

Heavy Metals Exposure on Urbanized and Industrial polluted territories and Effects on Functional State of Systems of different cohorts of population in Crimean region of Ukraine

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Abstract. On urbanized and industrial territories in Crimean region of Ukraine with exceedances of critical loads for heavy metals (HM) different cohorts of population were examined. Content of toxic HM (Hg, Pb, Cd, Ni) in hair of healthy children and adult mainly did not exceeded, but level of essential HM (Fe, Zn, Cu, Mn) frequently was decreased. The differences of HM content in some special cohorts (mental retardation, autonomic nervous system dysfunction, sportsman) was revealed. Content of HM in 375 samples of venous and umbilical cord blood, placenta, breast milk of puerperants and their new-born children strongly varied. Correlation analysis by Spearman and multiple regression analysis shown not so close but statistically significant relationships between levels of HM and functional state of central and autonomic nervous, immune and cardio-vascular systems, their different sensitivity to different HM in distinct cohorts of population.

Key words: Heavy metals, exceedances of critical loads, immune, central and autonomic nervous, hemodynamic systems

Introduction

To investigate of heavy metals (HM) effects on ecosystems and human health on territory of the Crimean peninsula, Ukraine, the complex approach is used, that includes: 1) calculation of critical loads (CL) for HM and assessment of HM exceedances for terrestrial ecosystems using the methods which are recommended by European Convention of Long-Range Transboundary Air Pollution (CLRTAP); 2) assessment of HM exposure in different cohorts of population by determination of HM content in biosubstrates of human body and related to HM effects on central (CNS) and autonomic nervous (ANS), immune, and hemodynamic systems.

Materials and Methods

The total number of the experimental sites where current depositions were determined is 16: 3 on the north, 1 on the west, 2 in the center, 8 on the south, 2 on eastern region of the Crimea peninsula. All of the sites in the south and one on the north belong to protected territory, in contrast 1 on the west and 2 on the north arable areas close to the large industrial factories. The calculation of CL for HM (Hg, Pb, Cd) for terrestrial ecosystems (forest and arable) and a comparison with current depositions in precipitations had shown the exceedances of these metals on urbanized and industrial territories. In the same places (3 sites: city Simferopol and 2 villages near large factories) Hg, Pb, Cd, Zn, Cu, Fe, Mn, Ni in 350 samples of hair were determined in different cohorts: adults, children of different age (10-16 years) healthy and with some pathologies (mental retardation, autonomic nervous system dysfunction), 50 sportsman (18-20 years), and in 375 samples of venous and umbilical cord blood,

placenta, breast milk of puerperants and their new-born children. HM effects on functional systems of tested individuals were estimated by Spearman's correlation analysis and by multiple regression analysis.

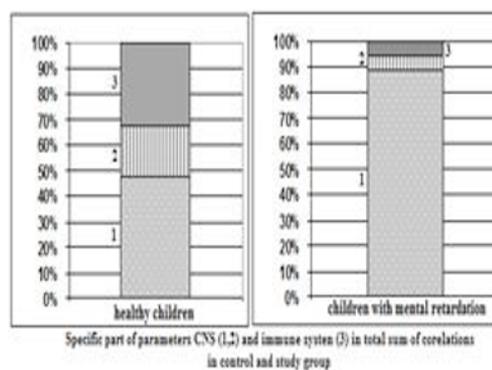
Results and Discussion

The results indicated that content of metals in the biogeochemical food chains (soil, plants) had some exceedances of national limits for cadmium but not in human body. In whole the content of toxic metals (Pb, Cd) in hair of adult and children on urbanized and industrial polluted territories is characterized by normal values, exceeding its in some cases. In the same time deficiency of essential metals (Cu, Zn, Fe) was revealed in the most part of tested children. In puerperants and their new-born children, content of HM significantly varied. In breast milk content of Cd was 0,001-0,042 mmol/l, Pb 0,01-0,111, Zn 1,83-21,67, Fe 0,001-1,21, Cu 0,0003-1,95; in umbilical blood 0,0010-0,033, 0,014-0,27, 3,19-10,11, 504,1-2271, 0,72-1,96; in venous blood of mothers 0,019-0,22, 0,093-0,25, 0,38-2,62, 296,1-598,1, 0,68-0,84 mmol/l, in mother's hair 0,013-0,155, 0,28-31,94, 23,64-321,53, 15,15-83,03, 2,52-48,31 mkg/g respectively.

It was found that the main feature of children immune status was abundant observed deficiency of specific cell-mediated immunity parameters some of which have been totally changed. Functional status of other investigated system and HM content is

characterized by some differences in different cohorts. For example in children with mental retardation observed increase of Mn and Ni content in hair and not strong but significant differences in cognitive functions and EEG-parameters. HM profile and functional characteristics of CNS in sportsman had some peculiarities in comparison with ordinary students.

Correlation analysis revealed different sensitivity of the functional systems to levels of metals (fig.1) depending on type cohort and heavy metal.



Immune system of puerperants and their new-born children had the most sensitivity to Zn (18 correlations) and Cu (11), and then to Pb (8) and Cd (3). Coefficients of correlation varied from 0,30 to 0,76 but were statistically significant. Complex action of HM established by multiple regression was more significant.

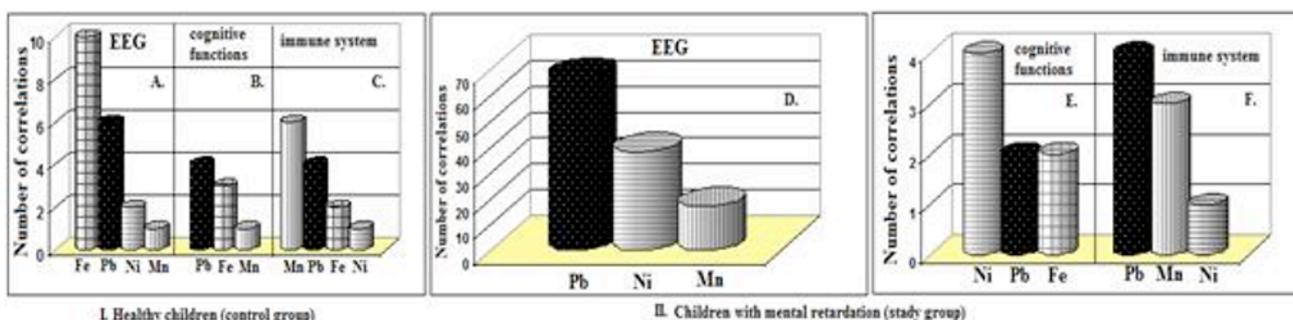


Fig. 1. Number of correlations between parameters of nervous (A, B) and immune systems (C) and content of heavy metals in the hairs of healthy children (I) and children with mental retardation (II).

Conclusion

On urbanized and industrial territories on the Crimea peninsula, where the exceedances of HM by methods of CLRTAP were established, the content of HM in healthy children and, in particular, adult, was mostly in the frames of norm but significant varied in organism of puerperants and their new-born children and some special cohorts. In the same time for all cohorts not strong but definite significant effects of HM on functional state of CNS, ANS, immune and hemodynamic systems were revealed. Sensitivity of different systems to different metals distinguished in depends on type of metal.

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