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The long-term effect of lead on the health of preschool children of the industrial city

Abstract: The biomonitoring of the lead in milk teeth of preschool children has been carried out; features of their psychophysiological state have been studied. The content of delta-aminolevulinic acid (δ -ALA) and coproporphyrin (CP) in the urine of the examined children, was also determined. An increased content of lead in the milk teeth, increased activity of delta-aminolevulinic acid and deterioration of the psychophysiological parameters of the examined children were determined in the research.

Keywords: Lead, prenosological changes, health of preschool children

Introduction. The issues of interaction between human and his environment are especially topical today. As a result of anthropogenic pollution of the environment with chemicals, this problem has turned into a global one. The greatest threat to the children's health from all the toxic substances is still lead, which shows the most well-known example of the neurotoxic effect on an extra sensitive child's organism. The modern experimental and epidemiological statistics show that this toxicant causes negative effects on the child's body in environmentally-related doses, which is associated with the increased absorption and manifests itself in the behavioral features of children as a result of their increased susceptibility during the critical period of their development. One of the most reliable methods that characterize the influence of toxicants on public health is the evaluation of their content in the diagnostic biosubstrates. The blood, urine, hair, teeth or nails [3,4,6] are usually used for biomonitoring of lead. The level of lead in the milk teeth is a marker of long-termed influence of this toxicant. Especially for children, this indicator allows to characterize the content of the accumulated metal in the body, though the amount of uptaken by the teeth lead is only a small fraction of the total amount in the body. The samples of milk teeth of preschool children are easily taken in contrast to the bone tissue. The concentration of lead in the teeth is clearly correlated with the content of it in the other human biosubstrates, and that's why this type of analysis is considered as one of the best for evaluating of the total intake and content of this toxicant in the child's body [1,2,7].

The purpose of the work is to give a hygienic assessment of the lead content in the milk teeth of preschool children, which are living in the conditions of an industrially polluted city of Dnepr and to study the indices of their psychophysiological state.

The lead content in milk teeth of preschool children was studied by the method of atomic absorption spectrometry and observations of the features of their psychophysiological state. 46 children at age of 6-7 years, who attend a kindergarten located at 700-800 meters from a battery manufacturing and utilization factory were examined. Hygienic studies were carried out in accordance with the requirements of analytical epidemiology on the principle of homogeneity: age, duration of living in the area, 1-2 health groups, parents' absence of occupational hazards and bad habits, and the average material income of the family. With the help of mothers, 30 dropped milk teeth, all incisors, with differentiation into upper and lower teeth. The results were expressed in $\mu\text{g/g}$ of dental tissue and compared with the literature statistic. The content of delta-aminolevulinic acid (δ -ALA) and coproporphyrin (CP) in the urine of the examined children was determined. Psychophysiological testing was carried out in the morning and in the afternoon individually in specially designated rooms by the tests that help evaluate the level of the development of intellectual abilities (attention, thinking, auditory and visual memory), arbitrary regulation of activity (the ability to subordinate their actions to the task), strength and vitrality of the nervous

system [7,8]. Statistical processing and analysis were carried out according to the standard methods of variational statistics.

Research results. Analysis of the performed studies shows that the average lead content in the milk teeth of the examined children is $23.23 \pm 1.82 \mu\text{g/g}$, which is 4.6 times higher than the limit of the physiological norm recommended by the European Bureau of WHO - $5 \mu\text{g/g}$. Such a high content of lead is determined in 100% of the examined milk teeth. The determined individual variations are significant enough - from 11.3 to $38.9 \mu\text{g/g}$. Comparing with the data of other scientists it should be noted that the lead content in the milk teeth varies considerably (Table 1). This may be due to the methodological difficulties caused by the selection of different types of teeth and interpretation of the results. An unrecorded factor may be the age differences of the examined children, because the lead content in the teeth according to the data of [5] increases, exceptionally other effects, on average by 3.4% ($0.46 \mu\text{g/g}$) annually.

Table 1

The content of lead in children's teeth according to various authors

Lead content in teeth, $\mu\text{g/g}$	Place of study
23,23±1,82	Dnepr, 2005
upper-26,78±2,37 lower – 18,75±2,14	
3,96	Goncharuk E.G., Ukraine, 2004
2,5±0,42 - 1,5±0,17	Lukovenko VP, Kyiv , 1999
2,8 - 66,0	Massachusetts, USA *
1,5 - 38,5 (M-6,2)	Stolberg, Germany *
1,4 - 12,7 (M-4,6)	Duisburg, Germany *
1,3 - 34,0	London *
2,8 - 12,7	Rabinowitz M.B., 1995 (Europe, USA, Asia)
3,96±1,07	F.Gil et al., La Corordien, Spain, 1994
2,8	Michael, Boston ,1989
10,7	Denmark ,1995
3,0-11,23	Trakhtenberg IM, 1998 (Ukraine, Sosnovka village, children)
29,7±1,3	Petersburg (near the battery factory), 1995, E-mail: x17@glas.ru
5,0	WHO, 1980
0,46 - 0,71	Background values (Rock), 1997

Note: * - according to [5].

The difference in the results is determined depending on the type of analyzed of teeth. Thus, the content of lead in the upper incisors is $26.78 \pm 2.37 \mu\text{g/g}$, which is 1.43 times more than in the lower one - $18.75 \pm 2.14 \mu\text{g/g}$ ($p < 0.05$), which coincides with the data of other authors about the difference between the lead concentrations in the upper and lower incisors - from 1.3-1.7 to $2.3 \mu\text{g/g}$ [5].

High concentrations of lead in the teeth are confirmed by the increased activity of δ -ALA in the urine of the children as a type-specific effect marker for this toxicant. Its level is - $2.81 \pm 0.17 \text{ mg/g}$ of creatinine, which is almost 1.8 times more than the recommended rate for children ($1.6 \pm 0.19 \text{ mg/g}$ of creatinine) [2], which shows the tension of porphyrin metabolism due to the constant presence of lead in their body. Individual assessment of the results revealed that 89.1% of the examined children has increased concentrations of δ -ALA.

The conducted psychophysiological study of preschoolers has allowed to reveal some of their changes (Table 2). Thus, during the background assessment it was established that each second child with a long-term and intense psycho-emotional load tends to get tired quickly (45%). These children need sufficient pauses of rest and a moderate tempo of mental activity during the educational activities. There founded that 88.2% of children has a high and moderate levels of visual memory and 86.3% has the same level of auditory memory, 84% of children showed a high and average level of perception of the form of objects, 94.1% were found to have a sufficient development of general erudition, but each second child (55%) showed the low concentration of attention. This indicates the difficulty of perceiving monotonous information and the weakness of volitional efforts when focusing in one direction. In addition, 39.2% of children have a low level of prompt processing of new information, due to the lack of development of the short term memory, thinking and attention. Thus, there is confirmed that lead has an adverse effect on the health of the child population.

Table 2

The results of psychophysiological testing of children of industrial district of Dnepr (%)

Psychophysiological testing		Level		
		high	average	low
Level	of intelligence	29,4	29,4	39,2
	of comprehension	17,6	76,5	5,9
Comparison by the form		66,6	25,4	7,9
Combinatorics		58,8	35,2	6,0
Memory	Auditory	45,1	41,2	13,7
	Visual	31,4	56,8	11,8
Perception		47,0	37,0	41,0
Attention		4,0	41,0	55,0

Conclusions. Thus, children of preschool age who live near the battery factory have an increased by 4.6 times more than the norm of lead content in the milk teeth, which is accompanied by an increasing of the activity of δ -ALA on the background of deterioration of psychophysiological parameters that appeared as fast fatigue, low level of concentration of attention and deterioration of the short term memory more than 60% of the examined ones.

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