THE ESTIMATION OF THE IMPACT UPON THE HEALTH OF PEOPLE LIVING IN THE VICINITY OF A LEAD POLLUTING INDUSTRIAL AREA. STUDY ON ADULTS

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Abstract. Existing medical literature offers extensive data on the effects in humans exposed to lead. It is in this context that we undertook an observational study aiming at: (1)the biochemical, hematological and biotoxicological changes in a group of subjects living in Pantelimon village, an area exposed to lead, assessing the results by correlation to 2 control groups: subjects with occupational exposure to lead and subjects which are not occupationally exposed to lead and do not live in Pantelimon village; (2)correlations between results of the quantitative analysis of soil lead levels and the biotoxicological results in the group of subjects living in Pantelimon village; (3)issues concerning study group subjects' health condition.

The main results of this study show: (1)significant changes in the biotoxicological aspects of Pantelimon residents (BLL, DAL and FEP); (2)the quantitative analysis of soil lead shows levels above the alert threshold for susceptible areas (populated areas); (3)occurrence of chronic diseases in the study group (cardiovascular, digestive, rheumatic, respiratory, etc.) does not differ significantly from the general prevalence of chronic conditions in young urban population (according to estimates released by the Ministry of Health). The present study results must be regarded as the starting point for conducting future studies aimed at exposing the long term effects of lead pollution in the general population.

Key words: lead pollution-alert threshold-general population-health condition- biotoxicological aspects.

Existing medical literature (WHO, 2000; Xintaras, 1992) offers extensive data on the effects in humans exposed to lead. It is in this context that we undertook the study of the biochemical, hematological and biotoxicological changes in a group of subjects living in Pantelimon village, an area exposed to lead, assessing the results by correlation to 2 control groups.

SELECTION OF STUDY LOCATION

The criteria for selecting the location of the study group are the following:

- the existence of a lead or lead based compounds polluting agent such as a plant, located in the vicinity of this community.
- long term exposure of the community to low quantities of lead due to the ongoing toxic effect of lead emissions (through soil, water and vegetation contamination).

SELECTION OF SUBJECT GROUPS

- **the study group** from the resident population of Pantelimon village is representative for the population in the 25-45 years old age group, both male and female. The results are 95%±3% accurate.
- The database used for the selection of subjects was comprised of medical lists provided by the general practitioners assigned to the aforementioned population. The structure of the study group is shown in Table 1.
- **the first control group** comprises only male subjects with occupational exposure to lead and lead compounds (the gender bias in this selection group is due to the fact that this is a typically male field of work).
- **the second control group**, having the same age and sex structure as the study group, comprises unexposed population (the subjects are not occupationally exposed to lead and do not live in Pantelimon village). The method used for selection was that of pairs.

NB: *The group sizes were limited by the costs of lab investigations.*

Table 1 Study group by age and sex

Age yrs.	M	F	Total
25-30	5	12	17
31-35	7	6	13
36-40	4	2	6
41-45	1	1	2
Total	**17**	**21**	**38**

DATA COLLECTION

The medical data is structured along 5 chapters:

a) Subject's personal data:
- sex
- age
- occupation
- personal and family medical history

b) Subject's daily habits:
- smoking/non-smoking
- alcohol intake
- eating habits
- other

c) Exposure to lead and lead compounds

d) Clinical investigation: signs and symptoms that can be related to lead exposure.

e) Laboratory investigation

During the first stage, we conducted:
- study group interviews;

interviews for control group 1 and 2.

During the second stage:
- we analyzed the lab results (hematological, biochemical and biotoxicological).

For all study groups, the lab exams were performed in the same certified laboratory.

During the third stage:
- we had 22 soil samples collected from a depth of 10 cm, from 8 different sites in Pantelimon village.
- we subjected the samples to a quantitative analysis in IMNR labs.

EPIINFO software was used both for the creation of the database and its management from the point of view of statistical assessment.

RESULTS AND DISCUSSION TOPICS

The main results refer to biotoxicological aspects correlated with the degree of lead contamination of the soil.

Biotoxicological results

The biotoxicological results for the 3 groups were interpreted by being measured against the normal values considered in the general population (Zenz *et al.,* 1994;Marsh *et al.,* 1983; Tadashi, 2000; O.M. no.1727/20.12.2006).

Blood lead level (BLL)

In what concerns the BLL, the results were compared to the 20µg/100ml considered to be the normal value in the general population. (O.M. no. 1727/20.12.2006)
- in the study group - 34 out of 38 subjects, totaling 89.5 %, had higher than normal BLL values; 19 subjects (50 %) had high BLL values ranging from 31 up to 40µg/100ml (Fig 1).
- control group 1 - 40 out of 40 subjects (100%) had higher than normal BLL values; 29 subjects (72.5%) had BLL values over 41 µg/100ml.
- control group 2 -19 out of 28 subjects (67.9 %) had higher than normal BLL values; 15 subjects (53.6 %) had BLL values between 21- 30µg/100ml.

The contrasting frequencies of subjects with BLL >20 µg/100ml, as shown by the study group and control group 2, are statistically significant ($p<0.001$) (Table 2).

The modal value of subjects with increased BLL for the study group diverge significantly from the values considered to be normal in the general population, as opposed to the values obtained from control group 2 (Fig. 2).

The BLL distribution curve displayed by the study group shifts more to the right (BLL values diverging from the values considered to be normal in general population), than the distribution curve displayed by control group 2.

Concerning the BLL's average values of both the study group and control group 2, the differences are statistically significant ($p<0.001$). The average value for the study group was 34 as opposed to only 24 for control group 2. We also emphasize that the BLL values of both the study group and control group 2 exceed the normal values considered in the general population (Table 3).

Deltaaminolevulinic acid (DAL)

DAL values were compared with the value ≤ 5 mg/l, considered to be normal in the general population.

They were found to have DAL values higher than normal:
- in the study group – 32 out of 38 subjects (84.2 %) (Fig. 3).
- in control group 1- 38 out of 40 subjects (95 %)
- in control group 2- 14 out of 28 subjects (50 %) (Table 4).

The contrasting frequencies of the subjects with DAL > 5 mg/l as shown by the study group and control group 2, are statistically significant ($p<0.001$).

The DAL level distribution curve displayed by the study group shifts more markedly to the right (DAL values diverg-

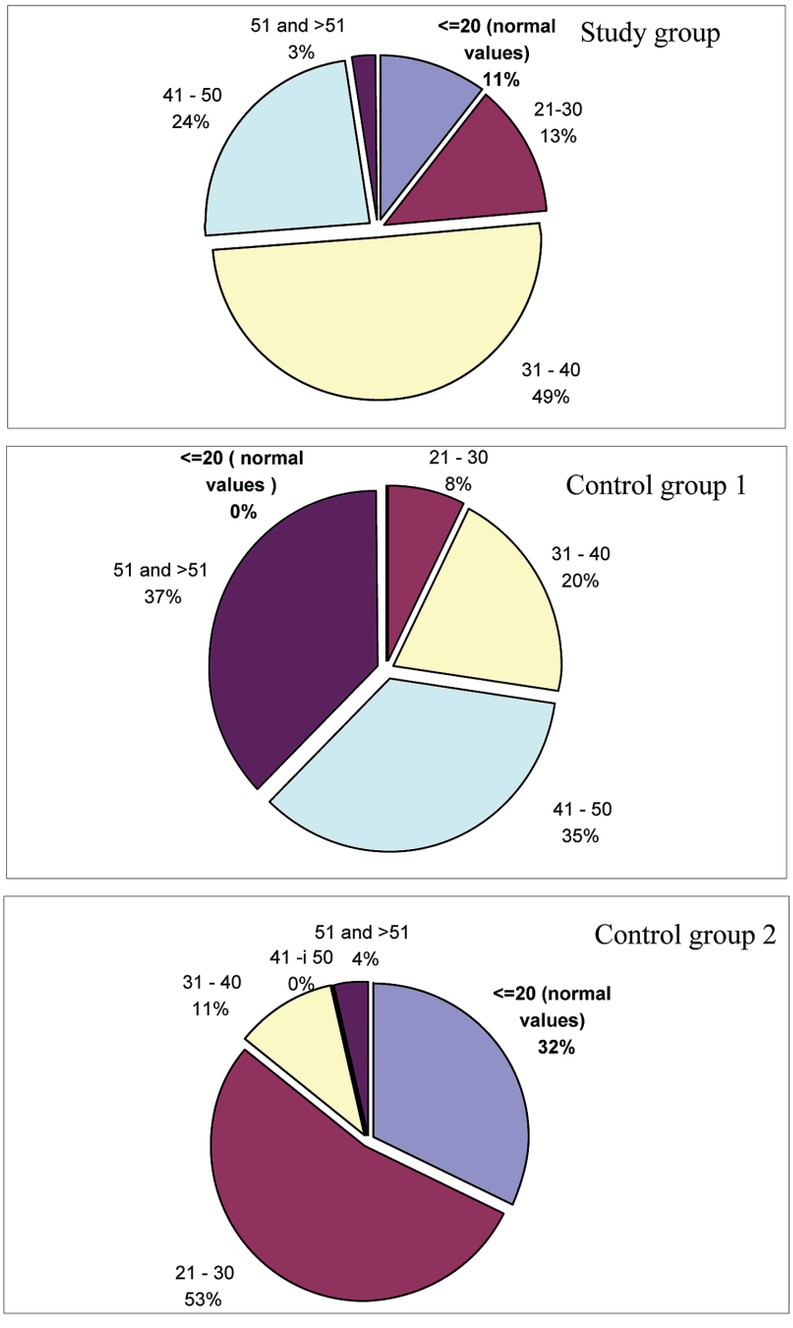

Fig. 1 Groups distribution by blood lead level

Table 2 Groups distribution by blood lead levels

Blood lead level	Study group		Control group 1		Control group 2	
	No.	%	No.	%	No.	%
≤ 20 (normal)	**4**	**10,5**	**0**	**0,0**	**9**	**32,1**
21-30	5	13,2	3	7,5	15	53,6
31-40	19	50,0	8	20,0	3	10,7
41-50	9	23,7	14	35,0	0	0,0
≥ 51	1	2,6	15	37,5	1	3,6
Total	**38**	**100,0**	**40**	**100,0**	**28**	**100,0**

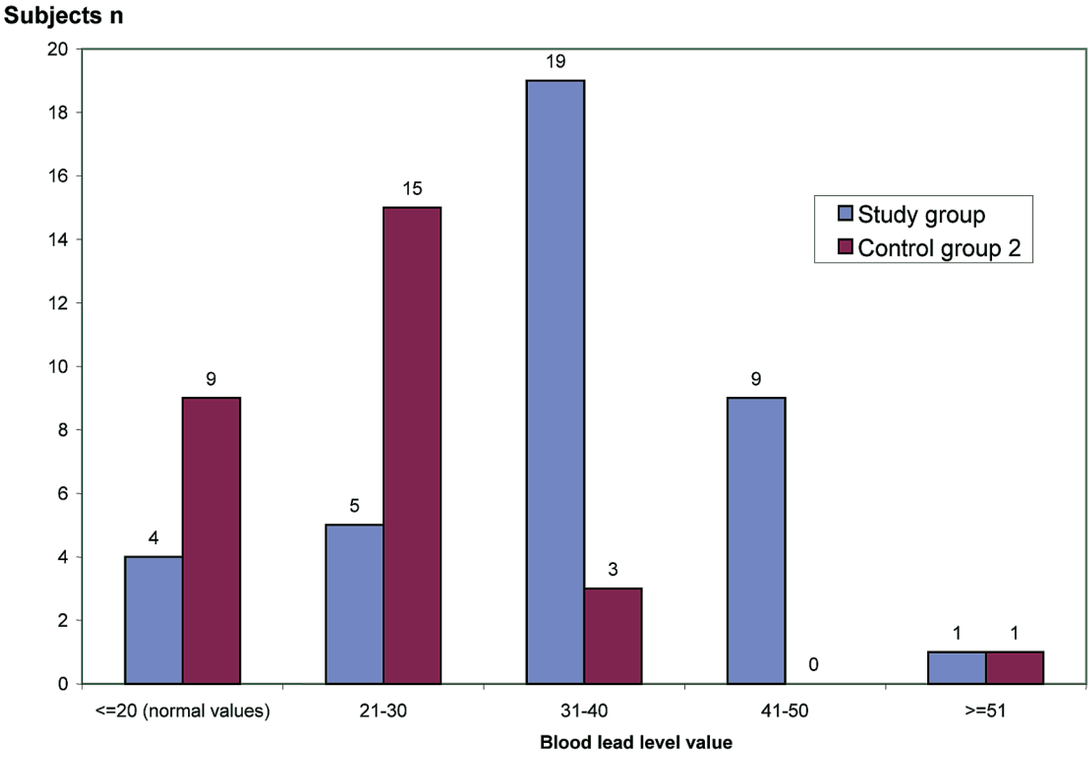

Fig. 2 Study group and control group by blood lead level

Table 3 Statistical analysis of biological average values in study group and control group 2

Variable	Study group				Control group 2				Statistical test	p-value
	Min.	Max.	Average	Std. Dev.	Min.	Max.	Average	Std. Dev.		
blood lead level	8	54	**34,63**	10,07	10	55	**24,36**	9,27	4,23	p<0,001
free erythrocyte protoporphyrin	28	122	**83,45**	25,39	25	126	**44,04**	20,43	6,76	p<0,001
delta-aminolevulinic acid	2	13	**7,76**	2,79	1	66	**9,00**	12,77	-0,58	"NS"
sideremia	32	162	**76,58**	28,76	45	153	**102,07**	31,01	-3,44	p<0,01
creatinine	0,5	1,6	**0,86**	0,20	0,5	1,3	**0,83**	0,20	0,62	"NS"
uric acid	2,5	6,9	**5,22**	1,18	3,0	7,6	**5,73**	0,96	-1,85	"NS"
hemoglobine	11,8	16,8	**14,29**	1,33	11,4	16,7	**13,92**	1,55	0,90	"NS"

ing from the values considered to be normal in the general population), than the distribution curve displayed by control group 2 (depending on the same parameter) (Fig. 4).

In what concerns the average values of DAL level in the study group and control group 2, the differences are not statistically significant (Table 3).

Free erythrocyte protoporphyrin (FEP)

The FEP values were compared with the value ≤ 80 µg/100 l, considered to be normal in the general population.

They were found to have FEP values higher than normal:

- in the study group – 23 out of 38 subjects (60.5 %) (Fig. 5).
- in control group 1- 40 out of 40 subjects (100 %)
- in control group 2 - 1 out of 28 subjects (3.6 %).

In one subject from control group 2 increased values of the BLL, FEP and DAL have been linked to the intake of improperly distilled plum liquor.

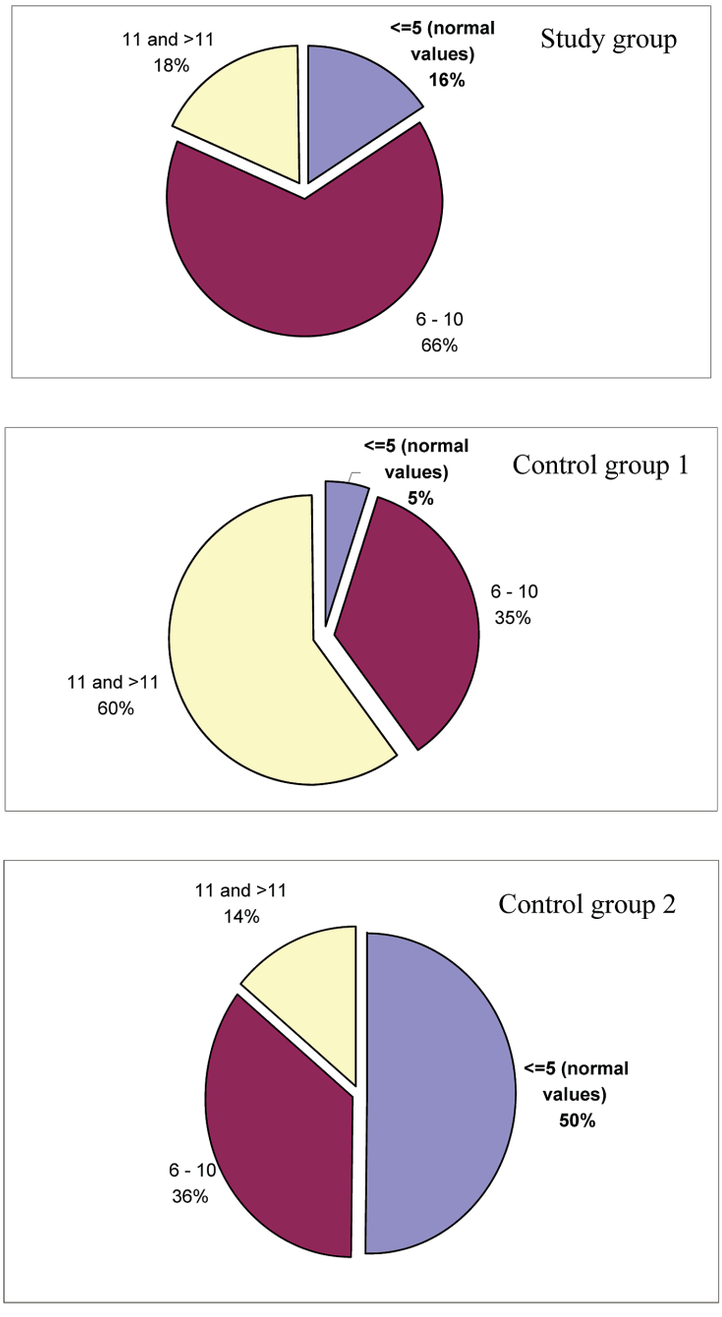

Fig. 3 Groups distribution by delta-aminolevulinic acid

Table 4 Groups distribution by delta-aminolevulinic acid

Delta-aminolevulinic acid	Study group		Control group 1		Control group 2	
	No.	%	No.	%	No.	%
≤ 5 (normal)	**6**	**15,8**	**2**	**5,0**	**14**	**50,0**
6 –10	25	65,8	14	35,0	10	35,7
≥ 11	7	18,4	24	60,0	4	14,3
Total	**38**	**100,0**	**40**	**100,0**	**28**	**100,0**

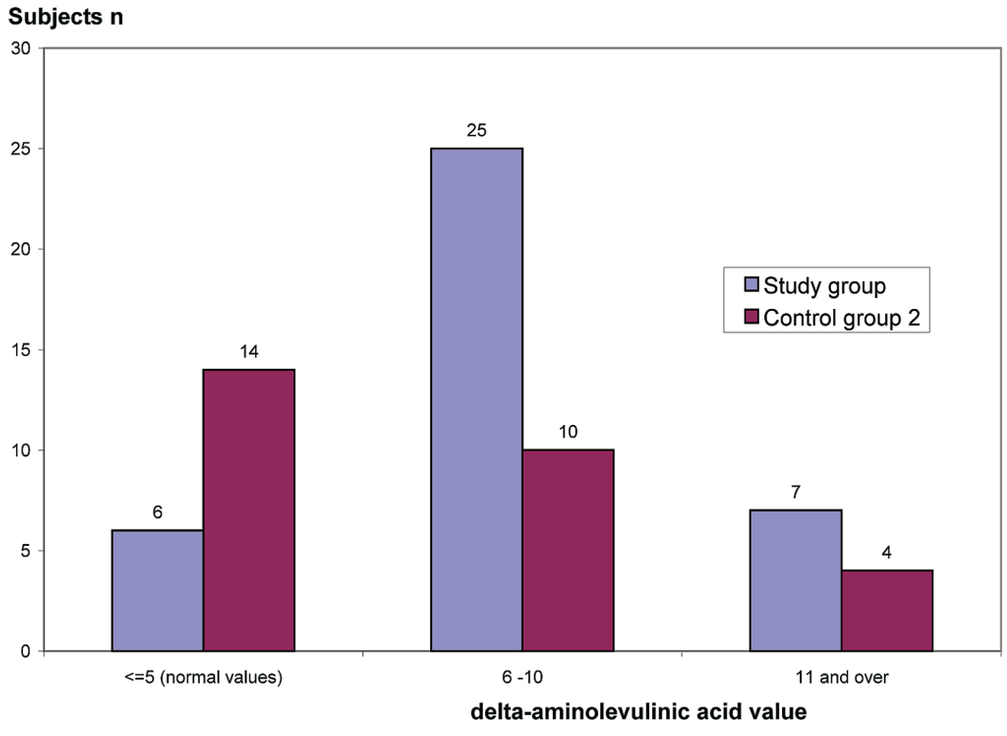

Fig. 4 Study group and control group by delta-aminolevulinic acid

The contrasting frequencies of the subjects with FEP>80µg/100ml as shown by the study group and control group 2, are statistically significant (p<0.001) (**Table 5**).

Statistically, the average value of FEP for the study group is significantly higher than the established value of control group 2 (p<0.001) (Table 3).

The differences between the biotoxicological results for the study group (residents of Pantelimon village) and for control group 2 (not residing in Pantelimon village), may be explained by the historical pollution of the environment (sustained by increased soil lead levels) and by the fact that lead stays in the surface layer for long periods of time.

RESULTS OF THE QUANTITATIVE ANALYSIS OF SOIL LEAD LEVELS

The quantitative analysis of soil lead levels has been carried out on all 22 soil samples collected from 8 separate locations in Pantelimon village and has shown lead levels above the alert threshold for susceptible areas (>50mg/kg soil) in all of the 22 samples. (O.M. no.756/03.11.1997) 19 samples had values above the intervention threshold for susceptible areas (>100 mg/kg soil) (**Table 6**).

Concerning the results of the comparative analysis of soil lead levels and the BLL values in the study group, we highlight the following:

- the northern area : 10 out of 10 subjects had BLL values above the normal level in the general population. These results are linked to increased levels of soil lead that exceed both the alert threshold and the intervention threshold for susceptible areas (populated areas).
- the southern area: 3 out of 4 subjects had increased BLL. These results are linked to levels of soil lead above the alert threshold in 3 soil samples and levels above the intervention threshold for susceptible areas in 2 soil samples.
- the eastern area: 5 out of 5 subjects had increased BLL. These results are linked to increased levels of soil lead that exceed both the alert threshold and the intervention threshold for susceptible areas in all 5 samples.
- the western area: 7 out of 9 subjects had increased BLL, 2 of which had suggestive values for chronic (non-occupational) lead intoxication (BLL > 40µg/100ml and FEP >100µg/100ml).These results are linked to soil lead levels exceeding the alert threshold in 8 out of 8 soil samples and above the intervention threshold in 6 soil samples.
- the central area: 8 out of 9 subjects had increased BLL. The results are linked to soil lead levels above the alert threshold.

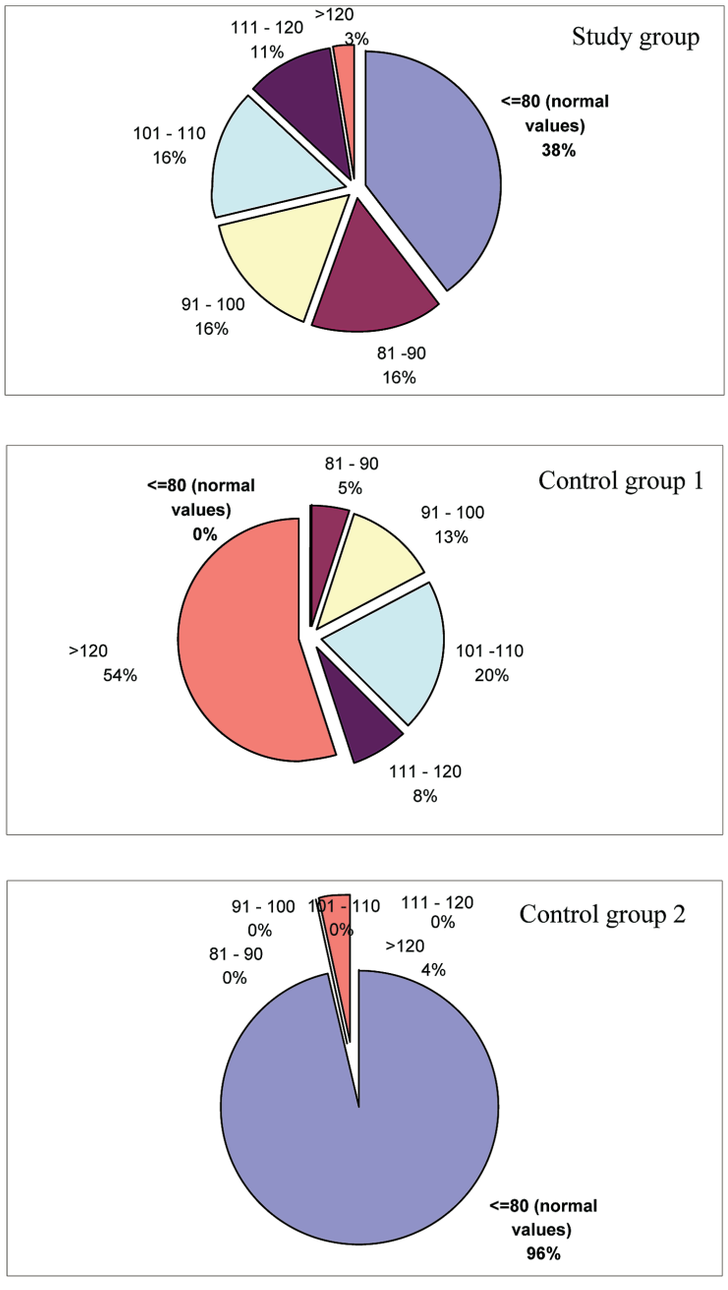

Fig. 5 Groups distribution by free erythrocyte protoporphyrin

Table 5 Groups distribution by free erythrocyte protoporphyrin

Free erythrocyte protoporphyrin	Study group		Control group 1		Control group 2	
	No.	%	No.	%	No.	%
≤ 80 (normal)	**15**	**39,5**	**0**	**0,0**	**27**	**96,4**
81 – 90	6	15,8	2	5,0	0	0,0
91 – 100	6	15,8	5	12,5	0	0,0
101 – 110	6	15,8	8	20,0	0	0,0
111-120	4	10,5	3	7,5	0	0,0
≥ 121	1	2,6	22	55,0	1	3,6
Total	**38**	**100,0**	**40**	**100,0**	**28**	**100,0**

Comments

The highest soil lead levels were detected in the western area (located farthest from the industrial area).

Table 6 Quantitative analysis of lead in soil

Soil sample	Measure unit	Lead
P1	mg/kg	405
P2	mg/kg	145
P3	mg/kg	140
P4	mg/kg	102
P5	mg/kg	154
P6	mg/kg	88
P7	mg/kg	292
P8	mg/kg	165
P9	mg/kg	324
P10	mg/kg	101
P11	mg/kg	1323
P12	mg/kg	660
P13	mg/kg	97
P14	mg/kg	600
P15	mg/kg	96
P16	mg/kg	130
P17	mg/kg	147
P18	mg/kg	116
P19	mg/kg	188
P20	mg/kg	275
P21	mg/kg	105
P22	mg/kg	217

The P1 and P7 samples, with high levels of soil lead, namely 405 and 292mg/ 1kg soil respectively, were collected from the eastern area, located in close vicinity of the industrial area. There were no subjects selected from this location for the study group.

The increased biotoxicological values recorded in the study group subjects are in direct relation with increased levels of soil lead.

ISSUES CONCERNING STUDY GROUP SUBJECTS' HEALTH CONDITION

Additional data on chronic diseases (cardiovascular, digestive, rheumatic, respiratory, etc.) of the study group subjects was collected through interviews and medical records.

The occurrence of chronic diseases for the study group, namely 50 diagnosed chronic conditions for every 100 examined individuals, does not exceed the prevalence of chronic diseases in urban environments (for young adults) according to the estimates released by the Ministry of Health in 1997 following its general health assessment of the population (Table 7).

Table 7 Chronic diseases in study group

Chronic diseases	Number of cases
cardiovascular diseases	5
digestive diseases	3
rheumatic diseases	2
respiratory diseases	2
other	6

CONCLUSIONS

1. This paper presents the results obtained by conducting an observational study aimed at identifying the health effects of environmental lead pollution in Pantelimon residents.

2. We used 3 groups – the study group (selected from the resident population of Pantelimon village) and 2 control groups: control group 1 (selected from professionals with occupational exposure to lead) and control group 2 (subjects that are not occupationally exposed to lead and do not live in Pantelimon village).

3. The health impact was assessed by means of biotoxicological investigation, interviews regarding personal and family medical history, daily habits, general symptomatology and clinical examination.

4. Local soil testing for lead was carried out in order to highlight any possible correlations.

5. EPIINFO software was used for the statistical management of gathered data.

6. The main results show:

- significant changes in the biotoxicological aspects of Pantelimon residents (BLL, DAL and FEP).
- statistically, the number of individuals that exceed the normal values in the general population and the average values is significantly higher than that of control group 2. Control group 2 also displays BLL values exceeding the normal BLL values in the general population. Consequently, we must infer that all urban environments have lead pollution due to multiple sources (lead based gasoline).
- the quantitative analysis of soil lead shows levels above the alert threshold for susceptible areas (populated areas).

- occurrence of chronic diseases in the study group (cardiovascular, digestive, rheumatic, respiratory, etc.) does not differ significantly from the general prevalence of chronic conditions in young urban population (according to estimates released by the Ministry of Health).

RECOMMENDATIONS

1. The authorities must be informed of the study results.

2. Use the present study results as the starting point for conducting future studies aimed at exposing the long term effects of lead pollution in the general population.

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