



Lead Levels in the Primary Teeth of Children in Tehran, Iran

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Abstract- Objective: Young children are very susceptible to the toxic effects of lead, one of the most common pollutants in the environment. Therefore, monitoring the level of lead in primary teeth to prevent its harmful effects might be necessary. The aim of this study was to investigate lead concentrations among all types of primary teeth and to determine if age could affect the lead levels in primary teeth.

Method: In this cross-sectional study, 250 shed or nearing exfoliation caries-free primary teeth were collected from patients, aged 6-12 years old, in dental clinics of Tehran, Iran from 2009 to 2010. The lead concentrations in these teeth were measured using atomic absorption spectrophotometry.

Result: Primary canines showed the highest mean concentration of lead [$1.67 \pm 0.75 \mu\text{g/g}$ dry weight (DW)], followed by incisors ($1.15 \pm 0.74 \mu\text{g/g}$ DW) and molars ($0.78 \pm 0.59 \mu\text{g/g}$ DW). Statistically significant differences were seen between canines and molars ($P=0.000$) and also between canines and incisors ($P=0.036$). The Analysis of Variance (ANOVA) test showed no significant differences between lead levels regarding age ($P>0.05$).

Conclusion: The results of the present study showed that tooth type affected the tooth-lead level concentrations. Mean concentration of lead in primary canines was higher than that in incisors and molars in the studied society. Our results suggested that age was not related to the lead concentration in human primary teeth.

Keywords: lead, lead concentration, lead level, primary teeth.

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I. INTRODUCTION

Lead is one of the most important and widely distributed pollutants in the environment. In the human population, children are particularly associated with an increased risk of toxic effects of lead due to being in the growth phase and their increased capacity for absorption and retention(1-4). It has been proved that lead is an unnecessary nutrient with no biological values(1). The lead level in blood is the best indicator of a recent exposure because lead in blood has a short half-life of one month(3, 5, 6). However, for long-term exposures, determination of the lead level in hard mineralising tissues (e.g. skeleton, deciduous teeth) is more predictable (7). Epidemiological studies have shown that the skeleton contains most of the burden of lead in humans(8, 9). Dental hard tissues are relatively stable and they can retain the deposited metals during mineralization to a large extent. Unlike in skeleton, there

is no turnover of apatite in teeth. Therefore, deciduous teeth are the most useful material for assessment of long-term internal exposure to lead during early life (10-13).

Use of lead in industry results in its release in the environment, which leads to contamination of air, water, and food and causes a significant rise in lead concentration in human blood and body organs including the nervous, haemopoietic, endocrine, renal, and skeletal systems(1). The source of lead may vary considerably. It may originate from industrial areas, gasoline, paint, plumbing and food(14). In general, it is recognised that the most important source of lead pollution is through leaded gasoline because most of this lead is redistributed into the atmosphere. Leaded gasoline accounts for $\approx 90\%$ of the total amount of lead released from all sources into the air (13-15).

Wherever leaded gasoline is an air pollutant, children are exposed to levels of lead that reduce intellectual performance throughout their lives. Some investigators have shown that prolonged pre-school exposure to low doses of lead in childhood results in the reduction of intelligence quotient (IQ) scores (4, 16). Uptake of lead can be very dangerous during the critical development periods of infants and young children due to the possibility of causing permanent impairment (17).

In addition to the systemic effects of lead through blood and saliva, gaseous forms of lead have a more direct effect through the oral environment. This might explain the higher levels of lead measured in hard dental tissues from children living in industrial cities (18).

Lead exposure is estimated by measuring lead levels in the blood and teeth. The US Center for Disease Control and Prevention has established a "level of concern" for children at $10\mu\text{g/dL}$ (blood lead) and at $5\mu\text{g/g}$ (tooth lead). According to Pococok et al., doubling of the body lead burden (from 10 to $20\mu\text{g/dl}$) blood lead or (from 5 to $10\mu\text{g/g}$) tooth lead is associated with a mean deficit in full-scale IQ of around 1 to 2 IQ points (7). Therefore, even lower exposures of lead are associated with unfavorable effects and no level of lead exposure could be considered safe enough (3, 19).

Tehran, the capital city of Iran, is a highly industrialised city where lead has been used in industry and as a gasoline additive for many decades. However, there are also other lead sources and occupations in Tehran: jewellery workers, traffic police, emissions from glass, pigment and paint industries, pottery, non-ferrous

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metal smelters, accumulator gratings, battery manufacturing plants and crops and vegetables irrigated by lead-polluted sewage. Since Tehran is one of the most polluted cities in the world and they still use the leaded gasoline for the cars, the present study was carried out to investigate lead concentrations among all types of primary teeth. The other objective was to determine if age could influence lead levels in the primary teeth of children in Tehran, Iran.

II. METHODS

This was a cross-sectional study in which 250 teeth (117 molars, 74 canines, 59 incisors including shed or nearing exfoliation caries-free primary teeth) were collected from 250 children (1 tooth from each individual), aged 6–12 years, residing in the city of Tehran, Iran after obtaining written informed consent of the parents from 2009 to 2010. The research has been conducted in full accordance with the World Medical Association Declaration of Helsinki. The study has been independently reviewed and approved by ethics committee of Tehran University of Medical Sciences. Information about age, sex, lifestyle, place of residence and medical history of children were collected from their parents. Teeth with fillings, caries or developmental defects were excluded from the study.

To prevent sample contamination with exogenous lead, all laboratory glassware was cleaned with surface detergent and distilled water. To remove organic material, each tooth was cleansed and soaked in a 3% solution of hydrogen peroxide and then washed several times with distilled water and the final rinse was with deionized water. Each tooth was air dried and weighed. The tooth was then digested in a mixture of 1 mL of 70% perchloric acid (HClO_4) and 3 mL of 70% HNO_3 and in a 50-mL beaker. The mixture was heated slowly until a clear and colorless solution was reached. The solution was then evaporated until dry. The digest was then rinsed with distilled water, made up to 10 mL and shaken(1).

The lead concentration in the final digested solution was determined by using Flame Atomic Absorption Spectrophotometer with electrothermal atomization (Varian Inc., Palo Alto, CA, USA). The specifications of the instrument were: lamp current 9.0 mA, wavelength 217.0 nm, band pass 0.5–1.0 nm, ash temperature 800°C and atomization 2300°C without temperature control(1).

After natural logarithmic transformation of lead data the Kolmogorov-Smirnov test was used to verify the normal distribution of the data. The values obtained were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS-16) software for windows. Group comparison between tooth types was carried out by using the independent *t-test*. The level of significance was set at $P < 0.05$.

III. RESULTS

The current study was performed to determine the lead levels in teeth of children from Tehran and evaluate if tooth type and age of the child could affect the concentration of lead in the primary teeth. An analysis of the tooth levels of children showed that primary canines had the highest mean lead level [$1.67 \pm 0.75 \mu\text{g/g}$ dry weight (DW)], followed by incisors ($1.15 \pm 0.74 \mu\text{g/g}$ DW) and molars ($0.78 \pm 0.59 \mu\text{g/g}$ DW) [Table 1]. Statistically significant differences were seen between canines and molars ($P=0.000$) and also between canines and incisors ($P=0.036$). There were no statistically significant differences between incisors and canines with respect to lead levels ($P > 0.05$) [Table 2]. There were no significant differences between lead levels with respect to age ($P > 0.05$).

IV. DISCUSSION

In general, lead poisoning occurs gradually from the accumulation of lead in skeleton and hard tissues after repeated exposures to lead. This is especially evident in children who are exposed to heavy traffic during where leaded petrol is used. Lead in exhaust fumes from cars, affects children much more than adult due to their lower height and weight (14).

Lead poisoning can damage many internal organs including the nervous, haemopoietic, endocrine, kidney, and skeletal systems (1-4). Blood-lead levels indicate recent exposure and correlate poorly with lead levels in shed deciduous teeth(20). Shed primary teeth can reflect long-term lead exposure during early life because of their increased capacity for absorption and retention during mineralization(17).

In epidemiologic studies of childhood lead toxicity, levels of lead in the hard dental tissues of primary teeth have been served as proxy measures for skeletal lead and total body lead burden. Also studied have shown higher lead levels in primary teeth than adult teeth because of the more prominent lead burden of children (21-24). Therefore, We analyzed the lead concentration in primary teeth that were either shed or nearing exfoliation in the current study.

The results of the present study indicated that lead concentration varied according to tooth type, which is in accordance with the results of other studies (3, 10, 15, 25). Some studies have reported that the mean concentration of lead in incisors was higher than that in canines and molars which is inconsistent with the results of our study (3, 15, 25). In the present study, canines had the highest lead concentration, followed by incisors and molars which is parallel with the findings of other studies (10, 17). This could be explained by the difference in morphology and size between canines and incisors and also the fact that the formation of the enamel and dentin of the upper canines begins during the fifth month of gestation and the crown calcifies

during the 4–9th month after birth(3). Compared with other teeth, this leaves canines with a greater exposure time to lead.

Some researchers reported that lead levels in teeth increased with age (5). However, the results of the present study showed that tooth-lead concentration was independent of age. This finding is consistent with the results of other studies which suggest that exposure levels from various environmental and dietary sources could contribute more than age to the uptake of lead in teeth(3, 10, 17, 25, 26).

V. CONCLUSION

The following conclusions could be drawn from the present study:

- The tooth type affected the tooth-lead level concentrations. Primary canines had the highest concentrations of lead, followed by incisors and molars.
- The tooth-lead level concentrations were independent of age.

Further research of different Iranian populations with larger sample sizes is necessary to confirm the results of the present study. In addition, future studies need to be carried out on carious teeth as higher lead levels have been reported in carious than in non-carious teeth (26).

Tehran is a highly industrialised city with more than 2 million motor vehicles, and a large percentage of them use leaded gasoline. In recent years, a partial reduction of atmospheric lead levels has been observed due to the reformulation of leaded gasoline. However, there are other lead sources in Tehran: emissions from glass, pigment and paint industries; pottery; non-ferrous metal smelters; accumulator gratings; battery manufacturing plants and crops and vegetables irrigated by lead-polluted sewage. These sources could have effects on lead accumulation in the human body, especially teeth. Therefore, we suggest that the Iranian authorities should eliminate lead from all types of fuels and other environmental sources of this city.

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Author Disclosure Statement

No competing financial interests exist.

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Table 1: Lead distribution in different primary tooth types

| Type of tooth | n | Lead level ($\mu\text{g/g}$) (mean \pm SD) | Min-max ($\mu\text{g/g}$) |
|---------------|-----|--|-----------------------------|
| Molar | 117 | 0.78 \pm 0.59 ^a | 0.04-3.2 |
| Canine | 74 | 1.15 \pm 0.74 ^a | 0.11-3.08 |
| Incisor | 59 | 0.89 \pm 0.64 ^a | 0.05-2.8 |

a: not significantly different

Table 2: Independent Sample T-test

| Teeth | Leven test for quality of Variance | | Mean \pm SD (difference) | t | df | Sig. (2-tailed) |
|------------------|------------------------------------|-------|----------------------------|--------|-----|-----------------|
| | F | Sig. | | | | |
| Molar & incisor | 9.408 | 0.002 | 0.376 \pm 0.102 | -3.786 | 130 | 0.000 |
| Canine & incisor | 1.969 | 0.163 | 0.259 \pm 0.122 | 2.115 | 131 | 0.036 |
| Canine & molar | 1.949 | 0.164 | -0.108 \pm 0.097 | -1.113 | 174 | 0.267 |