Prevalence of Blood Lead Levels (BLL's) in children visiting tertiary care hospitals of Peshawar from February to April 2015: A pilot study

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Abstract

Objective: To determine blood lead level in young children visiting tertiary care hospitals.

Methods: This cross-sectional study was conducted from February to April 2015 at Khyber Teaching Hospital, Kuwait Teaching Hospital and Siffat Ghayoor Memorial Children's Hospital, Peshawar, Pakistan, and comprised children aged1-10 years. Purposive sampling technique (non-probability) was used. SPSS 17 was used for data analysis. Charts were made in Microsoft Excel 2007.

Results: Of the 100 children in the study, 79(79%) had lead present in their blood, while 21(21%) had no traces whatsoever. Of those who had lead in their blood, 5(6%) showed blood lead level of above 1 μg/dL. The overall mean blood lead level was 0.344± 0.05 μg/dL. There was significance association between lead level and the residential areas of participants ($p<0.05$).

Conclusion: Lead was found in the blood of children aged 1-10 years and was significantly related to the place of residence. Age and gender had no relation with blood lead levels.

Keywords: Lead poisoning, Children, Intellectual disability, Tertiary healthcare, Pakistan. (JPMA 66: 1350; 2016)

Introduction

Lead (Pb) is a toxic metal whose widespread use has caused extensive environmental contamination and health problems in many parts of the world. It is a cumulative toxicant that affects multiple body systems, including the neurological, haematological, gastrointestinal, cardiovascular and renal systems.[1] Lead poisoning is one of the most common and best-recognised childhood diseases of toxic environmental origin. Children around the world today are at risk of exposure to lead from multiple sources. Lead poisoning accounts for about 0.6% of the global burden of disease.[2] Susceptibility to lead toxicity is often assumed to be greatest during early childhood (e.g., 2 years of age). Moreover, a study concluded that blood lead level (BLL) taken at 5-7 years of age are more strongly associated with intelligence quotient (IQ).[3] A recent research illustrated that BLL of even less than 10ug/dL in early childhood was associated with reduced IQ at the age of 6 years.[4] Likewise, low levels of lead exposure can cause learning disabilities, mental retardation, hearing loss, hindrances in speech and language capabilities, difficulty in concentrating and staying focused, for example attention deficit hyperactivity disorder (ADHD).[5] Premature death, antisocial behaviour as well as propensity to commit crimes in adulthood are other complications that arise from low BLL (<10 μg/dL).[6-9] It was also found that for BLL between 1 and 10 μg/dL, the total decrease in IQ averaged 7.4 points, a drop of 0.82 points for each 1 μg/dL. Lead at levels below 10 μg/dL causes damage in greater increments than above this value. It is now clear that any level of lead would have an adverse effect on the mental acuity of children.[10]

Studies conducted in Pakistan have shown blood lead level prevalent in different population groups, but most of them have highlighted the effect BLL has had on children. Many causes of BLL have been identified in previous researches conducted in Pakistan which have pinpointed pica from leaded paint, vehicular exhaust fumes and surma as the leading causes of exposure to lead toxicity in children.[11-14] Even though lead is considered one of the most toxic heavy metals, only a few studies highlight the extent of BLL in Pakistan. Another Pakistani study evaluated the association of lead level and deficits in stature, mental ability and behaviour of children.[15] Another study tested blood samples of 430 children between 36-60 months of age for BLL. About 80% of children had blood lead concentrations above 10 μg/dl, with an overall mean value of 15.6 μg/dl.[16]

Recent studies measuring BLL in children living around

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automobile/battery repair workshops found significantly higher blood lead levels among the subjects; the overall mean BLL was 11.4 µg/dl (range: 1.3 - 34.2 µg/dl).[17] An Indian study found that children aged 4-11 months and 12-23 months had 84% and 146% higher BLL than children aged ≤3 months.[18]

Since 2002, only one research[19] in Peshawar on the BLL of children was conducted until now. The current study was planned to collect baseline and recent data regarding BLL in children to highlight the importance of this subject.

Patients and Methods

This cross-sectional study was conducted from February to April 2015 at the paediatrics wards and emergency outpatient department (OPD) of three major tertiary care hospitals - Khyber Teaching Hospital, Kuwait Teaching Hospital, Siffat Ghayoor Memorial Children's Hospital - of Peshawar, Pakistan, and comprised child patients. Khyber Teaching Hospital has been providing tertiary health care to the local population and teaching facilities to undergraduate as well as postgraduate medical students in Khyber Pakhtunkhwa(KPK) since 1976. This 1,202-bed hospital caters to the health requirements of over 500,000 patients per year. Kuwait Teaching Hospital is a private charity-based hospital with a capacity of 250 beds, delivering health services to the poor and ailing community of entire KPK, federally administered tribal areas(FATA) and adjoining areas of Afghanistan, along with teaching services to undergraduate and postgraduate medical students. Siffat Ghayoor Memorial Children's Hospital is located at the Grand Trunk (GT) Road and is a well-known tertiary care hospital, specialising in medical services for children. All of these hospitals have both fully functioning paediatric ward and emergency OPD.

The subjects were divided into 10 equal groups according to their age. This study used purposive sampling technique (non-probability). Children aged 1-10 years were included. Those who had any blood disorder such as haemophilia, thalassaemia, etc., were excluded. The methodology of choosing a patient was such that the research team would wait for patients who fit the criteria. When identified, the investigators would ask the sitting physician if he/she needed any sort of blood test from the child. If yes, the researchers would present the parents with the consent form regarding the study informing them that only a small amount of blood (2ml) from the sample that will be going for the tests prescribed by the physician will be used for this study. If they accepted, their child/children were included in the research. If they disagreed, they were excluded. Blood samples of 2ml were drawn from children using disposable syringes and transferred to ethylenediaminetetraacetic acid (EDTA) test tubes (AXIVAC), mixed, stored in cooler bags and immediately sent to the Pakistan Council of Science and Industrial Research (PCSIR), Peshawar, for analysis of lead.

Lead was analysed by polarised Zeeman atomic absorption spectrophotometer, (model Z-800, Hitachi, Tokyo, Japan) with a graphite furnace. The instrument was calibrated with lead standards (lead nitrate, 1,000 mg/dL, Cat. # 45556, BDH, Dorset, England) by the standard addition method as described by Miller et al.[20] Samples and standards were prepared with a matrix modifier solution which contained 0.5% v/v Triton X-100, 0.2% v/v 65% (16 M) extra pure nitric acid and 0.2% dibasic ammonium phosphate,[20] all from Sigma Chemical Co. (St. Louis, Missouri). Water used for reagents preparation was purified to approximately 18 M W/cm with a Milli-Q system (Millipore). The Centres for Disease Control and Prevention (CDC), United States, provided quality control for analyses.[21]

Informed consent was obtained from the institute, respective hospitals and the parents of participants as well as doctors who referred the patients for blood sampling before ensuring their participation in the study, in accordance with the ethical standards of the responsible institutional committee, i.e. Undergraduate Medical Research (UMR) Ethical Review Committee, Peshawar Medical College, Peshawar, on human experimentation. The patients 'names, initials, or hospital numbers were not used in any way whatsoever. The consent forms were also translated in Urdu to make it easier for the parents to understand why this research was being conducted. If they were illiterate, the doctor would read it out to them and explain what this study meant in simpler terms. No member of the research team explained the consent form to the parents to avoid any kind of bias. If an adequate amount of blood was not drawn, the technician decided whether the sample was to be included in the research or not. Fortunately, this never occurred during the course of the study. If it had occurred, the blood would have been handed over to the hospital staff to aid in the tests they required.

SPSS 17 was used for data analysis. Microsoft Excel 2007 was used to construct graphs and tables. BLL was compared to other variables using Pearson's chi-square test. A p-value of 0.05 was considered significant.

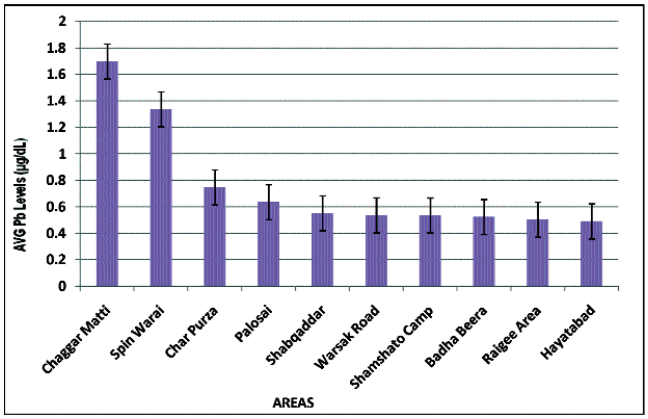
Results

Of the 100 children, there were 50(50%) boys and

Table: Comparison of age, gender and residential areas with children's blood lead levels (BLL's).

S.No	Variables		Chi Square test P - Value
1	Age	BLL*	0.185
2	Gender	BLL*	0.449
3	Residential Areas	BLL*	0.001

*BLL: Blood lead level.



AVG: Average. Pb: Lead. BLL: Blood lead level

Figure: Top ten areas with the highest average BLL's presence in children.

50(50%) girls. Each group had 10(10%) participants, 5(5%) boys and 5(5%) girls. The age of the participants ranged between 1 and 10 years. Moreover, 79(79%) children had lead present in their blood while 21(21%) had no traces of the metal. Of those who had lead in their blood, 5(6%) showed BLL of above 1 µg/dL. The mean BLL was 0.344± 0.05 µg/dL. The mean BLL was 0.317±0.05 µg/dL among boys and 0.372± 0.05 µg/dL among girls.

Of the 42 different areas of Peshawar from where data was collected, 8(19%) were completely free from any sort of lead contamination, whereas participants of 6(14.3%) areas had some degree of lead in their blood. Chaggar Matti, Spin Warai and Char Purza were at the top among areas which had the highest mean BLL (Figure).

BLL was also compared among the different age groups of the participants but no significant difference was found (p=0.185). The difference between the BLL values among boys and girls was also not significant (p=0.449). On the other hand, when a comparison was made between the residential areas of the participants and BLL, the difference proved to be significant (p=0.001) (Table).

Discussion

The scientific world is divided on a value to diagnose a child with lead poisoning; however, studies and international health regulatory bodies such as the World Health Organisation (WHO) have pleaded that even BLL lower than 10 µg/dL does cause serious detrimental effects on a child's health and that there is hypothetically no "normal" level acceptable in the body.[4-10] Long-term exposure to lead, which is a naturally occurring metal present in everything from petrol, paint, household water supply as well as food, does not affect the body immediately if taken in low quantities but may cause the problems mentioned earlier over the course of the child's life. Lead poisoning is almost never taken seriously; unfortunately, this condition is a "silent killer" and is responsible for 143,000 deaths as well as 600,000 cases of mental disabilities each year.[22] Therefore, this study is being conducted with great optimism so we can avoid a problem that can be avoided, which is often not the case these days.

In countries such as the United States, it is a common practice that children entering the educational system have to be screened for elevated lead levels.[23] Unfortunately, this is not the case in Pakistan, and if this issue is not given any importance it will most definitely cause problems in the future. A study conducted earlier in Peshawar analysed blood samples of 60 children aged between 7-14 years working at auto-rickshaw shops. That study showed a mean BLL value of 38.2ug/dL.[19] However, mean blood lead level in our study sample was much lower. This discrepancy could be explained by the hypothesis that blood lead level is a reflection of the current exposure, as most of the lead gets accumulated in bones after thirty days.[24]

Unfortunately in Pakistan, socio-economic factors and the incidence of prevalent treatable diseases have never been looked upon with great stress. In comparison to the study conducted in the United States where less socio-economic stability was considered as a marker for higher BLL in children, this research showing higher BLL in the relatively less-developed areas of Peshawar, such as Chaggar Matti, Spin Warai and Char Purza, speaks volumes.[25]

The unacceptable notion that can be inferred from this study is that there was no follow-up study conducted after 2002 in Peshawar on the condition of lead levels or the extent of lead poisoning in the city.[19] This thirteen-year gap has made it difficult for this research to make a

significant impact on the current situation of lead levels and its underlying reasons for its existence.

The current study also had its limitations, including the small sample size which was due to the fact that funds were raised by the investigators themselves. It also did not properly accommodate socio-economic factors as well as other aspects of blood chemistry into its study design to make results more conclusive. Therefore, its results cannot be generalised to the entire region. This study did not associate the levels of IQ with the BLL as well, therefore neglecting the effects caused by BLL among the participants.

Future studies should compare BLL with socio-economic factors and should include other aspects of blood chemistry. The association between child labour in Pakistan and BLL can be an avenue that needs exploring in the future as well. Linking BLL with its effect on different organ systems of the body can also be further researched upon. Studies linking the water supply of the areas mentioned earlier in this study can also be investigated for a correlation with BLL. Policies regarding the control of lead levels in developed countries should be adopted by Pakistan and implemented as soon as possible so that this problem may not escalate out of hand in the future.

Conclusion

Lead was found in the blood of children aged 1-10 years and was significantly related to the place of residence. Measures taken by the relevant authorities in Pakistan to control this problem were found to be insufficient. Stern actions are needed to reduce the use of lead in industries, which may be the source to an increase in the levels of lead in the environment and thus in the blood of our future generations.

Acknowledgments

We are grateful to Dr Muhammad Aman Khan (Head of Department at Community Health Sciences, Peshawar Medical College) for rendering valuable support and supervision for this research. We are also grateful to Dr Nadeem Khawar (Khyber Teaching Hospital), Dr Saima Ali (Kuwait Teaching Hospital) and Dr Alam Khattak (Siffat Ghayoor Memorial Children's Hospital) for their help in the smooth collection process at their respective hospitals. Thanks are also due to all the staff of the respective hospitals that helped us throughout, and to our sweet young patients and their parents for being so obliging.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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