THE AGA KHAN UNIVERSITY

eCommons@AKU

Department of Pathology and Laboratory Medicine | Medical College, Pakistan

December 2017

High burden of subclinical lead toxicity after phase out of lead from petroleum in Pakistan

Hafsa Majid
Aga Khan University, hafsa.majid@aku.edu

Aysha Habib
Aga Khan University, aysha.habib@aku.edu

Nadeem Ullah Khan
Aga khan University, nadeemullah.khan@aku.edu

Imran Siddiqui
Aga Khan University, imran.siddiqui@aku.edu

Farooq Ghani
Aga Khan University, farooq.ghani@aku.edu

See next page for additional authors

Follow this and additional works at: https://ecommons.aku.edu/pakistan_fhs_mc_pathol_microbiol

 Part of the Pathology Commons, and the Public Health Commons

Recommended Citation

Majid, H., Habib, A., Khan, N. U., Siddiqui, I., Ghani, F., Jafri, L. (2017). High burden of subclinical lead toxicity after phase out of lead from petroleum in Pakistan. *Journal of the College of Physicians and Surgeons Pakistan, 27*(12), 767-770.
Available at: https://ecommons.aku.edu/pakistan_fhs_mc_pathol_microbiol/719

Authors
Hafsa Majid, Aysha Habib, Nadeem Ullah Khan, Imran Siddiqui, Farooq Ghani, and Lena Jafri

This article is available at eCommons@AKU: https://ecommons.aku.edu/pakistan_fhs_mc_pathol_microbiol/719

ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/321704726

High Burden of Subclinical Lead Toxicity after Phase Out of Lead from Petroleum in Pakistan

Article · December 2017

CITATIONS
0

READS
22

6 authors, including:

Hafsa Majid
Aga Khan University, Pakistan
17 PUBLICATIONS **8** CITATIONS
SEE PROFILE

Aysha Habib Khan
Aga Khan University, Pakistan
106 PUBLICATIONS **419** CITATIONS
SEE PROFILE

Imran Siddiqui
Aga Khan University, Pakistan
42 PUBLICATIONS **229** CITATIONS
SEE PROFILE

Lena Jafri
Aga Khan University, Pakistan
41 PUBLICATIONS **62** CITATIONS
SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Inherited Metabolic Diseases View project

Relationship of Serum Transthyretin (Prealbumin) & Vitamin D deficiency with length of Stay and mortality in Critically Ill Surgical Patients View project

All content following this page was uploaded by Hafsa Majid on 19 February 2018.

The user has requested enhancement of the downloaded file.

ORIGINAL ARTICLE

High Burden of Subclinical Lead Toxicity after Phase Out of Lead from Petroleum in Pakistan

Hafsa Majid[1], Aysha Habib Khan[1], Nadeem Ullah Khan[2], Imran Siddiqui[1], Farooq Ghani[1] and Lena Jafri[1]

ABSTRACT

Objective: To evaluate the frequency of subclinical lead toxicity.

Study Design: Cross-sectional study.

Place and Duration of Study: Department of Pathology and Laboratory Medicine, The Aga Khan University Hospital, Karachi, from January 2011 to December 2014.

Methodology: Analysis of laboratory data for blood lead levels (BLL) was performed. Lead was tested by atomic absorption spectrometer. For all subjects, only initial test results were included while the results of repeated testing were excluded. Exemption was sought from institutional ethical review committee. BLL of 2-10 ug/dl and 10-70 ug/dl in children and adults, respectively were taken as subclinical lead toxicity.

Results: Amongst the total number of subjects tested (n=524), 26.5% (n=139) were children (<16 years) while rest were adults. Overall median BLLs was 6.4 ug/dl (20.9-3.1). The median BLL was 4 ug/dl (6.7-2.6) in children and 8.3 ug/dl (27.9-3.4) in adults, respectively. The BLL increased with age; higher levels were observed in age range 21-30 years of subjects [median lead level 16.9 ug/dl (36.1-4)] and lower level [4.2 ug/dl (6.8-2.6)] in children with <10 years of age. Only 16% (n=22) children had desirable lead levels while most had either subclinical (76%, n=106) or toxic lead levels (8%, n=11). In adults, (55%, n=212) subjects had desired lead levels, and 40% (n=154) and 4.99% (n=19) had subclinical and toxic lead levels.

Conclusion: Presence of subclinical lead poisoning even after phasing out of lead petroleum in Pakistanis is alarming, especially in children. A national population-based study to determine the lead status and targeted intervention to identify potential sources is need of the time.

Key Words: *Lead toxicity. Blood lead levels. Pakistan. Subclinical toxicity.*

INTRODUCTION

Lead is the second most hazardous substance according to priority list of hazardous substances by Agency of Toxic Substance and Disease Registry (ATSDR).[1,2] It has no physiological role and is ubiquitous in the environment, leading to clinical and subclinical toxicity primarily through ingestion and inhalation.[3,4] Between the two, more lead is absorbed into the circulation by inhalation (50-70%) compared to ingestion (adults 10%, children 40-50%). In addition to environmental exposure, there are occupations that can potentially cause lead exposure to workers.[5]

Understanding of lead toxicity has advanced considerably over the past years, and emphasis has shifted from toxicity effects in clinically symptomatic patients to the consequences of low exposure causing mild or no symptoms.[6] The availability of more sensitive analytical methods has made it possible to measure lead at much lower concentrations.[7] In 1991, the Centers for Disease Control and Prevention (CDC) redefined the cutoff value of elevated BLL in children from <25 µg/dL to <10 µg/dL and then lowered to 5 µg/dl in 2012, based on current BLL and accumulating scientific evidence of lead related adverse health effects.[8] In 2009 September, Germany set 3.5 µg/dL as the goal for children (up to the age of 12 years) and for men and women currently 9 µg/dL and 7 µg/dL, respectively for BLL based on the 95th percentile of results of national blood lead surveys.[9] Researchers propose that public health action lead level of 2 µg/dL to replace 10 µg/dL for children due to scientific, economic, and public health considerations.[10]

The environmental efforts, most importantly the phasing out of lead from gasoline, have been shown to dramatically reduce the prevalence of lead poisoning in countries like US, United Kingdom and Mexico with reported decrease in BLL.[11] Pakistan government in 2001 encouraged all the refineries in the country to phase out lead in petrol with permissible petroleum lead limit of 0.02 g/l, which was completed in July 2002.[12] There is paucity of data on lead toxicity in Pakistani children after phasing out of leaded petroleum, so this study primarily aimed to determine the frequency of subclinical lead toxicity in our setting.

METHODOLOGY

Analysis of laboratory data for patients tested for plasma lead from January 2011 to December 2014 was done at the Section of Chemical Pathology, Department of

Department of Pathology and Laboratory Medicine[1] / Emergency Medicine[2], The Aga Khan University Hospital, Karachi.

Correspondence: Dr. Lena Jafri, Assistant Professor, Department of Pathology and Laboratory Medicine, The Aga Khan University Hospital, Stadium Road, Karachi. E-mail: lena.jafri@aku.edu

Received: April 12, 2016; Accepted: November 07, 2017.

Pathology and Laboratory Medicine, The Aga Khan University Hospital, Karachi. For all subjects, only initial test results were included while the results of repeated testing were excluded. To maintain confidentiality, patients' identification were deleted and code was assigned. Exemption was sought from institutional ethical review committee.

Whole blood lead levels were performed by graphite tube atomizer, atomic absorption spectrometer 200 series AA (Agilent Technologies, California, US). Three-level quality control materials were run with each batch of samples. The laboratory participated in proficiency testing survey of College of American Pathologist twice a year with >80% performance when compared with peer group.

Adult subjects were categorized into three groups based on BLL as groups I, II, and III with BLL <10 ug/dl, 10-70 ug/dl and >70 ug/dl, respectively. The blood lead groupings in children were done at cutoff value of <2 ug/dl, 2-10 ug/dl and >10 ug/dl. In adults levels of 10-70 ug/dl and 2-10 ug/dl, and in children were taken as subclinical lead toxicity.[10]

The statistical analysis was performed using the SPSS version 19. Normality of data distribution was assessed by Shapiro-Wilk test. Median and interquartile ranges of age, and BLL, while frequency of gender and BLL groups were derived.

RESULTS

Five hundred and twenty-four subjects underwent BLL testing over a period of 36 months at the Clinical Laboratory. Among the 524 subjects, 424 (81%) were males and median age of the subjects was 27 (37-15) years. Out of the total 26.5% (n=139) were children (age <16 years) while rest were adults. The data was skewed (p<0.001).

Overall median BLL was 6.4 (20.9-3.1) ug/dl. The median BLL were 4 (8-3) ug/dl in children with only 16% (n=22) of the children had desirable BLL and most of them either had subclinical lead toxicity or toxic BLL; shown in Table I. The overall median BLL in adults were 8.3 (27.9-3.4) ug/dl with majority of subjects having normal BLL, while 4.99% (n=19) had BLL >70 ug/dl, warranting treatment initiation (Table I). Higher BLL were observed in subjects with age range 21 to 30 years [median lead level=16.9 ug/dl (36.1-4)] and lower levels were observed in younger age groups with lowest BLL [4.2 ug/dl (6.8-2.6)] in children with <10 years of age. Figure 1 shows the median BLL distribution in different age groups.

Table I: Lead level distribution of subjects tested for blood lead levels from 2011 to 2014. (n=524).

Blood lead levels	Frequency (%)	Lead levels (ug/dl) Median (IQR)
Children of <16 years (n=139)		
Desired level (<2 ug/dL)	22 (16)	1.8 (2-1.27)
Subclinical lead toxicity (2-10 ug/dL)	106 (76)	4.3 (6.4-3.17)
Elevated levels (>10 ug/dl)	11 (8)	13.8 (20.9-11.2)
Adults of >16 years (n=385)		
Desired level (<10 ug/dL)	212 (55)	3.7 (6.3-2.32)
Subclinical lead toxicity (10-70 ug/dL)	154 (40)	27.9 (48.6-20.2)
Elevated levels (>70 ug/dl)	19 (4.9)	83.6 (87.7-73.5)

Table II: Comparison of BLL in children reported by similar studies from our region.

Study	Present study	Rahbar *et al.*[10]	Khan *et al.*[9]	Manser *et al.*[11]
Study year	2011-2014	Aug-Dec 2000	Jun-Aug 1997	1990
Number of subjects	139	400	119	190
Age (years)	5 (8-3)	3.45 (4)	6.4	9 (4-18)
BLL (ug/dl)	4 (6.7-2.6) (median in <16 years)	15.6	7.9 ±4.5	38 ±14.35
Lead toxicity BLL >10 ug/dl	8%	80%	25.2%	92% had (BLL >40 ug/dl)

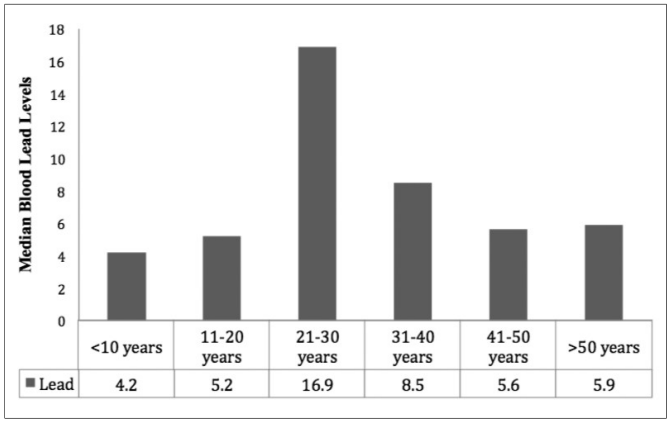

Figure 1: Distribution of median blood lead levels across different age groups.

DISCUSSION

The major finding of this study is high median BLL in both children and adults, which is a public health concern. There is limited data on lead toxicity burden after phase out of leaded petroleum in Pakistan. Previous studies on Pakistani population have reported higher mean BLL; a study by Khan, *et al*. reported mean BLL in children as 7.9 ug/dl and elevated BLL (≥10 ug/dl) in 25% children.[13] While another population-based study by Rahbar, *et al*. reported 15.6 ug/dl mean lead levels in children with elevated BLL in 80% of children.[14] A community-based survey of school children, conducted by Manser, *et al*. reported very high mean BLL (>40 ug/dl) with nearly 92% children having elevated BLL.[15] These studies were done before phase out of lead in petrol in Pakistan.[16-18] So compared to the present study, high prevalence of elevated BLL in previously reported literature is understandable (Table II). In the present study, it was observed that considerable decline in BLL has occurred over the past decade, reducing the

frequency of high BLL in children. A decline in frequency of children with BLL >10 µg/dL is obvious, from 80% to 8% (Table II). However, the median BLL is still high in children 4 (6.7 - 2.6 µg/dl). Present study also report high prevalence of subclinical toxicity (76%, n=106) in children, and most of them under 16 years of age, the age range 3 to 12 years (n=68). On comparing this study's findings with US National Health and Nutrition Examination Survey (NHANES) of lead exposure in children, BLL in Pakistani children are comparably higher. But these findings should be interpreted by keeping in mind that lead was phased out from petroleum products in 1970s in US and since then vigorous primary prevention strategies were adopted to reduce lead exposure.[19]

The observed BLL for adults in this study was also high with higher levels in 21-30 years and decreasing levels with increasing age with subclinical lead toxicity observed in one-fourth of the adults. A case control study done by Rahman, *et al*. on Pakistani adults reported higher BLL in hypertensive patients, with mean BLL 13.9 ug/dl (range 78 - 201 ug/dl) and 25.5 ug/dl (Range 165-497 ug/dl) in normal and hypertensive adults, respectively.[20]

There is limited information available regarding the status of lead in Pakistani children. The present study has provided us with insight into the current status regarding BLL in Pakistani population. These findings suggest that steps should be taken to reduce exposure, especially in children to avoid health risks associated with low levels of lead exposure because there appears to be no threshold for these effects.[21,22] The limitations of this study were that complete clinical information of the subjects could not be gathered as it was a retrospective analysis including a large percentage of outside referrals, so the study group is not representative of the general population and larger community-based studies are required for the confirmation of our findings.

CONCLUSION

This study highlights that BLLs have lowered after phase out of leaded petroleum from Pakistan, which is a major public health success in primary prevention efforts. However, lead exposure at levels that may adversely affect the health of children still remains. Strategies to identify the sources of lead exposure and eradicating/ controlling such sources be planned; and public awareness should be raised via different media, regarding sources of lead exposure, their impact on health and measures to reduce the exposure, especially in children.

REFERENCES

1. Agency for toxic, disease registry. Syracuse research. Toxicological profile for lead. Agency for toxic substances and disease registry. Syracuse Research Corporation; 1990.
2. Abadin H, Ashizawa A, Stevens YW, Llados F, Diamond G, Sage G, *et al*. Toxicological profile for lead. Agency for Toxic Substances and Disease Registry (US); 2007.
3. Pattee OH, Pain DJ. Lead in the environment. Handbook of ecotoxicology. 2003; p.373-99.
4. Falck AJ, Mooney S, Kapoor SS, White KM, Bearer C, El Metwally D. Developmental exposure to environmental toxicants. *Pediatr Clin North Am* 2015: **62**:1173-97.
5. Henretig FM. Lead. In: Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE, editors. Goldfrank's Toxicologic Emergencies. 9th ed. New York: McGraw-Hill; 2011: 1266-83.
6. Markowitz M. Lead poisoning: a disease for the next millennium. *Curr Probl Pediatr* 2000; **30**:62-70.
7. Barbosa Jr F, Tanus-Santos JE, Gerlach RF, Parsons PJ. A critical review of biomarkers used for monitoring human exposure to lead: advantages, limitations, and future needs. *Environ Health Perspect* 2005; 1669-74.
8. Schnur J, John RM. Childhood lead poisoning and the new centers for disease control and prevention guidelines for lead exposure. *J Am Assoc Nurse Pract* 2014; **26**:238-47.
9. Schulz C, Angerer J, Ewers U, Heudorf U, Wilhelm M. Revised and new reference values for environmental pollutants in urine or blood of children in Germany derived from the German environmental survey on children 2003-2006 (GerES IV). *Int J Hyg Environ Health* 2009; **212**:637-47.
10. Gilbert SG, Weiss B. A rationale for lowering the blood lead action level from 10 to 2 microg/dL. *Neurotoxicology* 2006; **27**: 693-701.
11. Lovei M. Phasing out lead from gasoline: worldwide experience and policy implications. World Bank Publications; 1998.
12. Paul R, White F, Luby S. Trends in lead content of petrol in Pakistan. *Bull World Health Organ* 2003; **81**:468.
13. Khan AH, Khan A, Ghani F, Khurshid M. Low-level lead exposure and blood lead levels in children: a cross-sectional survey. *Arch Environ Health* 2001; **56**:501-5.
14. Rahbar MH, White F, Agboatwalla M, Hozhabri S, Luby S. Factors associated with elevated blood lead concentrations in children in Karachi, Pakistan. *Bull World Health Organ* 2002; **80**:769-75.
15. Manser WW, Lalani R, Haider S, Khan MA. Trace element studies on Karachi populations. Part V: Blood lead levels in normal healthy adults and grammar school children. *J Pak Med Assoc* 1990; **40**:150-4.
16. Kadir MM, Janjua NZ, Kristensen S, Fatmi Z, Sathiakumar N. Status of children's blood lead levels in Pakistan: implications for research and policy. *Public Health* 2008; **122**:708-15.
17. Barker I. Clean air around the world: the law and practice of air pollution control in 14 countries in 5 continents. International Union of Air Pollution Prevention Associations; 1988.
18. Paul R, White F, Luby S. Trends in lead content of petrol in Pakistan. *Bull World Health Organ* 2003; **8**:468.
19. Pirkle JL, Brody DJ, Gunter EW, Kramer RA, Paschal DC, Flegal KM, *et al.* The decline in blood lead levels in the United

States: The National Health and Nutrition Examination Surveys (NHANES). *JAMA* 1994; **272**:284-91.

20. Rahman S, Khalid N, Zaidi JH, Ahmad S, Iqbal MZ. Non-occupational lead exposure and hypertension in Pakistani adults. *J Zhejiang UnivSci B* 2006; **7**:732-7.
21. Jusko TA, Henderson Jr CR, Lanphear BP, Cory-Slechta DA, Parsons PJ, Canfield RL. Blood lead concentrations <10 μg/dL and child intelligence at 6 years of age. *Environ Health Perspect* 2008; **116**:243.
22. Schnur J, John RM. Childhood lead poisoning and the new centers for disease control and prevention guidelines for lead exposure. *J Am Assoc Nurse Pract* 2014; **26**:238-47.