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STUDY OF THE CANCER INCIDENCE IN KIDS AND JUVENILES IN YEREVAN IN RELATION TO AIR AND SOIL POLLUTION ON THEIR DWELLING SITES

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The article covers a study of correlation between cancer incidence in children and juveniles and indices of air pollution as well as levels of heavy metal pollution of the territory of the Yerevan. No significant correlations of oncological diseases in children and juveniles in Yerevan were revealed with data on air pollution. Spatial correlation between the maps of distribution of oncological cases and values of summary index of heavy metal pollution of soils in 12 districts of Yerevan lead to obtaining the picture of superimposition of the number of disease cases and geochemical series produced for the same sites. The outcomes indicated no correlation of those indices in that case as well.

Cancer incidence – traffic-induced pollution of air – heavy metal pollution of soils

Ուսումնասիրված է հնարավոր համահարաբերակցական կապը երեխաների և երիտասարդների օնկոլոգիական հիվանդությունների բժշկական ցուցանիշների և ծանր մետաղներով Երևանի տարածքի աղտոտման մակարդակի, ինչպես նաև օդի աղտոտման ցուցանիշների միջև: Չի հայտնաբերվել արժանահավատ համահարաբերակցություն երեխաների և երիտասարդների օնկոլոգիական հիվանդությունների բժշկական ցուցանիշների և Երևանում օդի աղտոտման տվյալների միջև: Օնկոլոգիական հիվանդությունների բաշխման քարտեզների և Երևանի 12 վարչական շրջաններում ծանր մետաղներով աղտոտման գումարային ցուցանիշի արժեքների տարածական համադրման միջոցով ստացվել է այդ շրջանների երկրաքիմիական շարքերի հետ հիվանդությունների դեպքերի քանակության միատեղման պատկերը: Նշված ցուցանիշների համահարաբերակցություն չի հայտնաբերվել նաև այս դեպքում:

Ուռուցքաբանական հիվանդացություն – օդի տրանսպորտային աղտոտում – հողերի աղտոտում ծանր մետաղներով

Изучена корреляционная связь между показателями онкологических заболеваний у детей и молодых людей и уровнем загрязнения воздуха, а также территории Еревана, в том числе, тяжелыми металлами. Достоверной корреляционной связи между показателями онкологических заболеваний у детей и молодых людей и уровнем загрязнения воздуха в Ереване не выявлено. Путем пространственного сопоставления карт распределения онкологических заболеваний и значений суммарного показателя загрязнения тяжелыми металлами почв в 12 административных районах г. Еревана получена картина совмещения количества случаев заболеваний с геохимическими рядами для тех же районов. В данном случае также не выявлено корреляционной связи показателей.

Онкологическая заболеваемость – транспортное загрязнение воздуха –- загрязнение почв тяжелыми металлами

At present the environmentalists place a special emphasis on the health of population as it is inseparably linked to the health and stability of natural ecosystems. Zones with high contents of toxic elements are formed around industrial enterprises that threaten the health of the man. Such territories are potential zones of man-made micro-elements. Prior to the 1970s dominating pollutants involved dust, pesticides, CO_x, NO_x, SO_x and so on. Subsequently, the scope of pollutants was added by heavy metals [9, 10].

Recent years have been marked by abundant researches on metal biomonitoring and the role of separate macro- and microelements in health disorders in adults and children as well as on a micro-elementary “portrait” of a scope of diseases, interaction with the genetic apparatus and immune system. Excessive concentrations of metals may induce serious metabolic changes and disturbance of metabolic processes, and this favors the lowering of the organism resistibility, brings to disturbance of allergic and somatic status and finally to dysfunction of diverse organs and systems. The metals affect the process of haematopoiesis, this in turn adding to the immune deficiency of the organism [7]. Multiple long-term exposures to a number of metals and their compounds may result in origination of malignant neoformations as well. Metal ions carcinogenic to humans are Be, Cd, Cr and Ni (Co, Cu, Fe and Pt also can be included in this list). A set of molecular mechanisms was suggested that reflect diverse chemical properties of the noted metals. As indicated by epidemiological investigations, long-term exposure of parents to metals increases a risk of origination of malignant neoformations in their children. This might be connected with pro-mutagenic damage of sperm DNA [14]. The childhood cohort is a unique “indicative group” reflecting the local people’s response to adverse impacts of environmental factors. The appropriateness of accounting disease incidence in children is supported by the fact that in contrast to adult they commonly move throughout the city more limitedly, are “tighter” tied to their residence and study sites, are not exposed to direct impacts of occupational harms, practice harmful habits (smoking etc.) to a lesser extent. Due to their anatomic-physiological peculiarities, children are more sensitive to the quality of habitat, and the terms of manifestation of adverse effects in them are shorter. This adds to the significance value of statistical investigations helping make more objective conclusions on “ecological stipulation” of diseases. Oncological diseases in childhood are a rare phenomenon, which however may bring to dramatic consequences. As evidenced by existing evaluations, cancer in European countries is diagnosed in 1 out of 500 children under 15. The role of environmental factors in pathogenesis of oncological diseases in childhood is known to be limited, nevertheless children are more prone to the impact of biological factors potentially connected with development of malignant neoformations (multistage carcinogenesis) as exposition to carcinogens in childhood may subsequently lead to the development of cancer, as reported, for instance, in the case of UV exposure which is a causal agent of development of melanoma [3].

Series of investigations indicated significant relationships between the incidence of oncological disease and some environmental factors [2, 16].

With rare exception, carcinogenesis involves environmental factors that directly or indirectly exert a change in the cell's genome. Virtually all causes of cancer are multifactorial, sometimes involving an inherited predisposition to carcinogenic effects of environ- mental factors, which include chemicals, ionizing radiation, and oncogenic viruses [12].

As stated earlier, childhood cancer is a major concern in many countries, and the role of air pollutants in its etiology has become the issue that increasingly attracts researchers. Many ecological analyses describe the epidemiological evidence on childhood leukemia in relation to traffic-induced pollution of air, with particular reference to diesel exhausts, polycyclic aromatic hydrocarbons (PAH) and benzene [15]. The results of studies initiated to explore relationships between traffic-induced pollution of air and development of childhood leukemia (14 year of age or younger) showed that there was a significant exposure-response relationship between exposure to traffic emitted pollutants and a risk of leukemia in kids after controlling for possible confounders. A study of environmental and genetic risk factors of childhood cancers and leukemia underpinned the assessment of the effect of exposure to road traffic exhaust fumes on a risk of occurrence of childhood leukemia. The results obtained also support a hypothesis that living close to heavy traffic roads may increase the risk of childhood leukemia [11]. A 16-year-long follow-up of a cohort of 500,000 Americans living in different cities established the association of air pollutants with lung cancer mortality. It was revealed that carcinogenic volatile organic compounds, too, may be related with increasing cases of lung cancer [17]. Chemical contaminants may disrupt the function of the endocrine system and increase the occurrence rate of stillbirths, birth defects, and hormonally dependent cancers such as breast, testicular, and prostate cancers [20].

The amount of vehicles in Yerevan which has been steadily increasing for the last 20 years generates about 90% of air pollution. The city's relief and climatic conditions favor dispersion of gaseous toxicants. Hazardous air pollutants as was mentioned above cause cancer or other adverse health effects. Vehicle engine exhaust includes ultrafine particles with a large surface area and contains absorbed polycyclic aromatic hydrocarbons, transition metals and other substances. Ultrafine particles and soluble chemicals may be transported from the airways to other organs such as the liver, kidneys, and brain and thus increase a risk of origination of malignant neoformations [18].

Materials and methods. Data on cancer incidence in kids and juveniles (under 35 years) who resided in Yerevan were obtained in 2001 through 2010 from the National Center of Oncology after V.A. Fanarjian HM RA: 1) by results of registration of diagnosed patients in the clinics of Yerevan and the Republic of Armenia, 2) by results of autopsies, 3) by quarterly reports on registered patients and lethalities submitted by oncologists from polyclinics of Yerevan and the Republic of Armenia. As a matter of record, in the end of each calendar year the statistical team implements the alphabetic doubling of lists so as to exclude repetition and prepares annual reports on the incidence rate of malignant neoformations, neglected and disease-induced death cases in the city of Yerevan and the Republic of Armenia (form N61 Ж approved by the order of the RA Minister of Health as of 04.10.04, 1009/20).

Except data provided above, we obtained also the indices of levels of total traffic-induced pollution of Yerevan's air with CO, C_xH_x, NO_x. Data were obtained by a method of calculation (mathanalytical method) using satelite images for calculating traffic load, relevant mathematic methods and softwares [1].

As a geochemical base for detecting correlation between medical indices of oncological diseases in children and juveniles and a level of soil pollution with heavy metals, this research used the results of ecologo-geochemical assessment of the territory of the city of Yerevan obtained at the Center for Ecological-Noosphere Studies NAS RA [8, 13, 19]. Based on the outcomes of geochemical survey of Yerevan's soil cover (following a schematic plan sc.1:10 000, horizon A_1, sampling net – maximally approached to even, by methods developed in IMGRE) [4, 5], a geochemical database has been compiled on heavy metal contents. The ecologo-geochemical assessment of pollution of the city's soils and the assessment of the chemical elements accumulation level were done through collation between factual total and background contents (K_c) of metals [4, 5, 6], which is one of anomalousness criteria. By the value of K_c index, ranked geochemical quailtative and quantitative series were produced covering the soils of the entire territory and separate districts of Yerevan.

For an integral characteristic of poly-element pollution of the territory, a summary concentration index (SCI) was calculated which represents a sum of background-standardized contents of elements in a sample [4, 5, 6].

Employing ArcView software and an IDW (Inverse Distance Weighted) method, by SCI of heavy metals specialized geochemical maps were produced which included a map of Yerevan's soils pollution. To reflect the SCI values distribution all over the city's territory a 5-level gradation scale was used [6].

Through spatial collation between maps of distribution of oncological cases and values of SCI of heavy metal pollution (ArcView 3.2a) a picture was obtained of superposition of the number of cases with diverse-level pollution fields. Also, in pro mille (‰) calculated was the number of oncological cases per separate districts with a goal to analyze those data with regard for relevant ranked geochemical series of heavy metals on the same sites.

Results and Discussion. The goal of investigation was to study correlation between cancer incidence in children and juveniles and indices of air pollution as well as levels of heavy metal pollution of the territory of Yerevan cty. Data on the incidence rate of oncological cases among children and juveniles in Yerevan obtained on a basis of the cancer register of the National Center for Oncology for 2001-2010 are as follows (tabl. 1). They were compared with the data on traffic-induced pollution of the air and geochemical series of heavy metals in soils provided by the Center for Ecological-Noosphere Studies of the NAS RA.

Table 1. The incidence rate of oncological cases in kids and juveniles in the city of Yerevan vs. air pollution levels and geochemical series of soils

№/№	District	Population 2007-2010 (mean)	Number of diseased	‰, distr.	Sum of air pollution	Geochemical series of soils	SCI of soil
1.	Achapniak	107350	75	0.699	0.072	$Ag_{(28.0)}$-Pb,$Mo_{(2.5)}$-$Ni_{(2.3)}$-$Co_{(2.0)}$-$Cu_{(1.7)}$-$Cr_{(1.3)}$-$Zn_{(0.9)}$	41.2
2.	Avan	50775	57	1.123	0.122	$Ag_{(40.0)}$-$Pb_{(3.0)}$-$Ni_{(2.3)}$-$Cr_{(1.8)}$-$Mo_{(1.7)}$-$Cu_{(1.5)}$-$Co_{(1.4)}$-$Zn_{(1.1)}$	52.8
3.	Arabkir	131200	112	0.854	0.077	$Ag_{(26.0)}$-$Pb_{(2.8)}$-$Ni_{(2.3)}$-$Mo_{(2.0)}$-$Co_{(1.8)}$-$Cu_{(1.7)}$-$Cr_{(1.3)}$-$Zn_{(1.1)}$	39.0
4.	Davidashen	40700	34	0.835	0.049	$Ag_{(20.0)}$-$Pb_{(2.5)}$-$Ni_{(2.0)}$-$Mo_{(1.7)}$-$Co_{(1.5)}$-$Cu_{(1.3)}$-$Cr_{(1.0)}$-$Zn_{(0.7)}$	30.7
5.	Erebuni	120500	106	0.880	0.089	$Ag_{(26.0)}$-$Pb_{(4.0)}$-$Ni_{(2.3)}$-$Cu_{(2.0)}$-$Cr_{(1.8)}$-$Mo_{(1.7)}$-Co,$Zn_{(1.3)}$	40.4
6.	Kentron	129950	106	0.816	0.176	$Ag_{(40.0)}$-$Pb_{(4.0)}$-$Ni_{(2.3)}$-$Cu_{(2.0)}$-$Cr_{(1.8)}$-Mo,$Zn_{(1.7)}$-$Co_{(1.5)}$	55.0
7.	Malatia-Sebastia	140925	143	1.015	0.198	$Ag_{(26.0)}$-$Pb_{(2.5)}$-$Ni_{(2.3)}$-$Cr_{(1.8)}$-$Mo_{(1.7)}$-$Cu_{(1.5)}$-$Co_{(1.4)}$-$Zn_{(1.1)}$	38.3
8.	Nor-Nork	144975	115	0.793	0.166	$Ag_{(26.0)}$-$Pb_{(2.8)}$-$Ni_{(2.3)}$-$Cr_{(1.8)}$-$Mo_{(1.7)}$-$Cu_{(1.5)}$-$Co_{(1.4)}$-$Zn_{(1.2)}$	38.7
9.	Nork-Marash	11375	5	0.440	0.169	$Ag_{(40.0)}$-$Pb_{(2.8)}$-$Mo_{(2.5)}$-$Ni_{(2.3)}$-$Co_{(2.0)}$-$Cr_{(1.8)}$-$Cu_{(1.5)}$-$Zn_{(1.3)}$	54.2
10.	Nubarashen	9550	7	0.733	0.097	$Ag_{(40.0)}$-$Ni_{(3.4)}$-$Cr_{(1.8)}$-Mo,$Cu_{(1.7)}$-Zn, $Pb_{(1.0)}$	50.6
11.	Shengavit	144275	130	0.901	0.094	$Ag_{(26.0)}$-$Pb_{(3.3)}$-$Ni_{(2.3)}$-$Cu_{(2.2)}$-$Cr_{(1.8)}$-$Mo_{(1.7)}$-$Co_{(1.3)}$-$Zn_{(1.1)}$	39.7
12.	Kanaker	78575	81	1.031	0.217	$Ag_{(28.0)}$-$Pb_{(4.0)}$-$Ni_{(2.3)}$-Cu,$Cr_{(1.8)}$-$Mo_{(1.7)}$-$Co_{(1.4)}$-$Zn_{(1.3)}$	42.3

Geochemical investigations of Yerevan's soils indicate that natural geochemical association of heavy metals is represented by a weak intensive series: Zn (9.4)-Cu(2.9)-Co(1.8) (in brackets, clark exceeding is given). The results of long-term geochemical surveys of the city's soils indicate that the soils are strongly polluted with heavy metals (Pb, Ag, Cu, Ni, Mo, Zn, Cr, Co) predominantly of man-made origin [8,19]. The average geochemical series calculated for separate districts of Yerevan (tabl. 1) evidence that dominant pollutants in almost all the studied districts are Ag, Pb and Mo.

The research indicated no significant correlations between the incidence rate of oncological diseases in kids and juveniles from 12 districts of Yerevan (‰) and air pollution data (r=0.154, p=0.719) for the same sites. Also, no significant correlations were established between the incidence rate of oncological diseases in kids and juveniles in Yerevan (‰) and relevant geochemical series of soils (Table 2).

Table 2. Correlation between the incidence rate of oncological diseases in kids and juveniles in the city of Yerevan (in ‰) and geochemical series of soils

‰ cases/district	Summary assessment	Ag	Pb	Mo	Ni	Co	Cu	Cr	Zn
	-0,244	-0,247	0,214	-0,714**	-0,066	-0,738**	0,106	0,134	-0,029
P (2-lateral)	0,445	0,438	0,504	0,009	0,838	0,009	0,744	0,678	0,929

** - significance , $p<0.05$

Negative significant correlation between the incidence rate of oncological diseases in children and juveniles in the city of Yerevan (in ‰) and geochemical series of soils was detected only in respect to cobalt and molybdenum.

The results of our research are preliminary because lots of factors such as social, genetic, as well as personal peculiarities which are of great significance for oncological diseases have not been considered so far. However, existing spatially and temporally defined data will serve as a base for further investigations.

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