

UDC 543.272.82:502.175:613.95

Antonova O. V.

**Monitoring of Changes in the Premorbid Indicators of Children's Health
under the Influence of Low Lead Concentrations**

**State Institution "Dnipropetrovsk Medical Academy of the Ministry of
Health of Ukraine", Dnipro, Ukraine**

antonovlad@gmail.com

For the industrially developed territories, the problem of anthropogenic pollution of the environment is not just relevant, but also exacerbates on a qualitatively new level in connection with a significant deterioration of almost all indicators of population health, especially of the children's health. Among the large variety of factors that affect people, the leading place belongs to the chemicals. Lead (Pb) is the most global and potentially dangerous toxicant among them. The lead stress of the environment proved the significant deterioration of children's health. Preschool children who live in the environmentally unfavorable conditions constitute a risk group for the breakdown of the adaptation of homeostatic mechanisms. Namely the lead, even in small doses, has its unfavorable effect on the health of children, causing disorders of mental, physical and psycho-physiological development.

We have carried out a complex hygienic study of lead content in the environmental objects and biosubstrates of the 115 preschool children living in the conditions of increased influence of this toxicant and studied their psychophysiological features. The complex lead stressing of the children from an industrial city was 22.2% higher than that of preschool children living in the suburban area. The elevated levels of Pb in the biosubstrates, an increased δ -ALK activity, and disorders of psychophysiological indices of the industrial city children were determined.

The comparative analysis of the biomonitoring data confirmed the assumption of a more significant human impact on the child's body in the industrial districts of the city. 70-100% of the surveyed children of industrial areas had lead concentration in blood at the level causing intellectual disruption. These children are in risk group of developing a chronic lead intoxication. 20% of children in the first observation area had 7-10 mcg / l of lead concentration in blood. This means they are approaching the potential risk group.

Having assessed the results of the biomonitoring we can conclude that despite the relatively low external concentration of heavy metals in the environmental objects, such abiotic metal as lead was determined at elevated concentrations in organisms of children of industrial areas, which may be explained by its prolonged and continuous flow into the child's body with air, water, and food. Children living in industrial areas of the city have an excess of normative values of lead concentration in blood by 60-100%, in urine – by 33-66%, in hair – by 73.1-78.6%, and in the teeth – by 100% of the examined. The largest amount of lead in preschool children's bio-substrate was registered in the second surveyed industrial region, which is 2-4.5 times higher than the data of children in the first district. Statistically significant ($p < 0.001$) excess of lead in bio-substrates of industrial area children was established in comparison with control group children. The fact, that lead was defined both in organisms of children living in technogenic areas and in those living in almost pure areas, is another proof of the global distribution of lead in life-supporting environments and emphasizes its potential danger for the child's body even in small concentrations in the environment.

Thus, there is a systematic introduction of such a priority regional pollutant, as lead with air, drinking water, food into the body of a child in the industrial districts of the city. It is alarming that there is a decrease of getting copper and zinc with food as particularly important microelements for the

growth and development of children. It should be emphasized that this circumstance, together with the biological antagonism of these substances with lead, as well as the tropism of lead to the nervous system and psycho-emotional sphere, increase the potentially adverse effects on the health of children.

The obtained data confirm the necessity of revision of the relevant standards concerning the content of lead in various environmental objects, taking into account the total daily norm.

Keywords: lead, prenosological changes, preschool children's health.

Research relation to the plans, programs and department research themes. The study was carried in accordance with the research plan of the State Institution “Dnipropetrovsk Medical Academy of the Ministry of Health of Ukraine”: “Hygienic diagnostics of formation of ecologically dependent microelementoses in the population of the industrial region and their prevention”, state registration number 0114U005582.

Introduction. The deterioration of the environment situation, especially in the industrial regions, leads to the increased inflow of the xenobiotics in the human body, which contributes to the growth of the environmentally determined pathologies, complicates the course of the various diseases, and causes the changes of the nonspecific resistance. Prolonged action of these substances even in small doses of causes the development of nonspecific syndrome of functional maladaptation of population.

For the population that lives in the territories of the intensive technogenic stressing, which includes a powerful industrial center – Dnipro, the group of the environmental factors acquires an increased value [5]. Irremovable strengthening of the technogenic stress on the human body contributes to the deterioration of the population health and above all – of the children as the most sensitive contingent. In the spectrum of the chemical pollutants, Pb has a special

place. As a global and potentially dangerous toxicant it is widespread in the all life-providing environmental objects. It is listed as a priority pollutant by a number of the international organizations, including WHO and UNEP. Pb is especially dangerous for the child's organism; specialists associate the disorders of the physical and intellectual development of the child with its influence [7]. Up to the present moment, when analyzing the environmental impact, scientists used such a way as evaluating the existing level of the surveyed population health and determined the factors that had predetermined it. Searching the ways to manage the population health justifies the necessity for studying the processes of its formation [1].

The purpose of the work was to study the nature, degree and the main laws of environmental Pb influence on the pre-natological health indicators and psychophysiological status of the children population of the industrial city.

Material and methods. The research was carried out during 4 years, in Leninsky and Samarsky industrial districts of Dnipro. Leninsky district is characterized by saturation of the industrial metallurgical enterprises. Samarsky district has the facilities for manufacturing and processing of the batteries. Thus, both of them have difficult environmental situation. The districts differ in the location, nature and intensity of the air pollution, water supply system, terrain, etc. A conventionally "clean" rural district, located in the recreation area of the city of Novomoskovsk of the Dnipropetrovsk region was taken as the control one. We analyzed the average monthly samples of the air, drinking water and the local food products with the help of atomic absorption spectrophotometry; daily diets were analyzed on the Pb, zinc, and copper content. Zinc and copper were assessed as very important microelements for the growth and the development of children.

In order to determine the Pb influence on children's organism, it was provided a comprehensive clinical and hygienic examination of the 115

practically healthy preschool children aged 5-6, who permanently lived and attended kindergartens in the observation areas. The selection of children was conducted in accordance with the requirements of analytical epidemiology on the principle of the homogeneity, without chronic diseases, as well as taking into account the absence of professional contact, bad habits and the average material income in their families [3].

Surveyed pre-school children had a biomonitoring of the lead, zinc and copper in the indicator biological substrates (blood, urine, hair, milk teeth) using the atomic absorption spectrophotometry. We also evaluated the level of the delta-aminolevulinic acid (δ -ALK) in the urine as a specific biochemical marker of action in the diagnosis of the microangiopathy. The δ -ALK value was calculated on the 1 g of creatinine. The evaluation of the obtained data was carried out taking into the account the literature data, as well as the existing physiological norms. Psychophysiological testing was carried out in the morning and the afternoon individually in the specially designated premises. Tests were made up to help evaluate the level of the development of the intellectual abilities (attention, thinking, auditory and visual memory), arbitrary regulation of the activity (ability to act according to the task), strength and endurance of the nervous system. The results were processed using the traditional methods of the variation statistics [4].

Results and discussion. During Pb monitoring in the air of residential areas of the observed districts, in the drinking water of Dnipro and Novomoskovsk, and regional food products, this metal was determined in such concentrations that the average annual values practically do not exceed the corresponding normative values although they were above the background. These circumstances created the conditions for the comprehensive influence of Pb on the health of population and, on the first place, on children as its most sensitive category.

It was determined that the total Pb intake (IT) by Dnipro city children with the air, drinking water, and food was at the average values is 0.08-0.09 mg / day, which is 22.2% higher than in the control city [6]. Copper IT in the children's body practically corresponded to the physiological necessity according to the average values. But zinc IT was 5 times lower than required for a healthy child. It should be added that the actual nutrition of the children in Dnipro city is imperfect and unbalanced as for the all major macro- and micronutrients, particularly due to the insufficient supply of the physiological antagonists of Pb on the background of the protein deficiency, which in turn increases the toxic effect of the lead [2].

A comparative analysis of the data obtained from our biomonitoring of the lead, copper and zinc confirmed the assumption of a more significant technogenic stress of the child's body in a big industrial city. Thus, the average Pb content in blood of the surveyed children, living in Leninsky district is 1.5 times higher than the normative one. The results of children from Samarsky district were almost 5 times higher than the normative, which may be due to the peculiarity of the pollutant enterprise located in the district. In blood of the control district children, the Pb was defined in the average amount that corresponds to the limit of the physiological fluctuations and background values of the children in the unpolluted territories. The average Cu content in blood of the children of all areas of observation was at the physiological level, and the amount of Zn was lower than the normal level by 7-49%, which may contribute to the development of zinc deficiency in these children.

Analysis of Pb results in the urine indicates that it was determined in the examined children in both industrial and control districts. Average concentrations in comparison with norms were 6.4-11.2-12.8 times more and can be considered as a metal carrier or initial stages of the intoxication of an organism. This indicator of preschoolers in industrial districts was raised by 33-

66% and by 12% of the control group. The fact that Pb content in urine of the children of a conditionally clean area also exceeds the normative may be a proof of the long-term income of small concentrations of this xenobiotic from the objects of the environment, mainly from food, and confirms the view of the increasing importance of vehicles as the etiology of Pb intoxication, even in the rural areas. As for Cu and Zn, their average concentrations in children of different regions were at the level exceeding the physiological oscillations limits, confirming the assumption of the antagonistic interaction with Pb.

The hair of the surveyed Dnipro preschoolers [7] contained Pb in concentrations that were 2-3.5 times higher than in children of the control district and were at the children's limiting level of 8-9 $\mu\text{g} / \text{g}$ recommended by I. M. Trachtenberg and B. A. Revich. It should be emphasized that 73-78% of the surveyed children of the industrial areas had higher Pb content in hair than the given norm. The average content of Zn in the hair of Samarsky district children was 80% of the physiological value, in the hair of Leninsky district children it was only 40%. The content of Cu in the first district corresponded to the norm, while in the second it was 48% of the norm.

The average Pb content in teeth of the children from industrial regions was 4.6 times higher than the physiological norm recommended by the WHO, and the control children had it on the border. Such a high Pb content is determined in milk teeth of all examined children from the industrial area. Thus, the content of Pb in all biosubstrates of surveyed children living in the industrial areas of the city exceeds the normative values and values obtained in the control area. These data confirms the systematic Pb income from various environmental objects, which forms its complex effect on the body in various ways.

The Pb increasing in biosubstrates is accompanied by increasing of δ -ALK activity in children's urine as a type-specific biochemical marker for this toxicant. Its level is above the recommended norm for children by 1.2 and 1.9

times. It should be emphasized that the assessment of individual results established that 51% of the examined children in the first district and 89% of the second one have an increased δ -ALC concentration. It indicates the stress of the porphyrin metabolism in their body due to Pb influence. For the children of the comparative city, this value was significantly ($p < 0.01$) lower. It should be emphasized that the level of the δ -ALK in urine of the children of a conditionally clean area did not exceed the norm in all surveyed.

The psychophysiological study that has been carried out by us, allowed revealing the changes of the functional state of the central nervous system of preschoolers in the industrial districts. These children, compared with the children in the control area, have the slowed down reaction rate, the poorly developed biliary coordination, the slowed down fine motor skills, the violated logically determined order of the tasks. These changes are the evidence of the severe neurodynamic disorders and violations of the higher forms of regulation and cortical functions.

Thus, it was established that preschool children living near the industrial zone have a significant decrease of the psychophysiological indicators because of Pb accumulation in the biosubstrates and changes in the porphyrin metabolism compared with the children of the control group.

Conclusions. The obtained data allowed establishing the increased Pb stressing of preschool children living in the industrial city compared with the control group. It is not only accompanied by a significantly higher frequency of the psychophysiological disorders but is also correlated with the content of this toxicant in the air, food and the total daily intake. All these facts confirm the conclusion about the negative influence of Pb on children's health in conditions of technogenically polluted areas.

References

1. Berdnik OV, Serykh LV, Antamonov MYu. Pokazateli populyatsionnogo i individualnogo riska pri otsenke vliyaniya faktorov okruzhayushchey sredy na zdorove detskogo naseleniya. *Gigiena i sanitariya*. 2001; 5: 94-6. [Russian]
2. Biletska EM, Antonova OV, Glavatska VI, ta in. Osoblivosti nadkhodzhennya svintsyu u dityachiy organizm promislovikh rayoniv m.Dnipropetrovska. *Sb tez naukovo praktichnoyi konferentsiyi «Suchasni problemi epidemiologiyi, mikrobiologiyi ta gigiyeni»*. Lviv, 2004. [Ukrainian]
3. Revich BA. *Zagryaznenie okruzhayushchey sredy i zdorove naseleniya. Vvedenie v ekologicheskuyu epidemiologiyu: Uchebnoe posobie*. M: MNEPU, 2001. 264 s. [Russian]
4. *Statisticheskie metody v mediko-biologicheskikh issledovaniyakh s ispolzovaniem Excel*. 2-e izd, pererab i dop. K: MORION, 2001. 408 s. [Russian]
5. Belitska EM, Onul NM, Antonova OV. Contamination of industrial city atmospheric air as an actual and hygienic problem. *Nauka i studia*. 2014; 8 (118): 35-42
6. Beletskaya EM, Antonova OV, Zemlyakova TD, Golovkova TA. The alimentary intake of lead and hygienic evaluation of its impact on children's health. *Проблеми харчування*. 2016; 2 (45): 55-7.
7. Glavatskaya VI, Antonova OV, Zemlyakova TD. The long-term effect of lead on the health of preschool children of the industrial city. *Web of scholar Multidisciplinary Scientific Journal*. 2018; 1 (19): 10-3.

УДК 543.272.82: 502.175: 613.95

МОНІТОРИНГ ЗМІН ПРЕМОРБІДНИХ ПОКАЗНИКІВ ЗДОРОВ'Я ДІТЕЙ ЗА ВПЛИВУ НИЗЬКИХ КОНЦЕНТРАЦІЙ СВИНЦЮ

Антонова О. В.

Резюме. Для промислово розвинених територій проблема антропогенного забруднення навколишнього середовища не тільки актуальна, але й загострюється на якісно новому рівні у зв'язку із значним погіршенням майже всіх показників здоров'я населення, особливо здоров'я дітей. Серед великого розмаїття факторів, які впливають на людей, провідне місце належить хімічним речовинам, і серед них найбільш глобальним та потенційно небезпечним токсикантом є свинець (Pb). Діти дошкільного віку, які проживають у екологічно несприятливих умовах, є група ризику. Свинець, навіть у дозах, які не перевищують гігієнічні регламенти, має несприятливий вплив на здоров'я дітей, викликаючи порушення психічного та фізичного розвитку.

Проведено комплексне гігієнічне вивчення вмісту свинцю в об'єктах навколишнього середовища та біосубстратах 115 дітей дошкільного віку, які живуть в умовах підвищеного впливу цього токсиканта та оцінені їх психофізіологічні особливості. Комплексне навантаження свинцем дітей промислового міста на 22,2% вище, ніж у дітей дошкільного віку, які мешкають у «чистій» зоні. Визначено підвищений вміст Pb у біосубстратах, підвищена активність δ -АЛК, розлади психофізіологічних показників у дітей промислових районів.

Ключові слова: свинець, донозологічні зміни, здоров'я дошкільнят.

УДК 543.272.82: 502.175: 613.95

МОНИТОРИНГ ИЗМЕНЕНИЙ ПРЕМОРБИДНЫХ ПОКАЗАТЕЛЕЙ ЗДОРОВЬЯ ДЕТЕЙ ПОД ВОЗДЕЙСТВИЕМ НИЗКИХ КОНЦЕНТРАЦИЙ СВИНЦА

Антонова А. В.

Резюме. Для промышленно развитых территорий проблема антропогенного загрязнения окружающей среды не только актуальна, но и

обостряется на качественно новом уровне в связи со значительным ухудшением многих показателей здоровья населения, особенно детей. Среди большого разнообразия факторов, которые влияют на людей, ведущее место принадлежит химическим веществам, и среди них наиболее глобальным и потенциально опасным токсикантом является свинец (Pb). Дети дошкольного возраста, проживающие в экологически неблагоприятных условиях, являются группой риска. Свинец, даже в дозах, не превышающих гигиенические регламенты, имеет неблагоприятное воздействие на здоровье детей, вызывая нарушения психического и физического развития.

Проведено комплексное гигиеническое изучение содержания свинца в объектах окружающей среды и биосубстратах 115 детей дошкольного возраста, живущих в условиях повышенного воздействия этого токсиканта, оценены психофизиологические показатели детей. Комплексная нагрузка свинцом детей промышленного города на 22,2% выше, чем у детей дошкольного возраста, проживающих в «чистой» зоне. Определено повышенное содержание Pb в биосубстратах, повышенная активность δ-АЛК, расстройства психофизиологических показателей у детей промышленных районов.

Ключевые слова: свинец, донозологические изменения, здоровье дошкольников.

Стаття надійшла 11.04.2018 р.

Рекомендована до друку на засіданні редакційної колегії після рецензування