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The Comparative Evaluation of δ-Aminolaevulinic Acid and Creatinine Levels in the Urine of Children from Świdnik and Bystrzyca Stara Areas as a Manifestation of Exposure to Lead Compounds

Ocena porównawcza poziomu kwasu δ-aminolewulinowego i kreatyniny w moczu dzieci z terenu Świdnika i Bystrzycy Starej jako wyraz narażenia na związki ołowiu

INTRODUCTION

The dynamic industrial development has been greater and greater threat to the man's health during the latest years because of the emission of many harmful chemical compounds. The compounds produced in technological processes are not deactivated. They also appear as industrial wastes, gases, fumes or sewage (6).

Lead and its derivatives used in many branches of industry belong to such substances. It gets into the body mainly through the air, and to a lesser extent through the skin and the alimentary tract. The quantity of lead the body absorbs depends on its concentration in the place of living, its form, age and the state of man's health.

Adults absorb about 10% of lead contained in food and water and about 40% from the inhaled air. In children lead is absorbed in larger quantities, which is related to a quick growth in body weight and increased activity in childhood and adolescence. The absorption of lead by the human organism in the quantity of about 1 mg daily through the air or alimentary tract most often results in poisoning (7).

An increased excretion of δ-aminolaevulinic acid (ALA) in the urine is one of the first symptoms of lead poisoning (5). In comparison with the others this symptom occurs early so it may be treated as a warning sign. The quantity of ALA excreted with the urine is proportional to the resorbed lead. The level of lead in the organism increases with age, specially in the kidneys. It is supposed that this element takes part in kidneys diseases (8).

PURPOSES

The aim of this research was to find the dependence between the quantity of ALA and creatinine levels excreted with the urine and the age of children living in two areas: Świdnik area — a town with average industry, and Bystrzyca Stara —

an area of minimal degradation of the environment. The research was to prove the existing differences between the levels of ALA and creatinine eliminated with the urine, in two different age groups in children seven and fourteen years old (with regard to sex and the place of living).

METHODS

Urine samples collected from 7-year-old children and 14-year-old group from the primary schools in Świdnik and Bystrzyca Stara were tested for ALA and creatinine levels. In each school the urine tests were done in 40 7-year-old children, and in 40 14-year-old children, with regard to sex. ALA level was measured by the method worked out by Grabecki, Haduch and Urbanowicz (2). Creatinine was measured by modified Folin's method with picric acid (1). All urine samples unterwent N-Multistix test for *pH*, proteins, glucose, ketone bodies, bilirubin, blood, nitrites and uroblinogen. The results were evaluated statistically by *t*-Student test (9).

RESULTS

Totally, the urine from 160 children (80 from Świdnik and 80 from Bystrzyca Stara) was tested for ALA and creatinine. Mean values of ALA concentration in the urine of children from Świdnik were the following:

7-year-old group — 0.40 mg/100 cm^3,

14-year-old group — 0.45 mg/100 cm^3,

from Bystrzyca Stara:

7-year-old group — 0.22 mg/100 cm^3,

14-year-old group — 0.30 mg/100 cm^3.

Mean concentration of creatinine in the urine of children from Świdnik were the following:

7-year-old group — 60.0 mg/100 cm^3,

14-year-old group — 90.2 mg/100 cm^3,

from Bystrzyca Stara:

7-year-old group — 56.8 mg/100 cm^3,

14-year-old group — 70.1 mg/100 cm^3.

The obtained values of ALA in the urine of children from Świdnik in both age groups with regard to sex are essentially higher than in children from Bystrzyca Stara. These values are statistically symptomatic but they do not outrange the norms set in clinical diagnostics, in Grabecki, Haduch and Urbanowicz's method up to 0.60 mg/100 cm^3 (12). The level of creatinine in the urine of children from Świdnik is also 16% higher than in children from Bystrzyca Stara. It does not go beyond the clinical norms. The results obtained by N-Multistix test are presented graphically as percentage values with regard to the total number of children and places. Totally, the N-Multistix test proved greater percentage of changes in the urine in children from Świdnik in comparison with the results

obtained in children from Bystrzyca Stara. The increased level of nitrites more common in children from Bystrzyca Stara regardless of age is exceptional (Fig. 1)

Our research proved the existence of trace quantities of proteins in the urine of 52% of children from Świdnik and in 40% of children from Bystrzyca Stara. In healthy persons proteins in the urine may be present after excessive physical

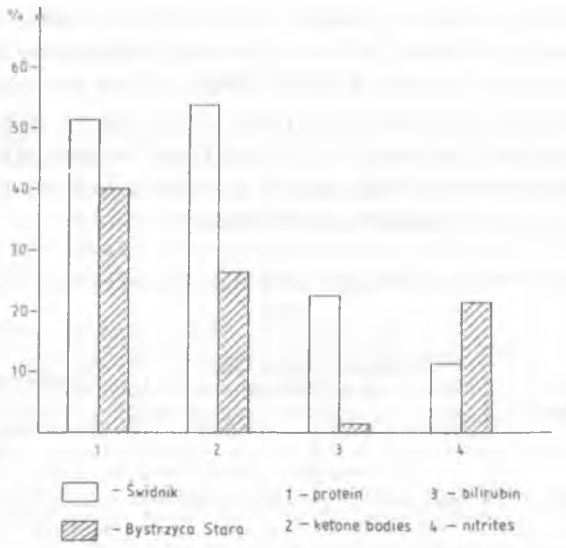

Fig. 1. Number of children with delected changes in urine

effort, after eating large quantities of protein food or after a cold bath. In all mentioned cases orthostatic albuminuria is temporary and slight, and is accompanied neither by such changes as: haematuria, pyuria, changes in quantity and specific weight of the urine, nor by changes in other organs (4, 11). The frequency of orthostatic albuminuria increases in 12-year-old children, reaching the highest level in 14—16-year-olds, up to 60% of all the examined (10).

The ketone bodies (aceto-acetic acid) were found in the urine of 54% of children from Świdnik and in 26% of those from Bystrzyca Stara. Ketonemia develops easily in children with malnutrition, after vomiting, fever, gastrointestinal diseases, and as a classic symptom of diabetes (3). It is highly probable that in our studies, a high percentage of children with detected ketone bodies in the urine results from nutritional deficiency. It is specifically remarkable of the group of pubescent children. N-Multistix test found no sugar in the urine in any of the children, so the occurrence of ketone bodies is not related to diabetes (3). Bilirubin was found in the urine of children only from Świdnik with one exception of a child fom Bystrzyca Stara in the group of 7-year-old children. Bilirubin can appear in the urine in case of damaged hepatic parenchyma, infectious and mechanical jaundice (3, 4). Nitrites in the urine were found in 21%

of children from Bystrzyca Stara and in 10% of those from Świdnik. It can be explained by greater exposure of country children to the nitrogen compounds pollutants, mainly from chemical fertilizers. N-Multistix test of the urine should be treated as signals and in case of more serious changes directed analytical tests should be performed.

It is likely that higher level of ALA and the lack of its significant growth with regard to the passage of time in children from Świdnik is due to their continuous living since the early childhood in the environment polluted by lead compounds. Country children from Bystrzyca Stara, however, are not exposed to greater absorption of lead compounds until their school age (which is presented in Table 1) and an evident increase in ALA level from the start of school education to the age of 14 is observed. Perhaps it is connected with the necessity of their going to school along communication routes.

Table 1. Mean values of ALA and creatinine in the urine of children from Świdnik and Bystrzyca Stara

No.	Children examined	δ-aminolaevulinic acid in mg/100 ml		Creatinine in mg/100 ml	
		Bystrzyca Stara	Świdnik	Bystrzyca Stara	Świdnik
1	Girls, 7 years old	0.21 ±0.07	0.41 ±0.12**	57.5 ±15.4	58.6 ±23.3
2	Girls, 14 years old	0.30 ±0.07*	0.45 ±0.06**	72.2 ±15.0	83.4 ±27.3
3	Girls, 7 and 14 years old	0.25 ±0.08	0.43 ±0.09**	64.8 ±16.8	71.0 ±28.0
4	Boys, 7 years old	0,24 ±0.07	0.44 ±0.07**	56.2 ±17.3	70.9 ±23.9*
5	Boys, 14 years old	0.31 ±0.05*	0.46 ±0.07**	68.1 ±21.8	78.6 ±21.0
6	Boys, 7 and 14 years old	0.27 ±0.07	0.45 ±0.07**	62.2 ±20.3	74.8 ±22.5*
7	Girls and boys, 7 years old	0.22 ±0.07	0.42 ±0.09**	56.8 ±16.2	64.8 ±24.0
8	Girls and boys, 14 years old	0.30 ±0.06	0.45 ±0.07**	70.2 ±18.6	81.0 ±24.1*
9	All children	0.26 ±0.10	0.44 ±0.08**	63.5 ±18.6	72.9 ±25.11*

Comparison: 1:2 *$p<0.05$; 4:5 *$p<0.05$.
Comparison Bystrzyca Stara — Świdnik: ALA **$p<0.001$; creatinine *$p<0.05$.

Conclusions

The research proved the existence of connection between the place of living and age of the child and the quantity of ALA excreted with the urine, and the concentration of creatinine in the urine.

1. The ALA and creatinine level increase with the child's age and depend on the exposure to lead compounds.
2. It is found that ALA and creatinine levels are higher in 7-year-old and 14-year-old boys.
3. There is a connection between ALA and creatinine levels and the place of living (Table 1).

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STRESZCZENIE

Przedmiotem badań było wykazanie różnic w poziomie ALA i kreatyniny w moczu dzieci 7- i 14-letnich zamieszkałych w Świdniku i Bystrzycy Starej. Badania przeprowadzono u 160 dzieci w 2 grupach wiekowych z podziałem na płeć. W wyniku badań uzyskano istotną różnicę między zawartością ALA i kreatyniny u 7- i 14-latków oraz między dziećmi z różnych miejscowości w tych samych grupach wiekowych.