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Delta aminolevulinic acid urinary excretion in rural region inhabitants

Lead compounds add to the most widespread contamination of human natural environment. This refers not only to the highly industrialised regions. Emission of great amount of vapour and gas containing harmful substances causes those compounds to be transmitted at long distances, which is the reason for their common presence not only in the vicinity of the emittors (1,8).

Lead compounds are absorbed by the human body mainly through the respiratory tract and alimentary canal, and along with blood they are transported to various tissues and organs (12). The toxic influence of lead refers to the central and peripheral nervous system, the bone marrow, kidneys and other organs (10,14). Lead poisoning is more frequently the result of constant exposure to small amounts of lead rather than a single and large consumption (2,7). Lead is enzymatic poison combining with sulphydrylic polipeptides groups selectively, mainly with metaloenzymes that are present in many stages of hem synthesis. Lead derivatives react mainly on the level of delta aminolevulinic dehydrogenase and heme synthesis (13). The excess of indirect metabolite of that reaction remaining in blood is excreted along with urine and it may be the marker of chronic lead intoxication (5). The purpose of the work was to estimate to what extent the inhabitants of a typical rural region, distant from the source of emission of environmental contamination, are exposed to the influence of lead compounds.

MATERIAL AND METHODS

132 people at the age of 9 to 74 (54 men and 78 women), the inhabitants of a village Majdan Nowy in the Lublin Province were included in the research. The village is situated at the edge of the Roztocze region. This is a typically agricultural region where tourism is dynamically expanding and the degree of industrialisation is low. Most of the examined have lived in this region since birth and showed the same hygienic and feeding habits.

The examined were divided into 4 age groups: group I – up to 18 years old – 38 people (15 boys and 23 girls), group II – from 19 to 40 years old – 42 people (17 men and 25 women), group III – from 41 to 60 years old – 35 people (14 men and 21 women), group IV – above 60 years old – 17 people (8 men and 9 women).

The urine for the examination was taken from the first morning portion to plastic, sterile containers. Concentration of delta aminolevulinic acid (ALA) was measured by means of G r a b e c k i and partners method, with the use of acetylacetone, acetate buffor with pH 4.7 and modified Erlich's reagent (6). The urinary creatinine concentrations were determined by Folin spectrophotometric technique using picric acid. Urinary ALA excretion was expressed in mg/1g of creatinine (urinary ALA creatinine ratio).

The results were described statistically by means of Student's t-tests.

RESULTS

Table 1 exemplifies the results of the research:

Table 1. Urinary ALA excretion in people living in the rural region

Group		Mean value (mg ALA/1 g creatinine)	Min-max values	SD
I (9 – 18 years old)	males	9.24	5.00 – 16.20	2.79
	females	6.02	3.90 – 8.90	1.37
	total	7.29	3.90 – 16.20	2.57
II (19 – 40 years old)	males	8.92	5.20 –18.30	3.02
	females	5.58	3.10 – 7.70	1.30
	total	6.92	3.10 – 18.30	2.70
III (41 – 60 years old)	males	8.86	5.20 – 13.10	2.34
	females	6.08	4.20 – 8.30	1.09
	total	7.19	4.20 – 13.10	2.17
IV (>60 years old)	males	8.65	6.90 – 11.90	1.82
	females	5.70	2.90 – 8.10	1.92
	total	6.88	2.90 – 11.90	2.35
Differences significance		Males : Females $p< 0.001$ I : II : III : IV - NS		

Among the examined, ALA excretion was within the limits of 2.9 – 18.3 mg ALA/1g of creatinine. The average value of ALA/creatinine ratio, among all age groups, remained at the significantly higher level in relation to the values regarded as the norm on the basis of specialist literature. The biggest excretion of ALA was observed in group I (7.29 mg ALA/1 g of creatinine) whereas the smallest was observed in group IV (6.88 mgALA/1 g of creatinine). No statistically significant differences in the quantity of ALA/creatinine ratio among the examined groups were stated ($p>0.05$). In each age group men showed significantly ($p<0.001$) higher level of ALA excretion than women.

DISCUSSION

According to many authors' opinion ALA concentration in urine may be quite a sensitive marker of chronic lead intoxication. Higher ALA concentration in urine correlates well with lead concentration in blood and may be useful to monitor the extent of poisoning (4,5,8,11). Estimation of ALA excretion along with urine as a simple and non-invasive method is fit for screening examination on a large scale. It also allows to separate groups of special risk requiring careful clinical observation and detailed medical examination.

In the carried out research it was stated that ALA excretion of the inhabitants of Majdan Nowy remained at the higher level in relation to the values accepted as the norm on the basis of specialist literature (3). This fact may prove lead intoxication of the inhabitants of that region. Despite the lack of industrial plants in the neighbourhood, the escalation of road traffic, connected with dynamic expansion of tourism in this region, may be the source of environmental contamination with lead compounds. The neighbourhood of arable fields and pastures in the vicinity of transport arteries may be of primary importance. However, in the last few years in many countries, including Poland, the content of lead in agricultural products significantly decreased, which is, first of all, the result of more and more common usage of free-lead petrol (15). It should be emphasised, however, that lead is neither biodegradable nor undergoes decay. Therefore, soil and dust are the significant source of risk, especially for children. As the research carried out in the USA showed, about 4-5 million tons of lead coming from that source still remains in soil although free-lead petrol was introduced in the 1970s (8).

In accordance with the results of other authors, in the carried out research the significantly higher value of ALA/creatinine ratio was observed in men's urine in relation to women's. It may be connected with physical activity that is generally more intensive in case of men, which contributes to greater absorption of xenobiotics, mainly through the respiratory tract (9).

In the present research no statistically significant differences among the examined groups in different age ranges were observed. However, ALA/creatinine ratio reached the highest value among the youngest inhabitants of Majdan Nowy and the lowest among people who were above 60 years old. It may be connected with various intensification of physical activity in those age ranges (7, 9, 11). It was also proved that among adults only 10% of lead taken in through the alimentary canal is absorbed into blood circulation. Among babies and younger children absorption from the alimentary canal is much greater and it may be up to 50% of the absorbed lead (7, 10). The influence of diet should be emphasised. Calcium and phosphates included in food lower absorption of lead from alimentary canal. Ascorbic acid and citric acid have the opposite effect. The shortage of iron also intensifies absorption of lead from the alimentary canal. This fact may mean that in the situation of the same exposure to toxic influence of lead compounds different answers can be given.

CONCLUSIONS

1. The inhabitants of Majdan Nowy show raised ALA excretion along with urine, which may be the indicator of chronic lead intoxication.
2. ALA excretion along with urine is higher in men.
3. Marking ALA excretion along with urine may be a simple screening examination classifying for further stages of diagnostic-therapeutic action.

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SUMMARY

The purpose of the work was to estimate to what extent the inhabitants of a typical agricultural region are exposed to the influence of lead compounds. 132 people at the age of 9 to 74 were included in the research. Urinary delta aminolevulinic acid (ALA) excretion was determined. The highest excretion of ALA was observed among the examined who were up to 18 years old, while the lowest was among those who were above 60 years old. These differences, however, were not statistically significant.

Wydalanie kwasu delta-aminolewulinowego u mieszkańców regionu rolniczego

Wydalanie kwasu delta aminolewulinowego (ALA) z moczem jest uznanym markerem przewlekłej intoksykacji ołowiowej. Celem pracy była ocena narażenia na oddziaływanie związków ołowiu u mieszkańców regionu typowo rolniczego. Badaniami objęto 132 osoby w wieku od 9 do 74 lat, mieszkańców wsi Majdan Nowy. Badanych podzielono na 4 grupy wiekowe : I. Do 18 roku życia – 38 osób. II. Od 19 – 40 roku życia – 42 osoby. III. Od 41 do 60 roku życia – 35 osób. IV. Powyżej 60 roku życia – 17 osób. W pierwszej rannej porcji moczu badanych oznaczano stężenie ALA metodą Grabeckiego i wsp., które przeliczano na jednostkowe stężenie kreatyniny. Wartości wskaźnika ALA/ kreatynina wahały się w granicach 2,9 – 18,3 mg ALA/1g kreatyniny i pozostawały we wszystkich badanych grupach na poziomie istotnie wyższym w stosunku do wartości uznanych za normę. Największe wydalanie ALA obserwowano w grupie I (7,29mg ALA/1 g kreatyniny), zaś najmniejsze - w grupie IV (6,88 mgALA/1 g kreatyniny). Nie stwierdzono jednak istotnych statystycznie różnic w wielkości wskaźnika ALA/kreatynina między badanymi grupami.