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Research Article

Establishing Relationship Between Maternal Sociodemographic Characteristics and Lead in Umbilical Cord Blood Serum

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ABSTRACT

Aim: To find the correlation between the concentration of lead and maternal socio-demographic characteristics like age, living area (urban or rural), housing style (slum type, cemented, or floored), living place (near industry or far from industry), water supply (piped water or direct water from source) and epidemiological characteristics like mother's occupation, mother's gestation age, mother's active smoking habit. **Method:** A total of 100 umbilical cord blood serum samples were collected from Lala Lajpat Rai Medical (LLRM) College, Meerut and estimation of lead was done using Graphite Furnace Atomic Absorption Spectroscopy (AAS). This study was conducted between April 2014 and March 2015. **Result and conclusions:** Data suggested that the percentage of lead is more in cord blood serum samples of mother who were working and were non-housewife and residing in urban area due to exposure to traffic, industries and pollution. The correlation of mother's working place with lead concentration showed that the mothers who were industrial worker had more lead concentration whereas the level of heavy metal was found elevated in mother's who were drinking piped water. The data suggested that the mothers who smoked have more lead concentration in comparison to non-smoking mother.

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INTRODUCTION

Heavy metal exposure to human being is potentially harmful. Both their excess and deficiency adversely affect the health of human organs where they may accumulate like kidneys, liver, lungs, skin, hair, and other tissues. Low concentration exposure can affect developmental problems in post-natal and childhood [1]. Among all heavy metals, lead is the most abundant and non-essential trace element. Lead's toxicity has become a major concern for the health authorities all over the world and especially in developing countries [2-4]. Lead is easily mobilized in the surroundings and ingested in food and water transported through lead pipes or from eatable plants [5]. Lead may enter into our body through inhalation, absorption, ingestion, through skin and mucous membrane. Lead is abundantly found in mineral deposits in earth and is released in the atmosphere via natural causes as well as artificial industrial activity [6]. It is non-biodegradable and acts as a long term source of exposure [7]. Lead possesses inherent property like high malleability and low melting point which make it a suitable candidate to form products like pipes, brass fixtures, crystal, paint, cable, ceramics, and batteries [8].It is found in dust, soil, drinking water, air, folk medicines, ayurvedic medicines and cosmetics such as Kohl and Surma, jewellery and toys. Markets are flooded with items like ceramics glazed with lead, lead crystal, imported candies and canned foods sealed with lead solder, etc [9]. The Centre for Disease Control (CDC) and Prevention has set the blood lead threshold level for intervention at 10 μg/dL [10]. The ill effect of lead toxicity at different levels of our body has been depicted in Figure 1.

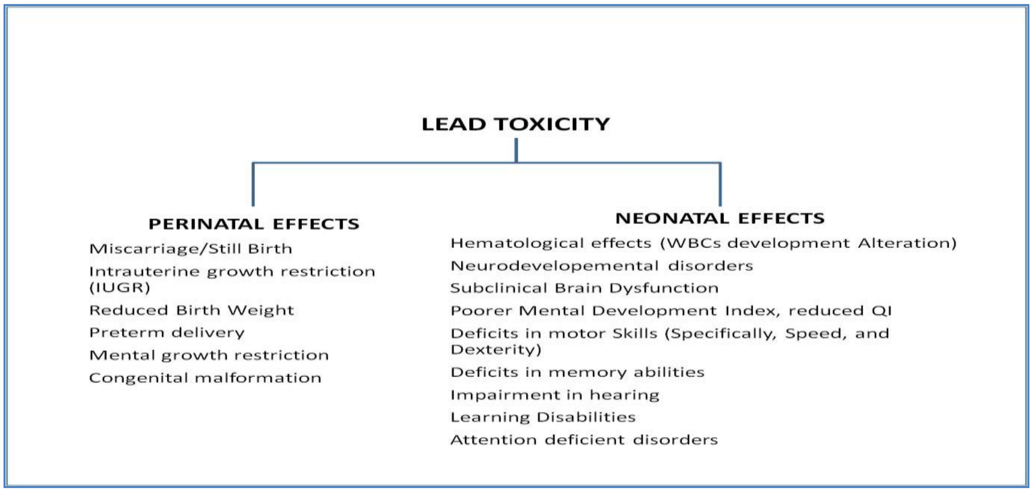

Figure 1: Schematic representation of the toxic effect of lead on human body.

The topic of concern is the exposure of lead in pregnant mothers. Several studies have shown that during pregnancy placental barrier is freely permeable to lead, which leads to foetal exposure to heavy metal [11-15]. Exposure to lead in the prenatal period is associated with abnormal neurobehavioral and cognitive development [16, 17].

When a woman is encountered to lead exposure during pregnancy, it may lead to several adverse effects like premature birth, miscarriage, low birth weight and development of fatuous brain in new born babies [18, 19]. Lead possess health risks to everyone, especially juvenile and unborn baby are more prone to ill effects of lead toxicity which affect development, behaviour and learning ability of growing children. In 2010, the CDC lead Pregnancy Report presented a report regarding the negative effects of exposure to lead on pregnant women and their developing foetus [20]. An expected mother's lead exposure history may put her unborn baby at risk. The pregnant woman should take enough calcium in her diet otherwise the body may reserve lead in her bones for the calcium needed by the baby. Lead in the blood stream may pass through the placenta and then into the developing bones and organs of a newborn [21, 22]. Unfortunately, there is no medical treatment universally recommended for pregnant women with elevated lead levels. Healthy nutritional diet and refraining from contact of lead can help mothers to protect herself and her baby from heavy metal.

The aim of our work is to analyse socio-demographic characteristics of maternal women and feed it into a prediction model to determine the potential risk of lead content. To find the correlation between the concentration of lead and maternal socio-demographic characteristics like age, living area (urban or rural), housing style (slum type, cemented, or floored), living place (near industry or far from industry), water supply (piped water or direct water from source) and epidemiological characteristics like mother's occupation, mother's gestation age, mother's active smoking habit. The study deals with evaluation of lead in umbilical cord blood serum using AAS in women in Meerut region, western Uttar Pradesh, India. Further, a comprehensive study was attempted to find the correlation between the concentration of lead and maternal socio-demographic characteristics like age, living area (urban or rural), housing style (slum type, cemented, or floored), living place (near industry or far from industry), water supply (piped water or direct water from source) and epidemiological characteristics like mother's occupation, mother's gestation age, mother's active smoking.

Methodology

With the aim of determining the most likely features that could determine the level of lead content, data was collected following a series of steps, which is described below:

Ethics

An informed, written consent was taken from husbands/parents of eligible mothers in regional language (local language) before delivery. The questionnaire form included following questions: mother's age, baby weight, gestation age, urban or rural living, type of house, slum house or cemented house, located near industrial area or not, water supply piped or non-piped, smoking mother or non-smoker, smoking by any other family member, alcohol consumption by mother during or before the pregnancy and mother's occupation.

Sample collection: The study was conducted in Department of Obstetrics and Gynecology, LLRM. College, Meerut and Department of Chemistry, Chaudhary Charan Singh University, Meerut, Uttar Pradesh, India. Umbilical cord blood samples were collected from LLRM College, Meerut. The study was conducted between April 2014 and March 2015. In total 100 blood samples were collected in close observation by medical practitioners for the analysis. Out of which 47 were analysed for the study based on the inclusion and exclusion criteria chosen. For inclusion criteria, all term new born babies (37 to 42 weeks) delivered by either normal vaginal delivery (NVD) or lower segment caesarean section (LSCS) at LLRM College, Meerut, who gave consent for cord blood sampling were included for analysis. For exclusion criteria, babies with very low birth weight babies (< 1500grams), < 32 weeks of gestation were excluded from study [23]. The subject was observed by a physician. Blood sample was collected using sterilized micropipette in heparinized vials. After collection, blood was allowed to coagulate, and then serum was separated.

Chemicals and Instrumentation

1% Nitric acid, Triton X-100, ammonia phosphate were procured from Fisher Scientific, India. AAS grade lead standard (1000 ppm) was procured from Loba Chemie, India. AAS 7000 SP (Lab India) was used for estimation of lead. Instrument parameters selected were as follows: Slit: 0.2 nm, High Voltage: 341.11 V, Lamp Current: 5.00 mA, Background Correction: off, Volume of injection: 20 µL, Ash Temperature: 800 °C, Atom Temperature: 2000 °C.

Solution preparation

1% Nitric acid solution was prepared. Triton X-100 solution was prepared in 1% nitric acid and 0.5 % ammonia phosphate. Standard samples were prepared by dissolving the known quantity of AAS grade lead in 1% nitric acid. Standard lead samples were prepared of different ppb (parts per billion) i.e, 200, 100, 50, 25 ppb. 1 ppb is equal to 1 µg/L. Modifier lanthanum nitrate (Thomas Baker, India) was added to each sample. All standard was prepared from stock solution of 1000 ppm in 1% nitric acid. Dilution factor considered was 2 (2 mL sample was prepared by adding 1 mL standard solution and 1 mL diluents (triton X-100 solution)). Diluent alone was taken as a blank.

Serum sample preparation

Forty seven samples of blood were collected and serum was isolated. Samples for estimation of lead were prepared by adding 1 mL of 1% nitric acid, 0.5 mL of triton X-100 solution and 0.5 mL of blood serum.

Experimental Analysis

The correlation of mother's age with lead concentration was studied as shown in Figure 2 (a). Herein, samples were collected from the mother's with age variation from 24 to 36 years. Data suggested that an enhanced concentration of lead in cord blood serum of mother's after the age of >= 30 years (Table 1.0).

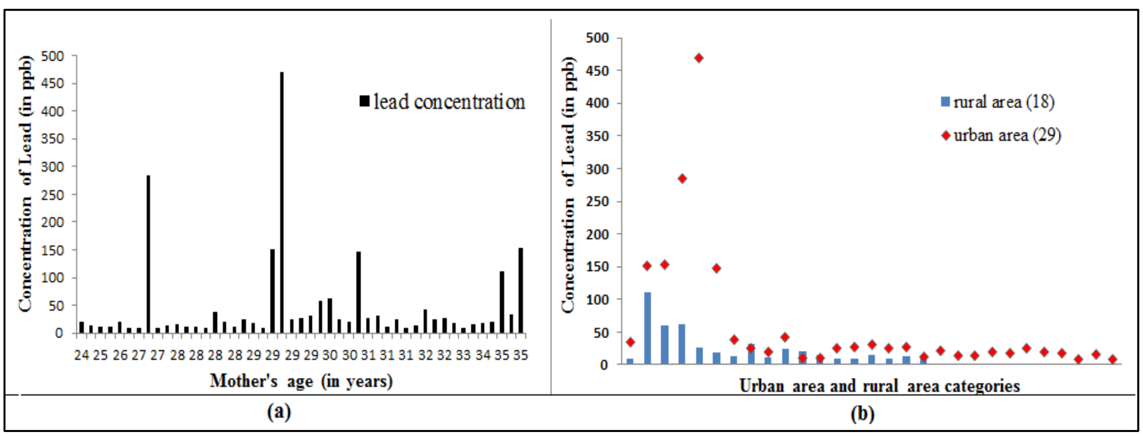

Figure: 2: (a) Correlation of lead concentration with mother's age (b) Correlation of mother's living place versus lead concentration.

The correlation of mother's living area with lead concentration showed that mothers who are living in rural area had more lead concentration in comparison to mother's living in rural area as shown in Figure 2(b). Data suggested that the exposure of lead is more in urban area (geometric mean 19.2 µg/L) in comparison to rural areas (geometric mean 29.6 µg/L). A possible reason of this could be that the urban area has more traffic and various industries around them which may lead to more heavy metal exposure to pregnant women.

Mother's occupation was categorized in three types as housewife, non-housewife and worker. The correlation of mother's occupation with lead concentration showed that working mother (labour class) (geometric mean 29.3 µg/L) have elevated level of heavy metal in cord blood serum samples in comparison to housewife (geometric mean 23.9 µg/L) and non-house wife (geometric mean 22.8 µg/L) (Figure 3.(a)). Data suggested that the mother's going outside have more exposure to lead as compared to mothers who are housewife. Two categories of mother's working place such as industrial worker and non- industrial worker are chosen for study. Non-industrial worker (geometric mean 22.3 µg/L) mother include teacher, doctor, domestic maid etc. Industrial worker mothers (geometric mean 27.5 µg/L) include low grade worker as working in tobacco, cigarette making industries as well as sweepers in industries. The correlation of mother's working place with lead concentration showed that the mothers who were industrial worker had more lead concentration as shown in Figure 3(b).

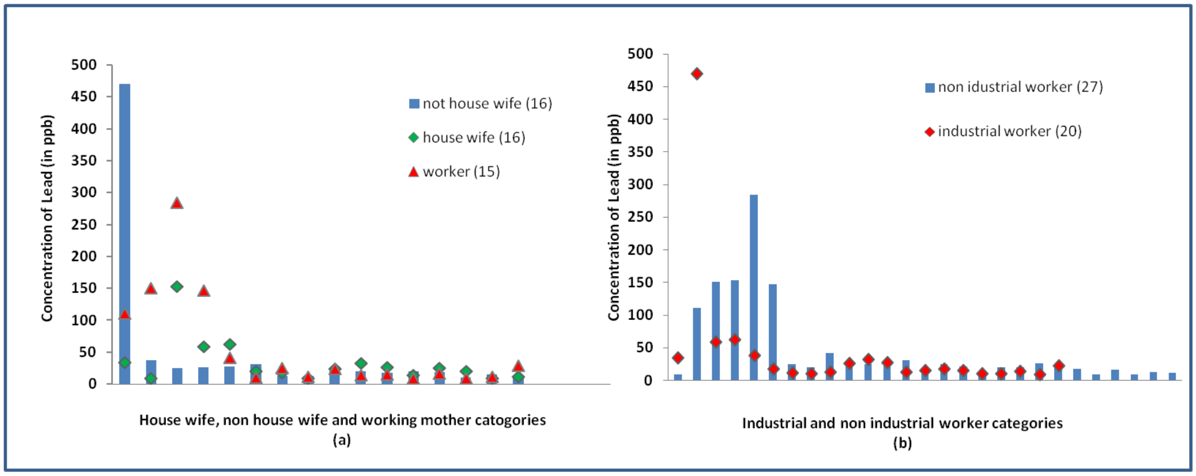

Figure 3: (a) Correlation of mother's occupation versus lead concentration (b) Correlation of mother's working place versus lead concentration.

Further, few maternal epidemiological character were analysed like smoking and non-smoking. Among 47 case studies, samples with smoking mother were less than 14. The data suggested that the mothers who smoked have more lead concentration in comparison to non-smoking mother as shown in Figure 4 (a). Out of 47 samples, 14 were of smoking mother (geometric mean 30.3 µg/L) and 33 were of non-smoking (geometric mean 22.6 µg/L). Three samples showed an average of 21.42% lead concentration among 14 smoking mothers whereas 3 samples showed an average of 9.09% lead concentration among 33 non-smoking mothers.

Questionnaire interaction with subject gave information regarding mother who are exposed to smoke due to smoking of any family member. Among 47 samples, 31 samples have smoking members in family (geometric mean 25.5 µg/L) whereas 16 mothers have no exposure to smoke by family member (geometric mean 24.3 µg/L). Data suggested among 16 samples, 4 samples are crossing boundary line (25%), whereas 2 samples among 31 have more lead concentrations (6.45%) as shown in Figure 4 (b).

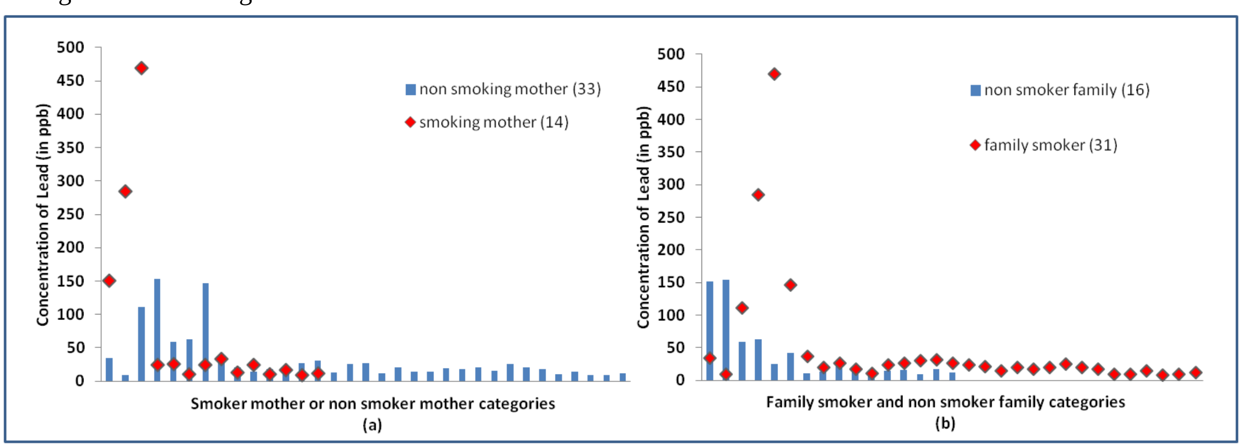

Figure 4: (a) Correlation between smoking mother and non-smoking mother for lead concentration (b) Correlation between family smoker or not and lead concentration.

In the collected data, drinking water source had two categories one in which water is supplied through pipeline, and another in which water is obtained directly from source such as tube well or submersible. The collected data suggested that among 47 samples 21 mothers drank piped water (geometric mean 26.3 µg/L) and 26 mothers drank water from direct sources (geometric mean 24.2 µg/L) (Figure 5).

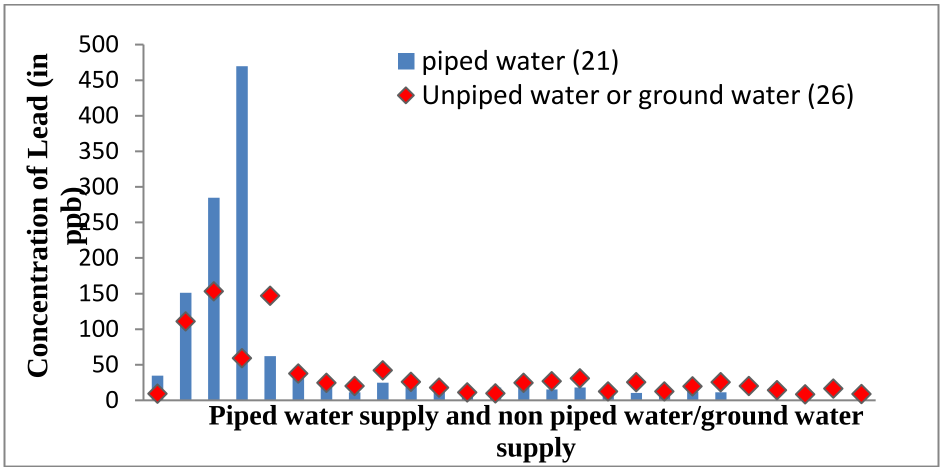

Figure 5: Correlation between drinking water source and lead concentration.

The frequency of lead concentration was found elevated in mothers who were taking piped water because of the presence of lead in pipe, 3 samples in 21 (14.28%). Whereas the mothers who consumed ground water have lower frequency of lead concentration, 3 samples in 26 (11.53%). Table 1 shows a descriptive summary of the findings of the study.

Table 1: Summary of lead concentrations (µg/L) in the collected data.

Descriptive analysis by maternal characteristics					
Overall		**Sample size (*N*)**	**Mean**	**Geometric Mean**	**Confidence level 95%**
		47	46.65	25.13	22.91-70.39
Sociodemographic characteristics					
Age	<30 years	25	51.41	22.23	9.27-93.54
	>=30 years	22	41.23	28.88	23.32-59.14
Area (Locality)	Rural	18	26.15	19.2	13.67-38.63
	Urban	29	59.37	29.6	22.206-96.53
Tobacco exposure					
Active smoker	Yes	14	79.18	30.39	6.37-151.98
	No	33	32.003	22.42	23.66-40.35
Passive Smoker	Yes	31	50.35	25.54	16.27-84.43
	No	16	39.49	24.34	15.92-63.06
Mother's occupation					
Housewife		16	33.29	23.94	15.41-51.18
Non-housewife		16	48.28	22.84	8.05-104.61
Worker (Labour)		15	59.15	29.28	17.80-100.49
Work exposure					
Industrial		27	75.13	27.46	21.15-129.14
Non-industrial		20	45.27	22.29	0.05-90.49
Drinking water source					
Piped water		21	60.64	26.27	11.10-110.18
Ground water		26	35.35	24.23	19.77-50.93

Results and Discussion

In this study, data suggested that the umbilical blood serum of mother may have high level of lead because of polluted atmosphere, piped water supply, working in industry environment, smoking surrounding etc. Pregnancy in age as more than 30 years may also generate complications due to exposure to heavy metals. The study will help us to quantify the problems arose by the elevated level of lead in cord blood of women delivering in Meerut region. The finding of significant proportion of high lead level may help in developing new protocols for screening of the patients to improve their outcome and will set a reference range for other heavy metals for future study. This study consistently followed previous studies [23,24]. Smoking mother's children showed higher % of lead concentration in blood, mainly among existing smokers. The new-borns of the mothers who were passively exposed to tobacco smoking also showed high blood lead concentration suggesting passive smoking as an important factor in determination of blood lead in children [25].

Another study supports present study that the mother with age more than 30 years have highest lead level in cord blood whereas in ages 20 to 25 years old mother showed low lead level in umbilical cords of infants [26]. It specifies that the body's defence capacity decreases with aging due to reduction of many physiological and biochemical functions. The main strength of the study is its randomized controlled trial good blood sample size. Methodology of each intervention was standardized. Technique of cord blood clamping was meticulously taught to all pediatricians posted in Neonatal Intensive Care Unit (NICU) through video from Willam Tarnow Mordi [27] and live demonstration. The expected adverse outcomes of placental transfusion like instability, respiratory, distress and jaundice in initial 48 hours of life was also analysed. Serum bilirubin levels were not measured beyond 48 hours of life just to avoid frequent blood sampling. A longer follow up would have answered the longevity of interventions which were carried out at birth. The study is significant and first of its kind in North India for heavy metal exposure which is quite high in this zone [28].

Conclusion

The study demonstrated the collective information on maternal demographic features, pertinent medical history, parity, pregnancy induced hypertensions, history of high lead level in childhood, history of smoking, standard of living of the subject. On the neonate, information was collected on gender, gestational age, weight at the time of birth and head circumference. The result of the cord blood lead level was shared with the primary clinical team and the parents of the infant. Data suggested that the umbilical blood serum of mother may have high level of lead because of polluted atmosphere, piped water supply, working in industry environment, smoking surrounding, etc. The future prospective of the work covers building of a prediction model to determine the level of lead content based on the identified set of feature. These prediction models could be a part of a screening process to benefit healthcare professionals at the point of judging the lead level in pregnant woman and appropriately suggesting the treatment well in advance.

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