Impact of lead poisoning on school academic performance in children

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ABSTRACT

Aim: To assess impact of lead poisoning on school academic performance in children.
Methodology: One hundred thirty children of both genders were enrolled. 5 ml of venous blood was collected and the level of blood lead was determined using atomic absorption spectrometry and micro sample flame atomization.The Strengths and Difficulties Questionnaire (SDQ)19, the Development and Well-being Assessment (DAWBA)20, and the Anti-social Behaviour Interview (ASBI)21 were used to evaluate the behaviour of children and attention was evaluated using the Test of Everyday Attention for Children (TEACh). The outcomes of tests were used to determine the children's educational performance.
Results: Out of 130 children, 60 (46.1%) were male and 70 (53.9%) were female. Lead level between 0-2 µg/dl was seen in 26, 2-5 µg/dl in 58, 5-10 µg/dl in 37 and >10 µg/dl in 9 children. The difference was significant (P< 0.05). The SATs results started to decline above 5 mg/dl, but the two behavioural outcomes (hyperactivity and anti-social conduct) did not start to significantly decline until above 10 mg/dl.Writing SATS scores decreased by 0.2 points as a result of the effect of increasing exposure from 5 to 10 mg/dl. It was linked to a 0.3-point increase in the teacher-reported hyperactivity scores.
Conclusion: Even when blood lead levels are as low as 5-10 mg/dl, early childhood exposure to lead has a significant impact on future educational achievement and behavior. Therefore, it is recommended that the threshold for concern be reduced to 5 mg/dl.
Key words: Hyperactivity, Lead, Children

INTRODUCTION

Lead poisoning in children is a serious health issue caused by the accumulation of lead in their bodies.[1]Due to their developing bodies, children are more susceptible to the adverse effects of lead exposure compared to adults. Their growing bodies absorb lead more readily, and their developing brains and nervous systems are particularly vulnerable to its detrimental impact. Lead, a hazardous metal, can be present in several sources such as lead-based paint, polluted soil, household dust, specific imported products, and certain types of water pipes.[2]
Exposure of children to lead can result in a spectrum of detrimental health effects, encompassing both immediate and long-lasting consequences. The symptoms of lead poisoning can vary depending on the duration and intensity of exposure.[3]Lead can interfere with the normal development of a child's brain, leading to learning difficulties, decreased IQ, and behavioral problems.Lead exposure can impair memory function and attention span.[4] Children may have trouble remembering information, following instructions, and staying engaged during lessons.Lead exposure can result in learning disabilities and developmental delays. Children with lead poisoning may have difficulties with reading, writing, math, and comprehension skills.[5]They may struggle to keep up with their peers in class and have a hard time grasping new concepts.Lead poisoning can cause neurological damage, leading to problems with coordination, concentration, memory, and speech.Lead can affect the digestive system, resulting in abdominal pain, constipation, and loss of appetite.[6]Prolonged exposure to

lead can damage the kidneys, leading to decreased kidney function.Lead interferes with the body's production of red blood cells, leading to anemia, which can cause fatigue, weakness, and other related symptoms.[7]We performed this study to assess impact of lead poisoning on school academic performance in children.

METHODOLOGY

The present study comprised of one hundred thirty children of both genders. We obtained approval from ethical review committee. Parents' consent was obtained before starting the study.

Data such as name, age, gender etc. was recorded. 5 ml of venous blood was collected in a test tube. The level of blood lead was determined using atomic absorption spectrometry and micro sample flame atomization.The Strengths and Difficulties Questionnaire (SDQ), the Development and Well-being Assessment (DAWBA), and the Anti-social Behaviour Interview (ASBI) were used to evaluate the behaviour of children between the ages of 7 and 8.At the age of 8, attention was evaluated using the Test of Everyday Attention for Children (TEACh). The outcomes of tests were used to determine the children's educational performance.The collected data was analyzed using the Mann Whitney U test for statistical evaluation. A significance level of $p < 0.05$ was established to determine statistical significance.

RESULTS

Table 1: Patients distribution

Total- 130		
Gender	**Males**	**Females**
Number (%)	60 (46.1%)	70 (53.9%)

Out of 130 children, 60 (46.1%) were male and 70 (53.9%) were female (Table 1).

Table 2: Assessment of lead level

Lead level (µg/dl)	**Number**	**P value**
0-2	26	0.05
2-5	58	
5-10	37	
>10	9	

Lead level between 0-2 µg/dl was seen in 26, 2-5 µg/dl in 58, 5-10 µg/dl in 37 and >10 µg/dl in 9 children. The difference was significant (P< 0.05) (Table 2).

Table 3: Regression analysis of the effect of blood lead levels on behaviour, attention, co-ordination and school performance outcomes

Parameters	**Variables**	**Linear log lead concentration**		**2-5 µg/dl**		**5-10 µg/dl**		**>10 µg/dl**	
		OR	**P value**	**OR**	**P value**	**OR**	**P value**	**OR**	**P value**
SDQ	Teacher-hyperactivity	1.43	0.91	1.83	0.81	1.26	0.42	2.71	0.03
	Teacher-Total difficulties	1.31	0.84	1.06	0.56	1.32	0.36	2.90	0.04
	Parents-hyperactivity	1.21	0.93	0.89	0.72	1.27	0.31	1.34	0.87

	Parents-Total difficulties	1.14	0.76	1.12	0.64	1.29	0.28	1.27	0.31
DAWBA	Activity score	0.12	0.61	0.83	0.32	1.25	0.35	0.92	0.48
	Attention score	0.14	0.52	0.87	0.47	1.29	0.38	1.14	0.82
Attention	Selective	1.13	0.91	1.04	0.95	0.96	0.91	1.12	0.77
	Dual	0.90	0.64	1.14	0.67	1.12	0.43	0.47	0.08
	Same world	1.24	0.19	0.98	0.92	1.08	0.25	1.45	0.32
	Opposite world	1.08	0.29	0.27	0.21	1.71	0.32	10.4	0.91
Behaviour	Anti- social activities	1.12	0.05	0.93	0.13	1.2	0.75	2.45	0.04
SATS	Writing	0.67	0.03	0.87	0.09	0.54	0.04	0.64	0.76
	Spelling	0.65	0.02	1.09	0.11	0.43	0.03	0.43	0.32
	Reading	0.58	0.04	1.33	0.16	0.75	0.67	0.72	0.35
	Mathematics	0.72	0.01	1.82	0.52	0.73	0.24	0.87	0.41

Research indicates that there is a discernible threshold up to 5 mg/dl, where estimates within this range do not exhibit significant differences. Among the five outcomes that yielded significant results, the estimates were divided into a ratio of 4:1, with four outcomes showing beneficial effects and one outcome demonstrating detrimental effects.The SATs results started to decline above 5 mg/dl, but the two behavioural outcomes (hyperactivity and anti-social conduct) did not start to significantly decline until above 10 mg/dl.Writing SATS scores decreased by 0.2 points as a result of the effect of increasing exposure from 5 to 10 mg/dl. Additionally, it was linked to a 0.3-point increase in the teacher-reported hyperactivity scores (Table 3).

DISCUSSION

Addressing lead poisoning and its impact on school performance requires a multi-faceted approach.[8]A healthy diet full of calcium, iron, and vitamin C can help lessen the absorption of lead. Encourage kids to eat a range of foods, such as fresh produce, nutritious grains, and lean meats.[9] Teach kids the value of washing their hands, especially before and after meals and playing outside or in places where lead exposure is a possibility.[10] Use a moist cloth to wipe down windowsills, floors, and other surfaces often to prevent lead-containing dust from building up.[11,12] Avoid giving children toys or anything that can contain lead to chew on. Give children toys that are secure and suitable for their age.[13]We performed this study to assess impact of lead poisoning on school academic performance in children.

Our results showed that out of 130 children, 60 (46.1%) were male and 70 (53.9%) were female. Evens et al[14]discovered that B-Pbs< 10 g/dL were negatively correlated with reading and math scores in third grade students after correcting for other school performance factors such as poverty, race/ethnicity, gender, mother education, and extremely low birth weight or preterm birth. The likelihood of failing increased by 32% for both reading (RR = 1.32, 95%CI = 1.26, 1.39) and maths (RR = 1.32, 95%CI = 1.26, 1.39) for a 5 g/dL increase in B-Pb. Lead had a nonlinear effect on reading, with greater failure rates at lower B-Pbs. Exposure to blood lead concentrations of 5 to 9 vs. 0 to 4 g/dL in schoolchildren is responsible for 13% of reading failure and 14.8% of maths failure.

In our studylead level between 0-2 µg/dl was seen in 26, 2-5 µg/dl in 58, 5-10 µg/dl in 37 and >10 µg/dl in 9 children. In our study, there was indication of a threshold up to 5 mg/dl, with

estimatesin this range not being significantly different and with theestimates for the five outcomes with significant results beingsplit 4/1 as beneficial/detrimental.The SATs results started to decline above 5 mg/dl, but the two behavioural outcomes (hyperactivity and anti-social conduct) did not start to significantly decline until above 10 mg/dl.Writing SATS scores decreased by 0.2 points as a result of the effect of increasing exposure from 5 to 10 mg/dl. Moreover, it was linked to a 0.3-point increase in the teacher-reported hyperactivity scores. Chandramouliet al[15]investigated if early lead exposure at levels below 10 mg/dl affects students' behaviour and academic performance in school. Venous samples were collected from the participants, and their lead levels were measured using atomic absorption spectrometry. Out of the total cases, 488 (84%) had complete data on confounding factors and outcomes. The analysis revealed significant associations between blood lead levels and performance in reading, writing, and spelling as measured by SATs (Standard Assessment Tests), as well as with antisocial behavior.

A doubling in lead concentration was linked to a decline of 0.3 points (95% CI 20.5 to 20.1) in SATs grades. When lead levels were categorized, with the reference group being 0–2 mg/dl, no noticeable effects on outcomes were observed at levels between 2–5 mg/dl. However, lead levels ranging from 5–10 mg/dl were associated with reduced scores in reading (OR 0.51, $p = 0.006$) and writing (OR 0.49, $p = 0.003$). Moreover, lead levels exceeding 10 mg/dl were connected to increased scores in antisocial behavior (OR 2.9, $p = 0.040$) and hyperactivity (OR 2.82, $p = 0.034$).

CONCLUSION

Early childhood exposure to lead affects later educational attainment and behaviour even at low blood levels (5–10 mg/dl), and the level of concern should be lowered to 5 mg/dl.

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