded that iron and zinc levels might be associated with a more significant impairment in dopaminergic transfusion in children with attention deficit hyperactivity disorder.[12]

A study was conducted on iron treatment in children aged between 7 to 11 years of boys with ADHD. The severity of attention deficit hyperactivity disorder symptoms was assessed by parents' and teachers' scores on the Conner's rating scale. Afterwards, each patient received an iron preparation of 5 mg per kg daily for 30 days. Blood samples were taken before and after administration. Results reported a significant increase in serum ferritin levels and a significant decrease in the parent's Conner's rating scale scores. There were no changes in other parameters or the teacher's scores on the rating scale.[13]

The study explained the effect of zinc and omega-3 supplements as adjunctive drugs in the treatment of ADHD. A randomized, double-blind clinical trial was conducted on 150 children aged 6-15. The study was evaluated for eight weeks. Besides the drug of choice for ADHD, there is a placebo in the control group, zinc sulphate in the second group, and omega-3 in the third group. Improvement was checked by Conner's parent and teacher rating scales before and after the treatment. Findings showed significant improvement in the zinc group compared to the experimental and control groups. The study concluded that zinc supplements significantly improved the symptoms of ADHD.[14]

A study reported that a 3-year-old child was referred to consultation for his hyperactivity, attention deficit, impulsivity and sleep problems. DSMD, 4th edition criteria for ADHD, made the diagnosis. At baseline, the Conner's parent rating scale and the Conner's teacher rating scale were assessed. The total scores were 30 and 32, respectively. The child had a low serum ferritin level (<13 ng/ml). After eight months of treatment with ferrous sulphate (80 mg/dl). The serum ferritin level increased to 102 ng/ml. Both parents and teachers reported considerable behavioural improvement, and scores decreased between 9 and 13, respectively.[15]

CONCLUSION

The present study compared serum iron and serum zinc levels between normal and ADHD children. There was a highly significant association of serum ferritin levels in blood plasma between boys and girls. The serum ferritin levels of blood plasma among normal and ADHD children were positively correlated. The serum zinc levels of blood plasma among normal and ADHD children were negatively correlated. The study suggests that serum iron and zinc levels among ADHD children are essential. The parents' motivation is to provide their children with a diet rich in iron, zinc, minerals and vitamins regularly. It increases dopamine in the brain, which helps to improve attention span and concentration among children.

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