LEAD IN THE ENVIRONMENT OF THE CITY OF DNIPRO AND ITS BIOMONITORING IN THE BODY OF THE PRESCHOOL CHILDREN

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ABSTRACT Among a variety of chemical environmental factors that adversely affect the health of the population, especially dangerous are the heavy metals. The most widespread among them is lead. Numerous researches by scientists indicate the negative impact of this metal on health and, above all, on the health of the children's population. The purpose of the work is a comprehensive hygienic assessment of the content of the lead in environmental objects of an environmentally dangerous area and its impact on the health of children of preschool age. The studies on the content of lead in the air, drinking water, local food products in 2 industrial districts of the city of Dnipro and conditionally clean area have been conducted. Its total daily income in the body of preschool children who live in these areas has been calculated. Its content in the biosubstrates of these children (blood, hair, teeth and urine) has been determined. The obtained data made it expedient and necessary to develop and implement a set of measures, the aim of which is to reduce the external "stress" of this abiotic metal and to increase the resistance and adaptability of the child's body.

KEYWORDS Environment, lead, health of children

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Introduction. For industrialized areas, the problem of the anthropogenic pollution of the environment is not only relevant [1 - 3], but it also exacerbates at a qualitatively new level due to a significant deterioration of almost all the indicators of the population health, especially children's health [4]. Among the wide variety of the factors that affect the people, the leading place belongs to the chemical one, in the spectrum of which the special place is occupied by the heavy metals and such a global and potentially dangerous toxicant as lead [5] is on the first place. This is due to the detection of some neurotoxic disorders of the children exposed to the relatively low and previously perceived as safe levels of the lead. Thus, the chronic lead poisoning creates a danger to the mental development of the younger generation and, consequently, to the national security of the country [6]. The given problem is actual first of all for the regions of the intensive technogenic pollution to which the Dnepropetrovsk area concerns. The main sources of the pollution are the enterprises of the metallurgical, machine-building, energy, chemical, manufacturing and processing of the batteries and of the other industries. A significant part of all the pollutants is taken by lead. In addition, the city of Dnipro is one of the first places in Ukraine as for the density of the population, the degree of

urbanization, the capacity of the road transport communications, which results in the additional entry into the environment of a large number of this xenobiotic [7]. In accordance with the abovementioned, the purpose of our work was a complex hygienic assessment of the lead in the environment of the ecologically unfavorable territory and its impact on the health of the preschool children. Studies were carried out for 5 years in 2 districts of the city, the choice of which is based on the presence of a large number of the intensive industrial sources of the environmental pollution with lead, and in a control conditionally clean rural area. Monitoring of the lead in the environmental objects was carried out using an atomic absorption method using the AAS-1 spectrophotometer of the Karl Zeiss Ysi firm (Germany). The regular sampling was carried out in the ambient air, drinking water, local foodstuffs, with an evaluation of the results according to the existing requirements. To study the content of specific pollutants of the environment of the urban technogenic agglomerations - heavy metals in the human biosubstrates is considered as high-potential. Such evaluations are the most specific and can be a proof of the influence of the activity of the industrial facilities on the formation of pathology or pre-pathological conditions in the population, including the children as one of the most sensitive part of the population [6, 8]. Complex influence of the lead on the organism of the preschool children was determined by calculating its total daily intake (TDI) with air, water, food products in accordance with the existing methodological recommendations. The actual daily intake of the metal with food by the children's body was carried out laboratorially (using the atomic absorption spectrophotometry). Taking into account the external exposure of the child's organism by the low concentrations of the lead, the state of health was studied in the conditions of the full-scale hygienic experiment in accordance with the requirements of the analytical epidemiology. Studies were carried out in 123 preschoolers. Research results. When carrying out the hygienic monitoring, it was established that lead in the ambient air of the observation areas was determined in the concentrations that did not exceed the corresponding normative values. At the same time, the lead content in the air of the industrial areas is 0.03-0.04 μg / m3, which is 14 times higher than the control one ($p < 0.001$). The conducted study of the lead content in the ground layer of the atmospheric air in the residential area of the second industrial region showed that the metal under the study was determined continuously with a difference in the absolute values from 0.01 to 0.34 μg / m3. Its concentrations over the years of observations averaged 0.079 ± 0.033 μg / m3. At the same time, in some months there was an excess of Maximal Limited Concentration (MLK). The dynamics of the changes in the average monthly concentrations of metals during the year indicates their increase in the air of this area in the summer and autumn seasons, but it is without the sufficient statistical evidence in relation to the average annual value ($p > 0.05$). In the tap water, lead was recorded in concentrations that do not exceed the corresponding MLC by the average annual values. The lead content in the drinking water of the observation areas is 0.004-0.008 mg / l, in the tap water of the control area is 0.003 mg / l. In some periods in the drinking water of the industrial regions the concentration of the lead was at the level of MLC. In regional food products, the lead was continuously determined in the concentrations of 0.01 0.1 mg / kg, which is not higher than MLC. The analysis of the dynamics of this xenobiotic during the 2009-2017 years shows its contradictory regularity, namely, a gradual increase of the metal concentrations in the drinking water and food, especially of the animal origin, but a decrease of it in the atmospheric air. When assessing the influence of the lead on the human health, the biomonitoring method is widely used, what makes it possible to estimate the total body stress with this metal. The blood most thoroughly characterizes the "internal contamination" of the organism from all types of biosubstrates, as the best indicator of the recent intake of this xenobiotic by the body [9]. The level of the lead in the blood is the main indicator of its influence on the health of children. The accumulation of the lead takes place already in the intrauterine period due to its transplacental migration from the mother's body even at the low external exposures [10]. In the umbilical cord of the newborns of the Dnepr was detected 87.0 ± 0.12 μg / dl of this metal, which is much higher than the existing standard. Children from Kiev have an increased content of the lead in their hair, as well as in teeth and urine in presence of a changed porphyrin metabolism and with a simultaneous disturbance of the central nervous system, attention, and the mental working capacity. At the same time, the lead content in the children's hair is 1.6 times higher than in the adults’, which may be due to its more active absorption.

In our study, the average concentrations of lead in the blood of children in the industrial areas are 1.6-5 times higher than the normative one and 9.5-30 times higher than the control concentration (Table 1).

Table 1. The average concentration of the lead in the children’s blood

The observational area The concentration of the lead, μg / dl Industrial №1 15,6�3,83*** Industrial №2 49,82�0,78*** Control 1,64�0,0 Physiological content 10,0 p<0,05, ** p<0,01, *** p<0,001.

70-100 % of them has the concentration of the lead at the level of the intellectual development impairment (scales of the USA, WHO, 1997). The concentrations of the lead in the urine of the surveyed children (Table 2) in both of the industrial and control areas are above the norm by 6.4-11.2-12.8 times and can be regarded as a metal bearing or the initial stages of the intoxication [8], which finds a place in 33-66 % of the preschoolers from the industrial regions, as well as in 12 % of children from the control area.

Table 2. The average concentration of the lead in the children’s urine

The observational area The concentration of the lead, μg / dl Industrial №1 0,28�0,01* Industrial №2 0,31�0,04** Control 0,16�0,03 Physiological content 0,001-0,03 p<0,05; ** p<0,001. The hair of the preschoolers from the industrial regions (Table 3) contains lead in the concentrations corresponding to the permissible level in the first one, but exceeds it by 1.3 times in the second one. It should be emphasized that in 73-78 % of children from the industrial areas, the lead content is higher than the quoted norm and 2-3.5 times higher than in the children from the control area.

Table 3. The average concentration of the lead in the children’s hair

The observational area The concentration of the lead, μg / dl Industrial №1 8,64�0,97** Industrial №2 10,43�0,53*** Control 5,83�0,95 Physiological content 4,33�0,8 p<0,05, ** p<0,01; *** p<0,001. The increased content of the lead in the biosubstrates was accompanied by an increased activity of δ-ALA by 1,2 and 1,9 times higher than the norm, which was observed in 51-89 % of the examined patients, with the normal values in the children of the control region [4, 11]. A reliable correlation between the lead content in the environmental objects and its concentration in the children's biosubstrates has been established. Thus, a strong direct relationship was established between the content of the lead in the air, products, its TDI and concentration in the blood (r = 0.85, p <0.001, r = 0.92, p <0.001, r = 0.78, p <0.001). The lead content in the environment (air r = 0.47, products r = 0.51, TDI r = 0.42, daily ration = 0.36) significantly (p <0.001) also affects on its biochemical marker - δ-ALA (medium force connection, straight in the direction). A pair correlation analysis found that the content of the lead in the blood is directly proportional to the activity of the δ-ALA and accumulation in the hair. Multiple correlation analysis indicates that the lead content in the blood and hair is most closely related to the concentration of the lead in the food. Regression analysis allowed to calculate the "thresholds" of the content of toxicant in the environmental objects, at which its concentrations in the body can go beyond the limits of the norm. For air, they are set at 0.023 mcg / m3, for TDI - 0.06 mg / day, for the ration - 0.04 mg / day. It is

important that these values are 1.3-2 times lower than the corresponding standards in the air and diet. It was found that with the lead content in the blood at the concentrations above the 4.16 μg / dl, in hair - 2.75 μg / g, its enhanced renal excretion is already taking a place. The established "threshold" for the concentration of δ-ALA is 1.2 mg / g of the creatinine, in which the content of the lead in the urine and hair exceeds the normative values [12]. Conclusions. So, despite the relatively low external concentrations of the lead in the environmental objects, with its integrated intake into the body of children, the internal content exceeds the permissible ones, which is confirmed by the increased concentrations in the biosubstrates, which can be associated with a long and constant intake of it into the body of a child with the air, water and food. The obtained data made it expedient and necessary to develop and implement a set of measures aimed to reduce the external "stress" of this abiotic metal and to increase the resistance and adaptability of the child's body.

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