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*Urinary delta aminolevulinic acid excretion in children
attending primary school in Kraśnik and Łęczna*

Wydalenie kwasu delta aminolewulinowego w moczu u dzieci
ze szkół podstawowych w Kraśniku i w Łęcznej

Dynamically developing industrialization and motorization exert injurious impact on natural environment. In industrialized areas heavy metals compounds are the most common agents contaminating water, soil and air. In these areas concentrations of heavy metals compounds, including lead compounds, frequently exceed acceptable values (1, 2, 6, 9, 10). Lead compounds enter human body mainly with food and to the lesser extent with inhaled air. In children about 50% of ingested lead may be absorbed from digestive tract i.e. 5–7 times more than in adults (4). Lead has a toxic effect on many tissues of human body. Lead compounds inhibit haemoglobin synthesis. They are inhibitors of delta aminolevulinic acid dehydrogenase and hem synthetase. Lead intoxication results in increased urinary delta aminolevulinic acid (ALA) excretion (1, 2, 4, 6, 9, 11). Accumulation of lead compounds in human body may lead to serious consequences for the whole population and especially for highly susceptible individuals like children and adolescents. Screening studies using simple techniques of assessment of biochemical lead intoxications markers may contribute to early detection of lead in poisoned children and to early commencement of prophylactic and therapeutic procedures in those children.

PURPOSE OF STUDY

The purpose of the study was to estimate the exposure to toxic influence of lead compounds in children and to determine possible relationship between urinary ALA excretion in children and their permanent residence and their school location.

MATERIAL AND METHODS

The study comprised 542 children aged 7 and 14 years attending primary schools in Łęczna and Kraśnik – two towns located in the Lublin region. Łęczna is a town located on touristic route leading to Łęczna–Włodawa Lake District, but it is also a part of the Lublin Coal–Basin. Kraśnik is a town with very intensive vehicular traffic. There is a roller–bearing factory in Kraśnik, too. In each of the mentioned above towns three primary schools were selected. In children attending selected primary schools ALA concentration was assessed in urine samples voided in the morning using Grabecki et al. technique (3). The urinary creatinine concentrations were determined by Folin spectrophotometric technique (after 1). The urinary ALA excretion was expressed in mg per dl of urine and in mg per 1 g of creatinine (urinary ALA/creatinine ratio).

Statistical significance of differences between values of urinary ALA concentrations were determined by Student t test.

RESULTS

The mean values of urinary ALA/creatinine ratio in children from the three selected schools in Łęczna are presented in Table 1. No influence of school location on urinary ALA excretion was observed. The mean urinary ALA/creatinine ratio in all children from Primary School No. 1, Primary School No. 2 and Primary School No. 3 were 4.17; 4.06 and 4.31, respectively (Tab. 1). In each of the selected schools in Łęczna the mean urinary ALA/creatinine ratio in children aged 14 years (girls – 3.99; 4.21; 4.32 and boys – 4.21; 4.10; 4.43) were significantly higher than those in children aged 7 years (girls – 4.16; 4.00; 4.00 and boys – 4.33; 3.93; 4.50) (Tab. 1).

The mean values of urinary ALA/creatinine ratio in children from the three selected schools in Kraśnik are presented in Table 2. In each of the selected schools in Kraśnik statistically significant differences in the mean urinary ALA/creatinine ratio between 7–year–old children (girls – 6.33; 4.83; 6.83, boys – 7.17; 6.17; 7.67) and 14 year–old children (girls – 5.10; 4.32; 5.21, boys – 5.32; 4.66; 5.32) (Tab. 2.) were observed. In addition there were statistically significant differences in the mean urinary ALA/creatinine ratio between children attending the particular schools in Kraśnik. The highest mean urinary ALA/creatinine ratio was found in the chil-

Tab. 1. Mean urinary ALA/creatinine ratio in children attending primary schools in Łęczna

	Primary School		Primary School		Primary School		Significance of differences
	N° 1	A	N° 2	B	N° 3	C	
	n	urinary ALA/creatinine ratio	n	urinary ALA/creatinine ratio	n	urinary ALA/creatinine ratio	
1. 7-year-old girls	25	4.16 ± 1.16	22	4.00 ± 1.00	23	4.00 ± 1.00	A : B ns A : C ns B : C ns
2. 7-year-old boys	23	4.33 ± 0.83	23	3.93 ± 0.82	18	4.50 ± 0.83	A : B ns A : C ns B : C *
3. 14-year-old girls	24	3.99 ± 0.99	23	4.21 ± 0.78	20	4.32 ± 0.65	A : B ns A : C ns B : C ns
4. 14-year-old boys	16	4.21 ± 0.89	18	4.10 ± 0.78	19	4.43 ± 0.67	A : B ns A : C ns B : C ns
5. 7-year-old girls and boys	48	4.25 ± 0.99	45	3.97 ± 0.91	41	4.25 ± 0.91	A : B ns A : C ns B : C ns
6. 14-year-old girls and boys	40	4.10 ± 0.94	41	4.15 ± 0.78	39	4.37 ± 0.66	A : B ns A : C ns B : C ns
7. Total	88	4.17 ± 0.97	86	4.06 ± 0.84	80	4.31 ± 0.78	A : B ns A : C ns B : C ns
Significance of differences	1 : 2 ns 3 : 4 ns 1 : 3 ** 2 : 4 ** 5 : 6 **		1 : 2 ns 3 : 4 ns 1 : 3 ** 2 : 4 ** 5 : 6 **		1 : 2 ns 3 : 4 ns 1 : 3 ** 2 : 4 ** 5 : 6 **		

n - number of children; * p < 0.05; ** p < 0.001; ns – statistically non-significant.

dren attending Primary School No. 6 in Kraśnik Fabryczny. The school is located in vicinity of the roller-bearing factory. The mean urinary ALA/creatinine ratio in the children attending Primary School No. 2 located in the centre of the town was only slightly lower than that in the children attending Primary School No. 6 (6.33; 6.83, respectively). In children attending Primary School No. 3 located far away from factories and communication routes the mean urinary ALA/creatinine ratio

Tab. 2. Mean urinary ALA/creatinine ratio in children attending primary schools in Kraśnik

	Primary School		Primary School		Primary School		Significance of differences
	N° 2	A	N° 3	B	N° 6	C	
	n	urinary ALA/creatinine ratio	n	urinary ALA/creatinine ratio	n	urinary ALA/creatinine ratio	
1. 7-year-old girls	24	6.33 ± 1.00	24	4.83 ± 1.00	20	6.83 ± 1.33	A : B * A : C ns B : C **
2. 7-year-old boys	24	7.17 ± 1.17	26	6.17 ± 0.67	29	7.67 ± 1.17	A : B * A : C ns B : C *
3. 14-year-old girls	25	5.10 ± 0.77	23	4.32 ± 0.66	20	5.21 ± 0.89	A : B * A : C ns B : C *
4. 14-year-old boys	25	5.32 ± 0.89	25	4.66 ± 0.67	23	5.32 ± 1.00	A : B * A : C ns B : C *
5. 7-year-old girls and boys	48	6.75 ± 1.00	50	5.50 ± 0.83	49	7.25 ± 1.25	A : B ** A : C ns B : C **
6. 14-year-old girls and boys	50	6.03 ± 0.99	48	5.08 ± 0.75	43	6.28 ± 1.12	A : B * A : C ns B : C *
7. Total	98	6.39 ± 1.04	98	5.29 ± 0.79	92	6.76 ± 1.18	A : B * A : C ns B : C *
Significance of differences	1 : 2 3 : 4 ns 1 : 3 2 : 4 5 : 6		1 : 2 ** 3 : 4 ns 1 : 3 ** 2 : 4 * 5 : 6 **		1 : 2 3 : 4 ns 1 : 3 2 : 4 ns 5 : 6		

n - number of children; * p < 0.05; ** p < 0.001; ns - statistically non-significant.

was significantly lower than those in children attending Primary School No. 2 and Primary School No. 6 (4.83; 6.33; 6,83, respectively). (Tab. 2).

The mean values of urinary ALA/creatinine ratio in children aged 7 and 14 years from Łęczna and Kraśnik are presented in Table 3. It should be noted that the mean urinary ALA/creatinine ratio in all children from Kraśnik (6, 15) was significantly higher than that in all children from Łęczna (4, 19) (Tab. 3).

Tab. 3. Statistical significance of differences in urinary ALA excretion in children attending primary schools in Kraśnik and Łęczna

	Kraśnik A		Łęczna B		Significance of differences A : B
	n	urinary ALA/creatinine ratio	n	urinary ALA/creatinine ratio	
1. 7-year-old girls	68	6.00 ± 1.11	70	4.05 ± 1.05	**
2. 7-year-old boys	79	7.00 ± 1.00	64	4.25 ± 0.83	**
3. 14-year-old girls	68	4.88 ± 0.77	67	4.17 ± 0.81	*
4. 14-year-old boys	73	5.10 ± 0.85	53	4.25 ± 0.78	*
5. 7-year-old girls and boys	147	6.50 ± 1.03	134	4.16 ± 0.94	**
6. 14-year-old girls and boys	141	4.10 ± 0.94	120	4.21 ± 0.79	*
7. Total	288	6.15 ± 0.99	254	4.19 ± 0.87	**

n - number of children; * p < 0.05; ** p < 0.001; ns – statistically non-significant.

DISCUSSION

In many authors' opinion urinary ALA excretion is a sensitive marker of chronic lead intoxication (2, 6, 9). In our study the mean value of urinary ALA excretion in the children from Kraśnik was significantly higher than that in children from Łęczna. The highest mean values of urinary ALA/creatinine ratio were observed in two groups of children – from Primary School No. 6 and Primary School No. 2. Both schools are located in the areas considerably exposed to toxic influence of lead compounds. On the one hand this seems to be a result of vicinity of a roller-bearing factory and vehicular traffic of high intensity on the other hand.

In children from Łęczna the mean value of urinary ALA/creatinine ratio was significantly lower than that in children from Kraśnik. In children from each of selected primary schools in Łęczna the mean values of urinary ALA/creatinine

ratio were comparable and there were no statistically significant differences between them.

In both towns there were statistically significant differences in the mean values of urinary ALA/creatinine ratio between children aged 7 and 14 years. Significantly higher urinary ALA/creatinine ratio in older children seem to be a result of longer time of exposure to lead compounds and their accumulation in children's organisms (4, 5).

It is well established that urinary ALA/creatinine ratio in boys tends to be higher than that in girls. This is related to a more intensive physical activity in boys than in girls. An intensive physical activity in boys may contribute to an increased exposure to environmental toxic substance (5). In our study there were no statistically significant differences in the mean urinary ALA/creatinine ratio between boys and girls attending schools in Łęczna. Statistically significant differences in the mean urinary ALA/creatinine ratio were observed between 7-year-old boys and 7-year-old girls in each of the selected schools in Kraśnik where, as compared with Łęczna, there was a higher exposure to toxic influence of lead compounds.

CONCLUSIONS

1. The area of Kraśnik as compared with that of Łęczna is more exposed to toxic influence of lead compounds.

2. There are statistically significant differences in the mean values of urinary ALA/creatinine ratio between the children attending selected primary schools in Kraśnik. The differences seem to be a result of school location.

3. Regardless of school location children in Łęczna are slightly exposed to toxic influence of lead compounds.

4. The mean values of urinary ALA/creatinine ratio in 14-year-old children are significantly higher than those in 7-year-old children.

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STRESZCZENIE

Badaniami objęto 542 dzieci w wieku 7 i 14 lat ze szkół podstawowych w Kraśniku i w Łęcznej. Oznaczano stężenie kwasu delta aminolewulinowego (ALA) oraz kreatyniny w pierwszej ranej porcji moczu badanych dzieci. Stężenie ALA przeliczano na jednostkowe stężenie kreatyniny. Średnie wartości wskaźnika ALA/kreatynina w moczu u dzieci ze szkół podstawowych w Kraśniku były istotnie wyższe w porównaniu z wartościami obserwowanymi u dzieci z Łęcznej. Najwyższe stężenia wskaźnika ALA/kreatynina występowały u dzieci ze szkół podstawowych w Kraśniku, położonych w centrum miasta oraz w pobliżu Fabryki Łożysk Tocznich. W przeprowadzonych badaniach wykazano także różnice między wartościami wskaźnika ALA/kreatynina u 7 – i 14 – latków.

