УДК 613.6

SOME HEALTH INDICES UNDER CONDITIONS OF LEAD CONTAMINATION OF THE ENVIRONMENT AND INDUSTRIAL AREAS

E.A.Babayan, V.Y.Kogan, R.D.Hovhanessian, V.V.Gabuchian, R.A.Burnazian (*Institute of General Hygiene and Occupational Diseases*);
L.A. Saryan (*Aurora Consolidated Laboratories, West Allis, WI, USA*);
R.H. Gurdikian (*Kaiser Engineering, Fairfax, VA, USA*);
A.K.Saghatelian (*Center for Ecological-Noosphere Studies of the NAS RA*);
S. H. Mkrtchian (*Yerevan Medical University*)
2, Koryun str., Yerevan 375025, Republic of Armenia

Key words: lead, pollution, workplase, environment, health condition

Lead, being in the list of the most spread environmental pollutants and having polytropic effect, damages nervous system, the process of hemoglobin synthesis, cardiovascular system, liver and kidneys, induces reproductive disturbances. The problem of lead pollution is urgent worldwide and particularly for highly developed countries.

Lead has been mined and used in Armenia since ancient times. During excavations at the Metsamor metallurgical complex located near Yerevan, which dates to the 3rd and 2nd millenniums BC, several leaded alloys have been discovered. Four of nine different alloy types discovered were found to contain lead; these were lead and copper; a leaded bronze containing copper, tin and lead; a leaded brass containing copper, zinc and lead; and a leaded bronze containing copper, lead, zinc and tin.

In ancient Armenia, lead was used in construction, for the joining of water pipes, as an alloy constituent in coinage, and for the manufacture of ceramics. In ancient and medieval manuscripts, there exist a number of prescription for the compounding of leaded paints and medicines. In the late middle ages lead was used for the manufacture of bullets and for fishing net weights. For centuries, mining complexes in Armenia have been operated where lead or leaded ore was extracted and processed into metal [1].

Accordingly, hygienic issues connected with wide lead usage existed in the past, which today are recognized as serious ecological and hygienic problems [5-8]. Various branches of modern industry, as well as the development of automobile transportation, have resulted in the deposition of large amounts of lead in the human environment. In the past contamination of the environment of Armenia by lead has not received the necessary attention. In order to fill this gap, our joint Armenian and American team initiated research on this issue.

Materials and Methods

Industrial establishments in the cities of Yerevan, Byureghavan, and Gagarinavan were studied, and the environmental contamination in Yerevan and Byureghavan was assessed. Workplace air samples, drinking water, soil, paint samples from dwellings and public buildings, and settled dust samples were obtained and determined for lead content. A series of studies have been carried out in some environmental objects in the earthquake zone of Armenia, too (Spitak, Gyumri, Akhurian).

Blood samples from 143 industrial workers, as well as 252 children and 47 adults from industrial districts were analyzed for blood lead, and if possible for erythrocyte protoporphyrin and hemoglobin. A group of 73 exposed male workers (and 26 controls) were studied for the effect of exposure on gonadotropic hormones, and on 14 male workers the morphology of sperm was examined.

Altogether, 442 blood samples, 110 samples of settled dust taken from dwelling houses (83) and industrial areas (27), 90 samples of paint, 97 samples of atmospheric air, 89 samples from working zone, 89 soil and 21 water samples were analyzed for lead using flame or Zeeman-corrected graphite furnace atomic absorption spectrophotometric methods. Hormone levels were studied using immunoenzymatic methods. Data was statistically analyzed using "T" and chi-square criteria.

Results and Discussion

Lead in atmospheric air

In the 1980s, the lead content of outdoor air in the industrial cities of Armenia - Yerevan, Vanadzor, Alaverdi, Hrazdan, and others - exceeded the Soviet maximum permissible level of 0.3 *mcg/m³* by as much as 4 to 5 times. In 1991-1992, during the economic blockade of Armenia, lead emissions decreased as a result of reduced industrial activity and transportation (table 1).

Table 1

Lead content in atmospheric air

City	Year	Number of samples	Determined (%)	Range (*mcg/m³*)	Average (*mcg/m³*)
Yerevan	1992 1995	72 15	4.17 73.3	0-1 0-1.8	0.4 0.997
Byureghavan	1996	10	40	0.5-0.9	0.72

For example, in 1989 automative emissions amounted to 500,000 tons and the level of lead in air varied from 0.21 to 3.0 *mcg/m³*. By 1992 emissions decreased to 50,000 tons, and lead could be detected in only 4% of the samples collected, at levels mostly of 0.1 to 0.4 *mcg/m³* to a maximum of 1.0 *mcg/m³*. By 1995 industrial and transport activity had increased, resulting in emissions

of 204,000 tons [2]. Lead was then detected in 73.3 % of samples studied and at higher concentrations, averaging about 1.0 *mcg/m³*. In Byureghavan, a lead crystal industry center, lead was detected in 40 % of air samples taken, at levels of 0.5 to 0.89 *mcg/m³*. In the classrooms of a school located 300 meters away from the crystal factory, lead levels in the air were still 0.3 to 1.0 *mcg/m³*.

Samples of settled dust (table 2) taken from the school and nearby buildings at Byureghavan showed significant levels of lead contamination ranging from 115-462 *mcg/m²* in classrooms, 450-600 *mcg/m²* in dormitories, and 357-756 *mcg/m²* in the cafeteria. In homes, surface dust lead content ranged from 385-1300 *mcg/m²*, and a nearby clinic and a store levels in surface dust ranged from 800-1700 *mcg/m²*.

Samples of settled dust taken from homes and public buildings in Yerevan in 1993 showed surface lead level in the range of 150-1100 *mcg/m²*.

Ecological research conducted in Yerevan showed that snow cover was 10 times more contaminated with metals than the underlying soil. The anthropogenic flow of lead to the soil which in 1989 amounted to 114 *kg/km²* had declined to 18 *kg/km²* in 1995, reflecting the considerable decline in industrial and transport activity.

Table 2

Lead contents in the air and settled dust samples taken inside dwelling and public houses

City	Number of samples	Determined	Range (*mcg/m²*)	Average (*mcg/m²*)
Byureghavan				
a) Air	8	8	0.3-1.0	0.8
b) **Settled dust**				
boarding school			115-462	
classrooms	4	4	450-500	420
dining hall	2	2	357-756	475
dormitories	4	4	385-1300	585
dwelling houses	8	8	800-1720	1050
shops, polyclinic	2	2		1260
Yerevan				
Settled dust				
dwelling houses	46	46	150-1100	390
3.The earthquake zone				
Temporary houses				
Gyumry	2	2	220-480	350
Akhurian	4	4	402-685	580
Spitak	8	6	550-690	648
Spitak, school N 1 classrooms	3	3	235-590	368

Drinking water and soil contamination

Determinations of lead in drinking water in 21 samples taken from Yerevan have not revealed contamination of this medium. Drinking water is remarkably free of trace element impurities. Lead in water is undetectable at less than 1 *mcg/l.*

Table 3

Lead content in soil

Soil surface	Number of samples	Range *mg/kg*	Average *mg/kg*
Near highways	9	112-249	182
300-400 *m* far from highways	4	40-50	42.5
At the depth of 20 *cm* near highways	107	90-240	154
300-400 *m* far from highways	50	46-102	66

Studies of the soil lead content of Yerevan and its suburban areas (table 3) showed that lead is present from geologic and anthropogenic sources to varying degrees in all areas tested. Contamination is especially noted near roadways to a depth of 20 *cm*. Nine samples taken from the upper 5 *cm* of soil near the roadways showed 112 to 240 parts per million (*mg/kg*) by weight - exceeding the Soviet maximum permissible level of 20 ppm about 5 to 10 fold. Four samples taken 300 to 400 *m* away from the roadways gave 40 to 50 ppm. Even samples collected at a depth of 20 *cm* were quite high: 100 to 227 ppm near roadways, and 38 to 47 ppm at a distance of 300 to 400 meters away from the roadway.

The Soviet standard is unrealistically low, but the data nevertheless indicates that lead contamination has deposited from transport sources.

Lead in paints

In regulations of the former USSR, which are largely still in force in Armenia, the use of lead in paints intended for residential and public use was either severely restricted or banned. This had a noticeable effect in reducing the environmental hazard associated with lead paint usage. Nevertheless, the presence of some lead in paints continues to be a source of environmental lead contamination.

Table 4 shows the concentration of lead in paint samples taken from many schools, hotels, hospitals and homes in and near Yerevan. Most of these are from older buildings constructed during the Soviet era. 61% of samples contained 0.06 % to 0.5 % Pb by weight, 25 % contained 0.5 to 1 %, and the highest contained 1.22 %, which is quite low in comparison with values found in the United States.

Table 4

Lead contents in the paint from public buildings and dwelling houses

Location and number of samples	Lead %	
Yerevan	Average	Range
Shengavit district schools (12)	0,29	0,01 – 0,73
Center district schools (16)	0,55	0,01 – 1,22
Erebuni district schools (14)	0,54	0,07 – 1,07
Shahumyan district schools (7)	0,25	0,03 – 0,68
Hospitals, polyclinics, hotels, appartaments (15)	0,15	0,01 – 0,53
Gyumri temporary houses (6)	0.53	0.12-1.3
Spitak (16)	0.62	0.17-2.37
Akhurian (4)	0.46	0.22-1.07

In northern Armenia's earthquake zone, however, leaded paint contamination of temporary homes and metal shelters is a problem. These shelters and pre-fabricated houses were installed after the 1988 earthquake and were brought to Armenia from several foreign countries. After ten years the exterior paint on these buildings is in deteriorating condition. The paint used on the exterior of these structures was found to vary in lead content from 0.14–2.372 %, which in some cases exceeds safe levels. Nearby soils were found to contain 725-2900 ppm lead, and lead content of surface dust samples taken within the shelters ranges from 220-690 *mcg/m²*. These constructions are not regularly maintained, and leaded dust from the exterior can be carried indoors. The use of leaded fuel for heating constitutes another source of potential human exposure.

Lead in the working environment

Hygienic studies of three industries have shown that outdated production technology and inadequate methods for environmental contamination control, as well as factors such as raw material and energy supply interruption causing ventilation system breakdowns, have resulted in highly contaminated workplace environments. Lead levels in workplace air and settled dust are extremely high, in some cases exceeding permissible levels by ten to one hundred times or more for air.

Table 5 shows the range of lead concentrations in the working zone air in various industries. These values exceed applicable OSHA* and the former USSR standards – 30 *mcg/m³* – several fold. For comparison, the US OSHA lead standard is 50 *mcg/m³*.

* OSHA - US Occupational Safety and Health Administration.

Table 5 shows the range of lead in settled dust in various types of industries.

Table 5

Lead content in industrial areas

Name of enterprise	Number of samples	Working zone air (*mcg/m³*)	Number of samples	Settled dust (*mcg/m²*)
Crystal production	48	530 – 1860	11	3800 – 415000
Chandelier production	27	350 – 1100	7	756 – 2490
Printing plants	10	10,1 – 13,4	5	156 – 490
Electromechanical production	4	0 –1,1	4	980 – 1840

Health effect of lead

Blood lead levels (BLL) of workers in the most contaminated factories were correspondingly elevated (table 6).

At the Byureghavan Crystal Factory, where the most extreme conditions were found, BLL of production workers were in the range of 15–89 *mcg/dl* with about 21% of workers tested exceeding 60 *mcg/dl.* At the Yerevan electrical chandelier factory, the intensity of lead usage and contamination is lower, and BLL here are correspondingly lower; here, only 2 of 27 production workers had blood leads exceeding 50 *mcg/dl.* Workers in printing factories, where lead is used at a low level, ambient lead levels are realistic and workers blood leads are mostly less than 20 *mcg/dl.* For crystal shops workers with BLL of 40 *mcg/dl* and higher, protoporphirine contents in blood was higher than 80 *mcg/dl* (from 81 to 260 *mcg/dl,* average – 160,9); for those with BLL higher than 60 *mcg/dl* – rotoporphirine contents in blood amounted to 120–529 *mcg/dl* (average – 316 *mcg/dl*). As for haemoglobin, its contents did not exceed permissible levels.

In pollution of the atmosphere with lead as well as with a number of other harmful substances, a great role plays the automobile transport to the direct and lasting occupational action of harmful substances of which, state transport staff are subjected. When in 1989-1991 health condition of these professionals was examined the situation in Yerevan was as follows: in the air of respiratory zone carbon oxide exceeded TLV 4.6–6.2 times, nitrogen dioxide 3.5–4.5 times, that of benzopyren 6.5–9 times and lead – 3.2–4.4 times. The investigations have shown that the morbidity among the trolley-bus drivers followed by temporary disability to work was high (198.1 + 3.9 cases and 1834.9 + 11.8 disability days to work per 100 people). The disease rate of the nervous system and respiratory tract was very high (61 and 70 cases per 100 people respectively). The average duration of one case was 9.4 days. In one of trolley-bus terminals the rate of the general morbidity was far higher – 1992 days per 100 people and one case duration was 10.7 days.

Table. 6

Blood lead levels in workers (*mcg/dl*)

Name of industrial sites	Number of workers	Average	Range	To 20	More than 20 to 40	More than 40 to 60	More than 60
Printing plants	51	11,7±5,25	3-21	50	1	-	-
Crystal smelting	39	43,5±21,4	15-89	3	9	19	8
Chandelier production	13	34,4±12,4	7-53	-	3	9	1
Crystal grinding	14	18,6±3,96	12-27	-	10	4	-
Electromechanical plant	26	10,3±2,3	5-28	10	14	2	-
Control group	47	4,99±1,76	2-22	35	12	-	-

63.8% of 227 policemen of the transport inspection were ill with this or that disease during the year. 27% (62 people) got ill for 4–5 times or even more, because of which 1991 days were idle (31 idle days).

Among the transport policemen morbidity of nervous disturbances and arterial dystonia was very high. Among 131 inspectors examined at the clinic of the Institute of General Hygiene and Occupational Diseases in 20 of them nervous system diseases were revealed, and in 32 of them – arterial hypertension, 35% of the examined suffered from obesity.

The second among the revealed health changes were the diseases of the policemen's respiratory tract, particularly bronchitis. The given data indicate that the health factors of transport inspectors and drivers are quite unsatisfactory, and there is a certain connection between those factors and the environmental pollution.

The same picture pertains to exposed people, particularly children who are most sensitive to the ill effect of lead exposure (table 7):

In Yerevan, where general environmental contamination is mostly the consequence of vehicle emissions, blood leads average 6.5 *mcg/dl* in children with values ranging no higher than 18 *mcg/dl.* In Byureghavan, where environmental contamination can be traced to the presence of the nearby crystal factory, the average blood lead in school children is 10 *mcg/dl* with values ranging up to 22 *mcg/dl*, and almost 4% greater than 20 *mcg/dl.* Haemoglobin content was reduced in the blood of substantial part of children in the background of the lack of protoporphyrines. Lead contents in the blood of adults varied from 7 to 22 *mcg/dl.*

Table 7

Blood lead levels in children (*mcg/dl*)

Index	May 1992 Yerevan	July 1992 Yerevan	August 1992 Yerevan	May 1995 Yerevan	October 1996 Byureghavan
Number of samples	62	44	37	55	54
Average	6,0±0,41	7,8±3,2	6,6±2,4	5,6±2,8	10,0±5,2
Range	1-18	2-17	2-12	2-12	3,1-21,6
<9 *mcg/dl* (%)	22,5	29,5	10,8	10,9	44,4
>20 *mcg/dl* (%)	-	-	-	-	3,7

No disturbances in haemoglobin and protoporphyrine levels were observed. Up to 1991 in lead industry 5 cases of chronic occupational lead poisoning were recorded. After 1991 no chronic poisoning cases were recorded, though during medical examination some biochemical disorders were found.

Gonadotropic hormone levels have been studied in male lead production workers and a group of controls.

Table 8

Content of gonadotropic hormones in blood of workers exposed to lead

Name of enterprise	Number of workers	Hormone				
		Indices	FSH(IU/L)	LH(IU/L)	PRL(MIU/L)	Testosteron (*nmol/l*)
Crystal factory	30	Range	1,12-11,5	1,9-9,4	65-470	10-22,7
		Average	5,54±1,15	5,62±1,3	206±30	17,5±2,2
Chandelier production	17	Range	1,12-6,8	2,3-9,4	65-250	10-22
		Average	4,24±1,79	6,56±2,2	149,7±49,8	16,7±3
Electrome-chanical pro-duction	26	Range	1,61-7,98	2,48-12,8	70-281	12-26
		Average	3,95±2,4	5,58±3,9	141,7±79,81	18,5±5,3
Control group	26	Range	2,08-2,93	6,46-8,7	207-257	19,1-23,4
		Average	2,6±0,33	7,58±0,7	230±16,97	21,4±1,4

The results (Table 8) show that the level of follicle stimulating hormone is elevated in lead workers, and the levels of luteinizing hormone, prolactin and testosterone are reduced, at levels generally corresponding with the intensity of exposure. Preliminary studies show a higher incidence of perinatal mortality in cities affected by lead contamination [3].

As the outcomes of our studies show, such environmental objects as the air of working zones, the atmospheric air, soil, paint, are contaminated with lead;

in a number of cases contamination exceeds many times maximum permissible level and thus threatens human health. Since our studies were mainly carried out in the crisis period when industrial enterprises and motor transport collapsed bringing to reduction of lead contamination level, so the urgency of current situation becomes quite obvious. Even when relatively low contents of lead are detected in the environment, cases of lead higher concentration, harmful for human health, in the blood not only of workers but also children and adults, the change in one of the most principal indices of them synthesis of protoporphyrines level in the blood; disturbances in producing gonadotropic hormones by hypophysis and testicles and spermatogenesis; biochemical disturbances; and at the early stage - the increase in rate of chronic poisoning by lead of workers as well as of perinatal mortality, have been revealed. At present a serious threat of adverse impact of lead upon human health represents the fact that industrial enterprises resume operating at the entire power and the functioning of motor transport has already been completely rehabilitated and thus the volume of lead emissions into the environment is increasing.

The given information makes it urgent to continue studies using newly obtained data on lead contamination level; to develop and put into practice complex measures on the reduction of contamination of environmental objects with lead and, therefore, to prevent the population's health from adverse impact of lead.

It is clear from the above data that Armenia has a lead problem associated with industrial usage of the metal and with vehicular transport. Our findings have pointed to several problem areas, but others need to be identified and investigated, and the effects of lead on the health of the population need to be studied. A preliminary estimate of the adverse economic impact of lead in Armenia has been calculated at $55 million. Taking into account the importance of this question, the problem of environmental lead contamination and reduction of lead usage for gasoline and other purposes in Armenia has been included in the National Environmental Plan funded by the World Bank and Armenian Government [4]. The implementation of the Plan will enable to protect the health of the population and the environment from adverse impact of lead.

Поступила 25.07.99

ԱՌՈՂՋՈՒԹՅԱՆ ՈՐՈՇ ՑՈՒՑԱՆԻՇՆԵՐԸ ՇՐՋԱԿԱ ԵՎ ԱՐՏԱԴՐԱԿԱՆ ՄԻՋԱՎԱՅՐԵՐԻ ԿԱՊԱՐՈՎ ԱՂՏՈՏՄԱՆ ՊԱՅՄԱՆՆԵՐՈՒՄ

Է.Ա.Բաբայան, Ռ.Դ.Հովհաննիսյան, Վ.Վ.Գաբուչյան, Ռ.Ա.Բուռնազյան, Լ.Ա.Սարյան, Ռ.Հ.Գուրզիկյան, Ա.Կ.Սաղաթելյան, Ա.Հ.Սկրտչյան

Ուսումնասիրվել է Հայաստանի որոշ բնակավայրերի շրջակա և արտադրական միջավայրերի աղտոտվածությունը կապարով և նրա ազդեցությունը աճմանց առողջության մի շարք ցուցանիշների վրա: Օդում, նստած փոշու մեջ, հողում, ջրում, ներկերում, ինչպես նաև աղտոտված միջավայրի ազդեցությանը ենթարկված մարդ-

կանց արյան մեջ կապարի պարունակությունը որոշվել է ատոմային աղսորբցիոն սպեկտրոֆոտոմետրիայի միջոցով:

Աղտոտված բնակավայրերում բնակվող 259 երեխաների, 47 մեծահասակների և արտադրություններում կապարի ազդեցությանը ենթարկվող 143 բանվորների արյան անալիզները ցույց տվեցին, որ հետազոտվածների թվում կան խմբեր, որոնց արյան մեջ կապարի պարունակությունը բարձրացած է: Երևանի երեխաների 18.7%-ի մոտ կապարի մակարդակը արյան մեջ գերազանցել է մտավոր զարգացման համար վտանգավոր 10 *մկգ/դլ* սահմանը՝ հասնելով 18 *մկգ/դլ*: Բյուրեղավանում հետազոտված երեխաների 40%-ի մոտ արձանագրվել էր 10 *մկգ/դլ*-ից բարձր, իսկ 3.7%-ի մոտ՝ 20մկգ/դլ-ից բարձր մակարդակ, որը սպառնալից է թունավորումների զարգացման հնարավորության տեսակետից: Հեմոգլոբինի պարունակությունը ֆիզիոլոգիական նորմայի սահմաններում է եղել (ավելի մոտ ստորին սահմաններին), իսկ պրոտոպորֆիրինների քանակը չի անցել վտանգավոր սահմանը: Բյուրեղավանի բանվորների մոտ, կապարի պարունակությունը տատանվել է 15-89 *մկգ/դլ*, ընդ որում 21%-ի մոտ կապարը գերազանցել է թունավորման տեսակետից վտանգավոր 60մկգ/դլ սահմանը:

Բյուրեղապակյա ջահերի արտադրության բանվորների մեծամասնության մոտ արյան մեջ կապարի պարունակությունը գերազանցել է անվտանգ 40*մկգ/դլ*, իսկ առանձին բանվորների մոտ՝ 50 *մկգ/դլ* սահմանը: Կապարի 40 *մկգ/դլ*-ից բարձր պարունակության դեպքում պրոտոպորֆիրինների քանակը գերազանցել է 80 *մկգ/դլ* սահմանը, հասնելով մինչև 529 *մկգ/դլ*: Արյան մեջ գոնադոտրոպ հորմոնների (պրոլակտին, ֆոլիկուլոստիմուլացնող և լյուտեինիզացնող հորմոններ, տեստոստերոն) որոշումը հայտնաբերեց մի շարք փոփոխություններ, որոնք վկայում են հորմոնալ պրոցեսների որոշակի խանգարման մասին:

Բերված տվյալները վկայում են, որ Հայաստանում շրջակա արտադրական միջավայրի կապարով աղտոտումը պետք է անհանգստացնի հիգիենիստներին և բնապահպանության խնդիրներով զբաղվող մասնագետներին, քանի որ առկա են բնակչության տարբեր խմբերի մոտ առողջության ցուցանիշների լուրջ շեղումներ:

НЕКОТОРЫЕ ПОКАЗАТЕЛИ ЗДОРОВЬЯ В УСЛОВИЯХ ЗАГРЯЗНЕННОЙ СВИНЦОМ ОКРУЖАЮЩЕЙ И ПРОИЗВОДСТВЕННОЙ СРЕДЫ

Э.А.Бабаян, Коган В.Ю., Р.Д.Ованесян, В.В.Габучян,
Р.А.Бурназян, Л.А.Сарьян, Р.Г.Гурдикян,
А.К.Сагателян, С.Г.Мкртчян

Целью настоящей работы являлось изучение загрязненности свинцом окружающей и производственной среды в некоторых населенных пунктах Армении и выявление нарушений со стороны ряда показателей здоровья лиц, подвергающихся воздействию этого загрязнителя. С помощью атомной абсорбционной спектрофотометрии установлено, что во многих пробах атмосферного воздуха, пыли, осевшей на поверхности жилых и общественных зданий, почвы и соскобов краски, а также в крови жителей содержание свинца превышает допустимые гигиенические нормы. Анализ крови 259 детей, 47 взрослых, проживающих в загрязненных районах, и 143 рабочих предприятий, использующих свинец, выявил наличие этого металла в крови. У 18.7 % детей г.Еревана уровень свинца превышал безопасную для умственного развития норму – 10 *мкг/дл*, достигая 18 *мкг/дл*. В Бюрегаване же у 40% обследованных детей уровень

свинца превышал вышеуказанный, а у 3.7% обследованных является угрожающим с точки зрения развития свинцовой интоксикации. У детей уровень гемоглобина был в пределах физиологической нормы (ближе к нижней границе), протопорфиринов не превышал опасного предела. У рабочих (Бюрегаван), подвергающихся профессиональному воздействию свинца, уровень в крови колебался в пределах 15—89 *мкг/дл*, причем у 21% обследованных он превышал 60 *мкг/дл*. У большинства рабочих производства хрустальных люстр содержание свинца превышало безопасный уровень (40—50 *мкг/дл*). Содержание же в крови протопорфиринов превышало 80 *мкг/дл*, достигая 529 *мкг/дл*.

Исследование содержания в крови гонадотропных гормонов (пролактин, фолликулостимулирующий и лютенизирующий гормоны, тестостерон) выявило ряд изменений, свидетельствующих о развитии серьезных нарушений.

Приведенные данные свидетельствуют о необходимости проведения дальнейших исследований в этом направлении.

LITERATURE

1. The Armenian Soviet Encyclopaedia, Yerevan - 1979, vol.5, p.250.
2. *Saghatelyan A.K., Kyureghyan T.N.* Snow cover contamination with heavy metals. In Environmental contamination with heavy metals, Yerevan, 1996, p. 83.
3. *Saghatelyan A.K., Koukoulian M.A., Khachatrian T.S.* Risk assessment of perinatal mortality under conditions of environmental contamination with heavy metals. In: Environmental contamination with heavy metals. Yerevan, 1996, p. 105.
4. National Environmental Action Plan. Report of the working group "Environment and Health", 1-st Stage, Yerevan, 1997.
5. *Babayan E.A., Saryan L., Hovhanesyan R.D.* J. Medical Science of Armenia, XXXV, 1-2 p.103.
6. *Babayan E.A., Saryan L.A., Amiryan L.A.* Occupational Blood Lead Survey. Morbidity and Mortality Weekly Reports, USA CDC and Prevention , Atlanta, 1996, .4, 10, p.14.
7. *Babayan E.A., Alexandrian A.V., Hairian A.P., Heinen S.,van Rijckevorsel L.* Public Health Division TNO Prevention and Health. Report, Leiden, Netherlands, 1998, p.117.
8. *Babayan E.A., Saryan L.A.* Lead Exposure in the Armenian Republic. The 6th Armenian Medical World Congress, 1995, Boston, MA, Abstracts, p.13.