УДК 613.1:669.018.674:616–053.2

E. Belitskaya,
O. Antonova

HYGIENIC ASSESSMENT OF BIOTIC AND ABIOTIC METALS INTAKE IN THE CHILDREN'S ORGANISM IN THE CONDITIONS OF TECHNOGENICALLY CONTAMINATED TERRITORIES

SE «Dnipropetrovsk medical academy of Health Ministry of Ukraine»
Department of General Hygiene
Sobornaya sq, 4, Dnipropetrovsk, 49027, Ukraine
ГУ «Днепропетровская медицинская академия МЗ Украины»
кафедра общей гигиены
(зав. – д. мед. н., проф. Э.Н. Белецкая)
e-mail: enbelitska@ukr.net

Key words: *lead, trace elements, influence on children's health*
Ключевые слова: *свинец, микроэлементы, влияние на здоровье детей*

Abstract. Hygienic assessment of biotic and abiotic metals intake in children organism in the conditions of technogenically contaminated territories. Belitskaya E.N., Antonova O.V. *Total daily load and the contribution of the different ways of the lead entry in children's organism in industrial and control area were calculated. The study of a complex metal intake in the children's organism with air, water and food has shown that in industrial areas its intake is increased and intake of micronutrients - copper and zinc is reduced as compared to the control area. This work made it possible to draw a conclusion on justified evidence that chemical loading of the environment makes a significant contribution into worsening of children's population. Lead occupies a leading place in this process. This necessitates the development of measures on prevention of ecologically-dependent pathology.*

Реферат. Гигиеническая оценка комплексного поступления биотических и абиотических металлов в организм детей в условиях техногенно загрязненных территорий. Белецкая Э.Н., Антонова Е.В. *Рассчитана суммарная суточная нагрузка и вклад разных путей поступления свинца в организм детей в условиях промышленных и контрольного района. Изучение комплексного поступления металла в детский организм с воздухом, водой и пищевыми продуктами показало, что в условиях промышленных районов его поступление повышено, а микроэлементов – меди и цинка в сравнении с контрольным районом – уменьшено. Проведенная работа позволила сделать вывод о том, что обоснованное доказательство значительного вклада в ухудшение уровня здоровья детского населения имеет химическая нагрузка окружающей среды. Доминирующее место в этом процессе занимает свинец. Это обуславливает необходимость разработки мер по предупреждению экологозависимой патологии.*

The problem of worsening of the environment is not only relevant, but exacerbated at a qualitatively new level due to a significant deterioration of almost all indicators of population's health, especially of children's contingent, living in the industrialized areas. [3]. Among the large variety of environmental factors that affect human body, the leading place is taken by chemical, in the spectrum of which special place is occupied by heavy metals (HM) and above all by such a global and potentially dangerous toxicant as lead [2]. Increased attention to the problem of lead is determined by the fact that from the professional area it moved to ecopathological one, due to the global spread of lead, which even in its small concentartions can cause a number of health hazards in urban areas.

Despite the numerous developments of domestic scientists [7], not all aspects of the problem are investigated in sufficient volume. The majority of them is associated with lack of the data on toxicokinetics of lead in the child's body because of its technogenic accumulation. Regional characteristics of a complex influence of lead as abiotic element, quantitative correlation of lead concentration in the environment with possible prenozological changes in the health of children are insufficiently studied [8].

Due to the intensive development of industry, transport, use of chemicals in the agricultural production, the increasing human impact of the environment with heavy metals (HM) leads to increase of their concentrations in the environment - air, water, soil, food and, in turn, to accumulation in the human organism, creating a real danger to population health. It is known that HM and their compounds belong to highly toxical elements for the human body. From all the spectrum of HM lead (Pb) is the most toxic. Therefore, lead pollution is one of the most relevant problems of hygiene in the world, including Ukraine [4].

Technogenic pollution with lead increases the likelihood of human exposure to not biological but to toxic concentrations through environmental features.

It is known that an excess of lead in the body leads to a decrease in the content of vital abiotic elements - calcium, iron, zinc, copper, selenium [7]. Microelements belong to essential food components, their adequate supply to the body is a prerequisite for health and ability to work, especially in childhood. Such elements, as zinc and copper play an important role in ensuring adequate growth, hematopoiesis, immune response, forming antioxidant status of a child. These vital metals are physiological antagonists of lead [5].

The intake of abiotic metals with air, water, food makes up a total daily dose and forms the basis for further improvement of single hygienic regulation. Therefore, the problem of its determination in relation to the impact on the child's health is relevant for the modern hygiene.

Summing up our previous studies on the content of lead in the environment has allowed to calculate the total daily load (TDL) and the contribution of different ways of its entry to the body of a child in industrial and control surveillance areas. The calculation was performed on the absolute daily amount (mg/day) for a child aged 5-6 years. The data were compared with the acceptable daily intake (ADI), which is set for xenobiotic metals in accordance with requirements of the Joint Committee of experts FAO/WHO for nutritional additives, as well as with the data from scientific literature on the subject. For metals - trace elements obtained daily values were compared with their physiological needs.

Analysis of calculations shows that TDI of lead for children is 0.08 mg with maximum value of 0.153 mg in the first industrial area and 0.09 mg in a maximal value of 0.150 mg in the second one. The results on TDI of metals in industrial and control areas are presented in Table 1. If, according to the average value, the entry of lead in the first region does not exceed ADI, and in the second it exceedes by 0.01 mg, then by the maximum it is almost twicw as large for this contingent of the population. A specific gravity of intake ways is different (Fig.). The contribution of food intake into the TDI is the largest – 98.8% and 93.8%, with drinking water and air lead enters in the smallest amounts.

The total daily intake of metals from food, water and air into the bodies of children of Leninskiy (1), Samarskiy (2) and control (3) districts

Daily intake of heavy metals, mg per day	Route of entry									TDI			ADI	DM
	alimentary			water			aerogenic							
Districts	1	2	3	1	2	3	1	2	3	1	2	3		
Lead	0.08	0.08	0.02	0.001	0.005	0.019	0.002	0.002	0.0030	0.083	0.087	0.042	0.08	-
Copper	1.43	1.43	1.55	0.007	0.021	0.038	0.009	0.176	0.0030	1.446	1.627	1.5883	-	0.95-1.5
Zinc	1.45	1.45	5.77	0.030	0.020	0.192	0.023	0.016	0.0003	1.503	1.486	5.9623	-	7.6

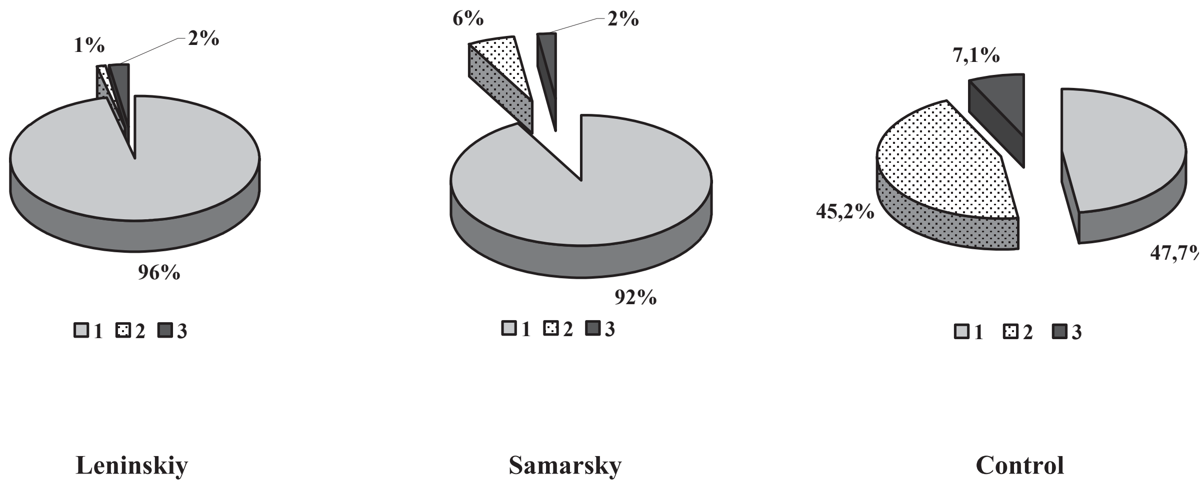
N o t e s : 1. TDI – total daily intake, mg/day; 2. ADI – acceptable daily intake, mg/day; 3. DM – daily maintenance, mg/day.

The obtained data do not exceed the literature ones and testify that the incoming value of lead in children's organism in Lviv region is 0.143 mg/day; Western Ukraine – 0.15-0.28 mg/day; central Ukraine – 0.128-0,64 mg day; Russia – 0.14-0.64 mg/day; Poland – 0.11 mg/day [2, 6].

Thus, such a toxic and dangerous xenobiotic as lead, is always defined in the vital objects of the environment, creating conditions for its complex impact on the children's organism.

Children's population of industrial Leninsky district receives on average 1.45 mg of copper and 1.5 mg of zinc per day, which mainly come with food (98.9% and 96.5% respectively).

Proportion of these metals entry with drinking water and with air is insignificant and for copper it makes up 0.5 and 0.6% and for zinc – 2.2 and 1.3% respectively. Average TDI of copper practically meets physiological needs for this age group (0.95-1.52 mg). However, daily intake of zinc into the body is 1.5 mg on average, which is 5 times lower than physiologically required needs for a healthy child (7.6 mg) [6, 7].



Proportion of income ways of lead into the children's orgainsms in areas of surveillance, %
(1- alimentary, 2 – water, 3 - aerogenical)

The children of the industrial Samarskiy district receive 1.63 mg of copper and 1.49 mg of zinc on average per day, mainly with food (87.9-98.9% and 97.5% respectively). Proportion of income of these metals wiht drinking water and with air is insignificant being, 1.3% for copper, and 1.4% for zinc. In this area the TDI of copper a little bit exceedes physiological need for this age group (0.95-1.52 mg).

Average entry of zinc into the children`s organism of this area is 1.5 mg per day, which is 5.1 times lower then the required physiological needs for healthy children (7.6 mg). Insufficient entry of zinc in a child's organism may stipulate zinc-defficient states, disorder of development of child's body, reducing of immunity and weakening of protection undert the influence of environmental contaminants.

The data on TDI of metals in the children's organism of the control (non-industrial) area show that the total daily intake of lead is 0.042 mg/day and on average does not exceed the acceptable, but by maximum value it is by 1.12 times higher. The dominant path of income of this xenobiotic is alimentary, as its proportion is 50.2% of the TDI. 48.8% of lead is supplied with drinking water, and with air it is only 1.02%. The surveyed contigent of children's population of this area receives 1.59 mg of copper and 5.96 mg of zinc per day on average, mainly at the expense of alimentary path of intake, the proprtion of which is 98.5%-96.8% respectively, and income with drinking water and inhaled air is insignificant and corresponds on average 1.5% and 0.02% for copper and 3.18% and 0.02% for zinc. The TDI of copper for this age group meets daily needs and for zinc it is slightly lower then it should be.

Thus, the analysis of conducted studies allows to make certain generalizations, such as: from 50.2% to 98.9% of all the daily intake of lead gets into the children's bodies with food products. Furthermore, the study of a complex income of metals into the children's organisms with air, water, food showed that despite the allowable averages of TDI of metals, complex income of lead as priority pollutant in the industrial areas for this age group is exceeded, and the income of trace elements - copper and zinc on the contrary is reduced as compared with the control areas.

Summarizing the above, it should be emphasized that the significantly worsened level of health of children has a justified evidence of sufficient contribution of chemical load of the environment into this process, among which HM and especially lead occupies the priority place as potentially dangerous, this causes the need to develop measures on preventing ecological-dependent pathology and strengthening state of children's health in general.

Thus, the problem of studying the adverse impact of lead as a prior technological pollutant of the environment on children's health refers to the actual scientific directions of preventive medicine, since there is justification of hygienic implementation of active preventive measures to prevent eco-dependent pathology, decrease morbidity and strengthen health of children.

REFERENCES

1. Aghajanian NA, Skalniy A. [Chemical elements in the habitat and environmental portrait of a man]. M.: CMC Publishing. 2001;11-59. Russian.

2. Biletska EM, Ryzhenko SA, Golovkova TA. [Experience of ecological and hygienic assessment of heavy metals in the environment linked with anthropogenic pollution of industrial cities]. Hygiene of settlements. 2003;42:373-6. Ukrainian.

3. Boyev VM. [Habitat and ecological imbalance caused by trace elements on the population in urban and rural areas]. Hygiene and sanitation. 2002;5:3-8. Russian.

4. Kundiev YI, Trachtenberg IM. [Chemical hazard in Ukraine and measures for its prevention]. Journal of Academy of Medical Sciences of Ukraine. 2004;10(2):259-67. Russian.

5. Gerasimenko TI, Domnin SG, Rosliy OF, Fedoruk AA. [Evaluation of the combined effect of binary mixtures of lead - copper and lead - zinc (experimental study)]. Occupational Medicine and Industrial Ecology. 2000;8:36-39. Russian.

6. Trachtenberg IM, Biletska EM, Demchenko VF. [Lead in the industrial mist: outdoor exposure, biomonitoring, markers of the actions and effects, prevention]. Environment and Health. 2002;3:10-12. Ukrainian.

7. Sheibak MP, Sheibak LN. [Zinc deficiency in children]. Russian Gazette on Perinatology and pediatrics. 2000;1:48-51. Russian.

8. Nielsen U, Kamp JJ, Grandjean P, White RF. Environmental lead exposure and neurodevelopmental outcome in Danish preschool children. Neurotoxicology. 2000;21(5):896-7.

СПИСОК ЛИТЕРАТУРЫ

1. Агаджанян Н.А. Химические элементы в среде обитания и экологический портрет человека / Н.А. Агаджанян, А.В. Скальный. - М.: Издательство КМК, 2001. – С. 11-59.

2. Білецька Е.М. Досвід еколого-гігієнічної оцінки важких металів у навколишньому середовищі у зв'язку з антропогенним забрудненням промислових міст / Е.М. Білецька, С.А. Риженко, Т.А. Головкова // Гігієна населених пунктів. – 2003. – Вип. 42. – С. 373-376.

3. Боев В.М. Среда обитания и экологически обусловленный дисбаланс микроэлементов у населения урбанизированных и сельских территорий / В.М. Боев // Гигиена и санитария. – 2002. – № 5. – С. 3-8.

4. Кундиев Ю.И. Химическая опасность в Украине и меры по её предупреждению / Ю.И. Кундиев, И.М. Трахтенберг // Журн. АМН України. – 2004. – Т. 10, № 2. – С. 259-267.

5. Оценка комбинированного действия бинарных смесей свинец – медь и свинец – цинк (экспериментальное исследование) / Т.И. Герасименко, С.Г. Домнин, О.Ф. Рослый [и др.] // Медицина труда и промышленная экология. – 2000. – № 8. – С. 36-39.

6. Свинець в умовах промислових міст: зовнішня експозиція біомоніторинг, маркери дії та ефекту, профілактика / І.М. Трахтенберг, Е.М. Білецька, В.Ф. Демченко [та ін.] // Довкілля та здоров'я. – 2002. – № 3. – С. 10-12.

7. Шейбак М.П. Недостаточность цинка у детей / М.П. Шейбак, Л.Н. Шейбак // Российский вестник перинатологии и педиатрии. – 2000. – №1. – С. 48-51.

8. Environmental lead exposure and neurodevelopmental outcome in Danish preschool children / U. Nielsen, J.J. Kamp, P.Grandjean [et al.] // Neurotoxicology. – 2000. – Т. 21, N 5. – P. 896-897.

Стаття надійшла до редакції
20.01.2016