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The Study of Serum Lead Level in Children With ADHD Referring to Psychiatric Clinic of Baharan Hospital, Zahedan, Southeastern Iran

Mahboube Firouzkouhi Moghaddam,[1] Tayebeh Rakhshani,[2,*] and Seyyed Mansour Kashfi[2]

[1]Department of Child and Adolescent Psychiatry, Research Center for Children and Adolescents Health, Zahedan University of Medical Sciences, Zahedan, IR Iran
[2]Department of Public Health, Shiraz University of Medical Sciences, Shiraz, IR Iran

*Corresponding author: Tayebeh Rakhshani, Department of Public Health, Shiraz University of Medical Sciences, Shiraz, IR Iran. Tel: +98-7137201005, Fax: +98-7137260225, E-mail: trakhshani@gmail.com

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Abstract

Background: Contamination by pollutants has been considered as one of the environmental concerns during the recent years. Lead is one of the most common industrial contaminants all over the world and increase in lead level is associated with behavioral and cognitive problems. Attention deficit hyperactivity disorder (ADHD) is among the most common psychological-behavioral disorders among children, with the incidence rate of 4% - 12%.

Objectives: This study aimed to investigate the relationship between serum lead level and ADHD through comparison of serum lead level between children with ADHD and the control group.

Patients and Methods: This case-control study was conducted on 20 children with ADHD and 23 healthy children in the control group. The serum Lead level measured by an atomic absorption spectrometer, equipped with graphite furnace system, was compared between the two groups. The data were analyzed using the SPSS statistical software, version 16.

Results: The mean level of serum lead was higher in the ADHD children (6.7330 ± 2.39747) compared with the control group (3.0304 ± 1.30573) (P = 0.001). However, no significant difference was observed between the two genders regarding the mean level of serum lead in the case (P = 0.088) or the control group (P = 0.365).

Conclusions: Based on the study results, the mean level of serum lead was significantly higher in the ADHD group in comparison to the control group (P < 0.001). Thus, environmental contaminants, such as lead, can be associated with increasing incidence of ADHD. Yet, further studies on larger sample sizes are recommended to confirm our findings.

Keywords: ADHD, Children, Graphite Furnace, Serum Lead Level

1. Background

Lead is a noxious agent which is generated by vehicles fuel or coal, enters the body through respiration, and accumulates in the body (1, 2). Hence, even a small amount of blood lead is abnormal and is considered dangerous. This element is incongruent with body tissues and, unlike vital elements such as zinc and selenium, is considered as a poison which can hurt different organs of the body. Recent studies have shown a positive relationship between blood lead and left ventricular hypertrophy and hypertension (3-9). Increase in lead level may also lead to systolic and diastolic hypertension. More than 5% of children living in industrial cities have higher lead levels compared to those living in non-industrial environments. It should be noted that the normal level of lead in the body should be near zero (1, 2, 10). The smoke which exits from vehicles and coal combustion contains a considerable amount of lead. An increasing amount of lead in blood, especially in children, can cause problems such as reduction in intelligence and power of learning, sluggish brain activities, insomnia, irritability, and hyperactivity (1, 11). Attention deficit hyperactivity disorder (ADHD) with a prevalence of 4%-12% is among the most common psychological-behavioral disorders in school-aged children. This disorder is known by three major signs; lack of attention, hyperactivity, and irritability. Diagnosis and classification of this disease are done based on the DSM-IV criteria. Children afflicted with ADHD exhibit disorders, such as anti-social behaviors and drug abuse, in their future life (11). Research has shown that the risk of ADHD increased with the increase in serum lead concentration and that blood lead had a positive relationship to the disease signs (12-14). The results of a study carried out in Wisconsin university U.S. indicated that contamination of the environment with lead was a risk factor for emergence of ADHD in American children (15). Extensive researches have also shown a positive relationship between ADHD to even low levels of serum lead. The results of these studies also showed that blood lead level was associated with the signs of hyperactivity and mobility, but not with the sign of lack of attention (11). Nowadays, children's exposure to lead can be determined by measuring the concentration of

blood lead (15), which if considerable, it can be treated by using chelators. In a case report, a patient with increased level of serum lead (blood lead level: 42 mg/dL) was treated using a chelator element called succimer, which is evident by some decrease in patient's hyperactive behavior during the treatment process (16). Among other coping measures, proper nourishment also has a considerable effect on preventing chronic toxicity with lead. Using foods enriched with vitamin E and selenium and increasing the consumption of vitamin C decrease the lead absorption, which facilitate the excretion of toxic metals. Dairy products are also effective due to their high calcium levels (17).

2. Objectives

The prevalence of ADHD is high among children in the Iranian society and it is increasing in developed societies. On the other hand, evidence has demonstrated a significant relationship between this disease and blood lead level, the present study aims to compare blood lead level in ADHD children who referred to the psychiatric clinic of Baharan hospital in Zahedan, Iran and a control group. Hence, the present study aimed to investigate the relationship between serum lead level in children with ADHD and the control group.

3. Patients and Methods

The present study was conducted in Baharan Psychiatric hospital in Zahedan, Iran in 2011. In this case-control study the patients referred to Baharan Psychiatric hospital were investigated by analyzing the corresponding outpatients' records. In this way, 20 ADHD children including 10 males and 10 females, aged from of 4 to12 years, and lacking other psychological or physical diseases were selected as the case group. Diagnosis was done through DSM.IV criteria and confirmed by a specialist in pediatric psychology. In addition, 23 healthy children, including 12 females and 11 males, who did not suffer from ADHD or any other special psychological or physical diseases, were selected as the control group. In order to eliminate any confounding factors, such as differences in social and economic levels and nutrition which is highly effective in decreasing the accumulation of lead and preventing chronic toxicity by this element, the children in the control group had the same age and gender as the patients and were selected from the relatives of the patients. Having obtained the signed written informed consents from the parents, their children were referred to the hospital for taking the tests and providing personal information. This was done by drawing 2 mL of blood, in 3.5% sodium citrate, from the children's arm vein. The blood samples were kept at 4°C for 3 days, until used, otherwise kept at -20°C for longer maintenance. The lead was extracted from the blood samples according to an instruction (18). In doing so, 0.1 mL of 5 mL per liter triton X-100 and 0.1 mL of 5 g per liter ammonium hydrogen phosphate were added to 0.2 mL of citrated blood. The volume of the solution was made up to 1 mL by adding deionized water. The samples were then vertexed for 30 seconds. Serum lead level was measured using an atomic absorption spectrometer equipped with graphite furnace system (19). In order to normalize the results, the logarithm of the lead concentration was used. Finally, the data were entered into the SPSS statistical software, version 16 and analyzed using t-test. Besides, $P < 0.05$ was considered as statistically significant.

4. Results

This study was conducted on 43 participants. The case group consisted of 10 males (50%) and 10 females (50%), while the control group included 11 males (48%) and 12 females (52%). The mean level of blood lead was 7.61 ± 2.59677 mg/dL in the male members of the case group, which was much higher compared to the control group (2.8 ± 1.46151) ($P < 0.001$). In addition, this measure was 5.8560 ± 1.91884 mg/dL among the female of the case group, which was significantly higher ($P < 0.001$) than that of the control group (3.2417 ± 1.6888).

In this study, the lead level was investigated using independent t-test, indicating significantly higher lead levels ($P < 0.001$) among the ADHD children compared to the controls (Table 1).

Table 1. Comparison of Blood Lead Level Between the ADHD Children and the Control Group

Group	Number	Mean Level of Serum Lead	Standard Deviation	P Value
ADHD	20	6.7330	2.39747	.001
Control	23	3.0304	1.30573	.001

Table 2. Comparison of Blood Lead Levels in Male and Female ADHD Children and the Control Group

Gender	Number	Mean Serum Lead Level	Standard Deviation	P Value
Male				.001
ADHD	10	7.61	2.59677	
Control	11	2.8	1.46151	
Female				.001
ADHD	10	5.8560	1.91884	
Control	12	3.2417	1.16888	

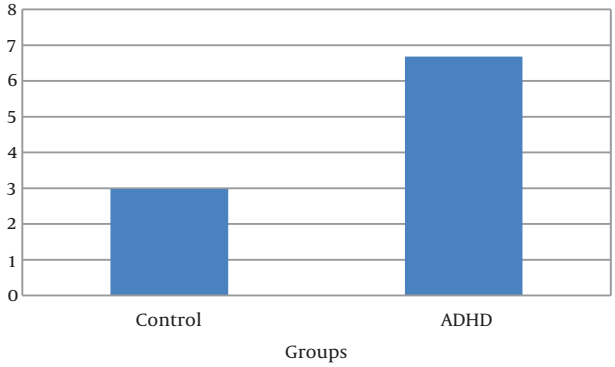

Figure 1. Comparison of Blood Lead Levels Between the ADHD Children and the Control Group

5. Discussion

Evidence has indicated that increase in serum lead level can be considered as an effective factor in causing ADHD disorder (11). This was also confirmed by the results of the present study, showing a significantly higher serum lead level (P = 0.001) in the ADHD group (6.7330 ± 2.39747) in comparison to the control group (3.0304 ± 1.30573). However, no significant difference was observed regarding genders in case or control groups. Similar results have also been obtained in other studies. Ha et al. (12), performed a study on 1778 Korean children in 2009 and reported a significant relationship between blood lead concentration and emergence of ADHD signs (P < 0.05). Hence, they concluded that even a small concentration of lead was a risk factor for ADHD. Also, Nigg et al. (11), conducted a study in the U.S. in 2008 and revealed that blood lead level was significantly higher in the ADHD children in comparison to the control group (P < 0.05). Moreover, a study by U.S. Wisconsin university in 2006 demonstrated that even a lead serum level below 2 mg/dL was related to ADHD. Additionally, there was a direct relationship between the blood lead level and the signs of ADHD (15). In this context, Wang et al. (2), carried out a case-control study in China in 2008 and concluded that blood lead level was higher in the ADHD group compared to the control group. In their study, the mean level of blood lead level was 8.77 ± 3.89 in the ADHD group, which was significantly higher compared to the control group (5.76 ± 3.39). The results of our study and other similar studies indicated that blood lead could have many adverse effects on children's growth and might cause personality and behavioral changes in future. It might also expose children to ADHD which, as discussed before, can cause personality and psychological disorders, learning problems, educational difficulties, or even delinquencies such as drug abuse and increase in crime which have deteriorating effect on the society's future (14). Hence, air pollution and the existence of lead in the air, demands further researches to be carried out which help organizations and health authorities design strategies at national and international levels to eliminate air pollution and create a healthy environment. Furthermore, monitoring body's lead status and controlling the level of lead in the air which children breathe and the objects they use are additional measures that prevent behavioral problems and learning disorders.

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Footnotes

Authors' Contribution: All authors contributed equally.

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