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An analytical study to evaluate the association and level of serum vitamin D in children with attention deficit hyperactivity disorder

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Abstract
Objective: To evaluate the association and level of serum vitamin D in children with attention deficit hyperactivity disorder.
Methods: This case-control study included Healthy and ADHD-diagnosed 6 to12 year olds. Those with ADHD medical records were the case group (n=50), whereas those without ADHD were referred to health clinics for weight and height checks.
Results: The age and gender of research participants did not significantly differ between cases and controls. Serum vitamin D levels differed significantly ($P < 0.001$) between the patients and control groups. The control group contained 20 youngsters with normal serum vitamin D. None of the children in either group had hazardous vitamin D levels. Serum vitamin D levels differed significantly (P=0.07) between ADHD and control groups.
Conclusion: ADHD children with low serum vitamin D levels should be monitored and treated for vitamin D deficiency. Additionally, lifestyle and diet should be changed to eliminate nutritional inadequacies in society.

Keywords: Vitamin D; children; psychiatric diseases; ADHD

Introduction

Attention deficit hyperactivity disorder (ADHD) is a highly widespread mental health problem that impacts approximately 5.3-7.1 percent of children and adolescents [1]. The three primary signs used to identify the illness before the age of twelve are attention insufficiency, hyperactivity, and impulsivity [1, 2]. In addition, there are various secondary symptoms that often accompany the condition, such as hostility, social incompetence, conflicts with peers, and anti-social behavior. These symptoms are clinically significant and should be taken into consideration [2, 3]. Currently, pharmacological therapy is the primary approach for treatment. Nevertheless, drug interventions have certain limits. Specifically, 30 percent of children with ADHD do not have a positive response to medication treatment [4, 5]. There is a need for more efficacious treatment and techniques to manage the disease [6, 7].

Researchers have recently started focusing on the importance of nutrition in preventing and treating the symptoms of the condition [8-10], as well as the broader role of the environment [11-13]. Diet therapy is a straightforward and cost-effective approach that may be easily embraced by parents and implemented by children. The significance of nutrition therapy, particularly the impact of supplements and vitamins, is highly evident. [11]. Neurotropic and neuro protective actions are crucial for maintaining cerebral function and promoting cognitive processes. Cerebral function relies heavily on it, and a lack of it may contribute to the development of ADHD. Vitamin D modifies the amounts of neuro trophic factors and monoamines, facilitating the responses to oxidative stress, and altering neurotransmitters. Vitamin D insufficiency is associated with aberrant regulation of dopamine, which suggests a potential role in the development of ADHD [14].

Vitamin D receptors and the enzyme 1α-hydroxylase are responsible for converting Vitamin D into its active form. These receptors and enzyme are widely present in the central nervous system, particularly in the neuronal cells of the substantia nigra, hippocampus, hypothalamus, prefrontal cortex, and cingulated gyrus [14-16]. The pathogenesis of ADHD has been observed to be related with most of these locations [16, 17].

The recommended approach for treating ADHD is multimodal, which involves a combination of medication, parent training, skills training counseling, behavioral therapy, and educational support. Only a fraction of patients, ranging from 30% to 70%, exhibit a positive response to the existing therapy for ADHD [18].
The objective of this study was to assess the correlation and concentration of serum vitamin D in children diagnosed with attention deficit hyperactivity disorder.

Materials and Methods

This study utilized a case-control design and included both healthy children and children diagnosed with ADHD between the ages of 6 and 12 years. Only children within this age range were eligible to participate in the study. In total, when the consent form was completed, 100 youngsters willingly took part in the study.
The case group consisted of 50 children with ADHD who had medical records at a pediatric department. The control group, also consisting of 50 children, was recruited from non-ADHD children who were referred for weight and height check-ups. Their demographic information was gathered when they were referred.
The psychiatrist has excluded the possibility of ADHD after conducting a thorough face-to-face interview with the kid and their parents, and applying the diagnostic criteria outlined in the Statistical Manual of Mental Disorders (DSM-IV) [19]. Once the diagnosis of ADHD is confirmed, the kid would proceed to follow the research procedure. Any youngster with liver, renal, or endocrine problems, or who was taking vitamin D supplements, was not included in the study. In addition, any youngster who was diagnosed with mental impairment, autism, or seizures was not included. The parents were provided with detailed information regarding the safety and objectives of the study, as well as the strict confidentiality measures in place to protect the data of each kid.
Following the acquisition of written informed consent from the parent of each participant, a total of three milliliters (ml) of venous blood was extracted from each child in both the cases and control groups. The level of 25-hydroxy vitamin D was measured using the Standard DIA source kit and ELISA techniques. The analysis of the blood determined the classification of the serum vitamin D level into four categories: very low (< 10 nanograms (ng) per ml), low (10 to 30 ng/ml), normal (30 to 100 ng/ml), or harmful level (> 100 ng/ml) [20, 21].
The parents were notified on whether their children were discovered to have serum vitamin D levels below or above the normal range.

Statistical Analysis

The data were analyzed using the statistical software SPSS version 20.0, developed by the company SPSS Inc. and based in Chicago, IL, USA. Statistical analyses were conducted using independent t-tests and chi-square testing. Associations were judged statistically significant at a significance level of ≤0.05.

Results

Table 1: Comparison of mean age, gender and mean Vitamin D levels between the groups

Variables	Gender		Age (yr)		Vitamin D level (ng/ml)	
	Boy	Girl	Mean	SD	Mean	SD
ADHD	30	19	9.16	2.36	18.12	10.12
Control	25	26	9.43	2.20	27.64	12.78
Total	55	45	9.32	2.28	22.88	12.96
P-value	0.721		0.202		0.001	

In terms of gender and age, the study's cases and controls did not differ significantly from one another. Nevertheless, serum vitamin D levels differed significantly ($P < 0.001$) between the patients and the control groups.

Table 2: Comparison of serum vitamin D levels of ADHD and control groups

Variables	Serum vitamin D levels (ng/ml)		
	Severe deficient n	Deficient n	Normal n
ADHD	18	25	13
Control	7	18	20
Total	25	42	33
P-value	0.070		

In the control group, 20 children had normal serum vitamin D level. None of the children in both groups showed toxic level of vitamin D. Analysis has shown a statistically significant difference (P=0.07) in serum vitamin D levels between the ADHD and the control groups.

Discussion

ADHD is one of the most common mental health conditions, affecting 5.3-7.1% of children and adolescents [22]. Before age twelve, attention insufficiency, hyperactivity, and impulsivity help diagnose the disease [22, 23]. Other clinically significant secondary symptoms include hostility, social ineptitude, peer conflict, and anti-social behavior [23, 24]. Drug therapy is the major treatment. However, pharmacological therapies have limits. Drugs don't work for 30% of ADHD kids [25, 26].
Disease control requires better treatment and tactics [27, 28]. The age and gender of research participants did not significantly differ between cases and controls. Serum vitamin D levels differed significantly ($P < 0.001$) between the patients and control groups. A study in Turkey found a significant difference ($P< 0.05$) in mean blood vitamin D levels between cases (20.9±19.4 ng/ml) and control groups (34.9±15.4 ng/ml) in children aged 7-18 [29]. A study comparing 1331 ADHD cases and healthy individuals under 18 found that the mean serum vitamin D level of ADHD children (16.6±7.8 ng/ml) was lower than the control group (23.5±9.9 ng/ml). Additionally, 8.15% of ADHDs had

normal serum vitamin levels [30]. The control group contained 20 youngsters with normal serum vitamin D. None of the children in either group had hazardous vitamin D levels. Serum vitamin D levels differed significantly (P=0.07) between ADHD and control groups. An interventional trial of 80 ADHD patients over 16 in New Zealand found 27% vitamin D insufficiency. Vitamin D supplementation for eight weeks reduced illness symptoms. Supplementing with zinc, vitamin B12, iron, and folate was ineffective [31]. Other study in England found no link between vitamin D and behavioral issues like ADHD [32]. Vitamin D deficiency causes various psychological illnesses because it is a neurosteroid [33]. Vitamin D also boosts transpeptidasec-glutamyl expression, which protects the brain. This enzyme boosts glutathione production, the main brain antioxidant [34]. Lack of this vitamin during fetal and early infancy affects neuron development, axon synapses, brain anatomy, and function [33]. Despite abundant sunlight, Persian Gulf countries have high vitamin D insufficiency rates. Vitamin D insufficiency affected 70% of young Iranian girls and 80% of Saudi girls [35]. Sunlight helps maintain blood vitamin D levels, but it alone cannot treat vitamin D deficiency [36].

Conclusion

Overall, the findings indicate that children with ADHD have insufficient amounts of serum vitamin D, highlighting the importance of periodically monitoring their vitamin D levels and providing appropriate treatment for those with deficits. Furthermore, it is imperative to make adjustments to one's lifestyle and dietary choices in order to effectively address and eradicate the prevalent nutritional inadequacies throughout society.

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