

## Primary Teeth and Hair as Indicators of Environmental Pollution

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**Objectives:** To study the influence of environmental pollution on the mineralization of dental hard tissues by using biosubstrates: teeth and hair. **Study design:** At the first stage epidemiological survey was conducted in polluted and less polluted areas of Tbilisi (Georgia). We studied 525 children aged 3 and 4 years. Caries prevalence and intensity was defined by the methodology of World Health Organization. At the second stage the chemical elements content was studied in hair and teeth hard tissues of 24 children by X - ray fluorescent spectroscopy method. **Results:** The prevalence of dental caries in the polluted region was 46%, caries intensity - 1.92 ( $\pm$  2.842). In the less polluted region prevalence was 37%, caries intensity - 1.47 ( $\pm$  2.571). These data are statistically reliable ( $p < 0.05$ ). The study of hair and tooth tissues showed that the toxic elements (Pb, Hg, Sn, Ti) content in these tissues was higher in environmentally unfavorable than in favorable conditions. **Conclusion:** Hair and dental tissues can be used as indicators of environmental pollution. Our survey showed that toxic elements content in dental hard tissues was higher and the level of essential elements was less in polluted than in less polluted areas of Tbilisi.

*Key Words:* environment, dental hard tissues, hair, toxic elements, deft index.

### INTRODUCTION

Environmental factors have a great influence on human health.<sup>1,2</sup> Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution.<sup>3</sup>

Assessing the environmental factors impact on the human body still remains an active problem because the human organism is closely related to the ecological conditions as it is a part of the biosphere.

The important task of medical ecology is to examine the accumulation of the air harmful compounds in the human body's tissues and organs. also, to determine their pathological effects on the whole body, especially on child's health, because the critical period of organs and systems of developing body, a weak immune system and other factors make the child particularly sensitive towards toxic elements.<sup>4</sup> It should be also noted that compared to adults, children breathe 50% more air per kilogram of body weight, because they have a larger lung surface area in relation of their body weight.<sup>5</sup>

Environmental pollution can be defined by physical and chemical methods and biological indicators: teeth, bones, hair, blood and nails that are used to control the pollution of the environment with toxic heavy metals.<sup>6</sup> Determination of heavy metals and essential chemical elements in teeth and hair tissues plays an important role to monitor the impact of environmental pollution, and evaluate risk factors for the development of dental diseases.<sup>7,8,9</sup> This is partly due to the fact that trace elements concentrate in hair and fully express the range as toxic elements (Pb, Cd, As and others.) as essential elements, and it gives a complete idea on metabolic processes and mineral composition in human body.<sup>10,11</sup> Tooth tissues exactly fix metabolic changes in organism. Therefore, the determination of chemical pollution on human dental hard tissues by biopsy method expands the teeth, as the possibility of using the monitor boundaries. It is noteworthy that the chemical elements accumulated in the dental tissues (especially heavy metals) will be maintained during the whole life, so great attention is paid to toxic substances, especially, the lead content because its presence in dental tissues is the permanent source of poisoning organism.<sup>12,13,14,15</sup>

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The **goal** of this work is to define chemical elements in dental hard tissues and hair as indicators of environmental pollution, and to determine its influence on young children's dental health.

**MATERIALS AND METHOD**

In order to determine the impact of environmental pollution on the dental status, especially on mineralization of the dental hard tissues, we examined 525 children aged 3 and 4 years in the kindergartens of Tbilisi (Georgia). To avoid the influence of socio-economic factors we conducted our study only in state kindergartens, where study the children from the same social group. Approval to conduct the study was received from the appropriate kindergartens authorities. Examination was carried out in two regions with different environmental conditions. As a quality indicator of ambient air pollution in different regions, we used data from the Center for Strategic Research and Development. According to these data central areas of Tbilisi are considered more polluted than the suburbs.<sup>16</sup>It should be also noted that fluorine content in drinking water in all regions of Tbilisi is very low, it's about 0.01-0.05 mg/L according to 1998 data<sup>17</sup> and there is no fluoride enrichment of drinking water. So the areas where the research was conducted do not differ from one other with fluorine content.

Children, examined by us, were divided according to age and environmental conditions in the region (Table 1).

**Table 1. Distribution of examined children according to the age and the environment.**

Age/ environment	Polluted	Less polluted
3	146	144
4	156	79
total	302	223

The examination was carried out by researchers with mirror and fillings. Dental caries prevalence and intensity were defined and special forms were filled. We used deft index to estimate the intensity of dental caries. This index is used in primary dentition: d-decayed teeth, e-extracted teeth due to caries, f-filled teeth.<sup>18</sup>

To monitor the impact of environmental conditions on the human body, we chose 24 children from the above mentioned 525 children, who had teeth for extraction. 12of them from environmentally unfavorable and 12 - from relatively clean areas. The examination was carried out after obtaining the informed consent from the parents. Some chemical elements (toxic and essential) were analyzed in children's dental hard tissues and hair.

Qualitative and quantitative content of chemical elements in hair were analyzed using X-ray - fluorescent spectrometry according to the methods provided by the World Nuclear Agency (hair washing method proposed by the International Atomic Energy Agency - IAEA 1978). Hair samples were taken from the occipital area and 28 chemical elements were analyzed in this sample: essential - Ca, Zn, K, Fe, Cu, Se, Mn, Cr, S, Br, Cl, Co, Ag, V, Ni, Rb, Mo, Sr, Ti and toxic - Ba, Pb, As, Hg, Cd, Sb, Zr, Sn, Bi (ppm).

The same method, X-ray - fluorescent spectrometry, was determined to investigate chemical elements in dental tissues. But only 9 chemical elements were analyzed in dental hard tissues. 7 essential (Ca, Zn, Mn, Fe, Rb, Ni, Sr) and 2 toxic (Pb and Hg) elements.

The obtained data were statistically processed using Statistical Package for Social Sciences (SPSS), version 21.

**RESULTS**

On the basis of epidemiological studies, carried out by us, we had estimated that air pollution affects children's dental health, particularly the mineralization of dental hard tissues.

As we see from the Table 2, the data of temporary dental caries prevalence in environmentally favorable conditions is less, compared to an average in areas where air pollution exceeds the allowed limit, and it is therefore 37 % and 46% (p <0,05). The same trend is observed in the intensity of dental caries (deft Index). The intensity of dental caries was higher in the environmentally unfavorable region than in less polluted areas, respectively, 1.92 ± 2.842 and 1.47 ± 2.571 (p <0,05). Untreated caries of the teeth was the biggest part of deft index, and it was an average of 96,4 %. That indicates a low level of dental care in the city. It should also be noted that caries prevalence and intensity increase with age (Figure 1).

**Table 2. Dental caries prevalence and intensity according to the environmental conditions (p < 0,05).**

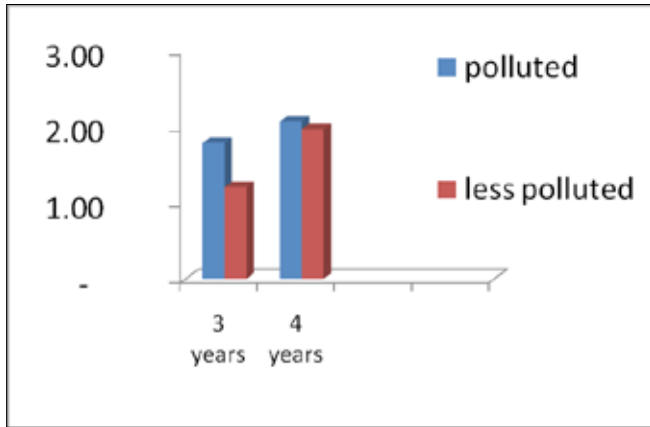
Cariesenvironment	Polluted	Less polluted
Prevalence of dental caries	<b>46%</b>	<b>37%</b>
Intensity of dental caries (deft)	<b>1.92 ± 2.842</b>	<b>1.47 ± 2.571</b>
Caries lesions	<b>1.85 ± 2.729</b>	<b>1.42 ± 2.479</b>

Analyzing the results of chemical elements' content in hair sample, there was not observed significant difference for some elements according to the environmental conditions. So we focused our attention on the chemical elements importance of which, in our view, is influenced by environmental conditions. And therefore affects both dental and general health (Table 3).

**Table 3. Chemical elements in hair according to the environmental conditions.**

Elements\ environment	Polluted	Less polluted	p
Ca	330±91.4	385±179	>0.05
Zn	105±31.5	99±27.6	>0.05
K	86.7±51.56	126±72.6	>0.05
Fe	20±6.8	21±7.0	>0.05
Cr	4.01±2.55	2.50±1.77	<0.05
V	0.24±0.198	0.096±0.120	<0.05
Ag	0.358±0.4	0.378±0.32	<0.05
Ni	0.999±0.61	0.69±0.38	>0.05
Sr	1.8±1.01	1.15±0.8	<0.05
Ti	1.76±1.37	1.17±1.08	>0.05
Pb	2.66±1.625	1.55±1.41	=0.05
As	0.168±0.13	0.07±0.05	<0.05
Hg	0.73±0.54	0.72±0.45	>0.05
Sn	0.45±0.36	0.15±0.07	<0.05

**Figure 1. Intensity of dental caries according to the age and environmental conditions.**



As we see, air pollution affects the content of almost essential chemical elements (except Fe). However, the most significant difference was got in Vanadium (V-0.24; 0.096), silver (Ag – 0.358; 0.378) and Strontium (Sr – 1.8; 1.15) values.

As for the toxic elements in hair sample, particularly significant difference according to the environmental conditions was observed in Lead (Pb -2.66; 1.55), Arsenic (As – 0.168; 0.07) and Tin (Sn – 0.45; 0.15) case, and mercury (Hg – 0.73; 0.72) content was almost the same for both ecological environment.

According to the study of dental hard tissues (enamel, dentin), particularly significant ( $p < 0.05$ ) results were obtained with the essential elements - Zinc (Zn -215; 111) , Strontium (Sr -103.5; 81.5). In particular, both elements' content was significantly elevated in the teeth samples taken from children from polluted areas. This suggests that Zinc and Strontium are important and necessary for the human body within normal range, but their extra content has negative impact on health. (Table 4)

**Table 4. Chemical elements in dental hard tissues according to the environmental conditions.**

Elements\ environment	Polluted	Less polluted	p
Pb	7.74±1.765	4.95±2.302	< 0.05
Hg	0.819±0.423	0.578±0.253	> 0.05
Rb	0.315±0.179	0.380±0.293	> 0.05
Ca	250078±33073	260593±33899	> 0.05
Zn	215±129	111±33	< 0.05
Ni	1.04±0.72	1.21±1.50	> 0.05
Mn	11.29±767	9.59±5.57	> 0.05
Fe	104.78±29.4	93.84±49.5	> 0.05
Sr	103.5±35.7	81.5±25.3	< 0.05

From the toxic elements, the content of Pb (7.74; 4.95) and Hg (0.819; 0.578) in dental hard tissues were much more in environmentally polluted areas than in less polluted, though statistically significant difference was only received in the case of Pb ( $p < 0.05$ ). This confirms the assumption that dental tissues can be used as indicator of environmental pollution.

It should be noted, that children with high level of toxic elements in dental hard tissues, also had a high rate of deft-index.

**CONCLUSION**

Environmental conditions have a significant impact on general health as well as on dental status. Nowadays, teeth and hair samples are widely used as indicators of environmental pollution. The study of various chemical elements in tooth and hair tissues showed that the level of toxic elements was higher in polluted than in less polluted areas. Also, caries prevalence and intensity were significantly higher in the more environmentally unfavorable conditions.

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