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Evaluation of Zinc Content in Children's Hair

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ABSTRACT

The zinc content in the hair of 654 children living in various rural and industrial areas in southern Poland was assayed by means of the atomic absorption spectrometry, following the dry digestion procedure. The hair of girls exhibited statistically significant higher level of Zn than the boys' hair, although in the site of extremal Zn contamination, the inverse relation was found.

Index Entries: Zinc; hair; pollution.

INTRODUCTION

There are many sources of zinc (Zn) content variations in human hair. The most frequently quoted factors affecting hair Zn are: age, hair growth, sex, time of year, and environmental Zn *(1)*. The latter one can be a crucial factor in certain circumstances. This study was aimed at answering the question whether the place of residence and the sex of children influence the Zn content in children's hair.

MATERIALS

Hair samples (approx 0.5 g each) were collected in the period of 1988–1991 from 654 children (m = 332, f = 322) at the ages of 10–12, who lived in:

1. Kraków and the nearby town of Skawina (n = 200);
2. Tarnów, Czechowice-Dziedzice (two big chemical industrial centers, n = 117)

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3. Boleslaw, Piekary Śląskie, Ruda Śląska, Miasteczko Śląskie (Upper Silesia, n = 237); and
4. Modlnica, Rabka (rural areas, n = 100).

Children's hair is regarded as a better indicator of environmental contamination than adults' hair for two reasons: (1) children use special hair treatment *(2)* (e.g., cosmetic dyes that can influence mineral content of hair) only sporadically, and (2) because of their outdoor activities, children are more exposed than adults to environmental effects. Another nonnegligible factor is that total uptake-to-body wt ratio is higher in children's organisms than in adults *(3)*.

METHODS

The hair was washed with acetone, threefold with deionized water, and again with acetone, according to the IAEA Advisory Group *(4)*. The samples were mineralized at 450°C and the residues were dissolved in 1*M* HCl. The Zn content was assayed by the AAS method using the Perkin-Elmer 1100B spectrometer. The main instrumental parameters for the analysis by AAS were as follows: wavelength 213.8 nm; band width 0.7 nm; lamp current 15 mA; air/acetylene flame (air 8 L/min acetylene 3.5 L/min). The calibration curve standardized for Titrisol (Merck) was linear in the range 0–5 mg/L. Accuracy and precision of the analytical method were confirmed by analyzing a certified reference material (Human Hair, Shanghai Institute of Nuclear Research, Academia Sinica, China). The mean ± SD (175.2 ± 8.3 ppm) was compared with certified value (189 ± 8 ppm). Statistical analyses were performed by the D Kolmogorov, Chi square, Bartlett and C Cohran Cox tests as appropriate.

RESULTS AND DISCUSSION

The data of mean Zn concentrations in children's hair from the areas with different industrial pollutions are listed in Table 1, whereas Fig. 1 shows the Zn concentrations according to the division into sexes. The smallest average Zn levels were found in Kraków, Skawina, Tarnów, and Czechowice, and slightly higher ones in Upper Silesia. Unexpectedly, the hair of children from rural areas accumulated more Zn, but the highest average Zn level was observed in children from Miasteczko Śląskie, where the biggest factory of Zn processing in Poland is localized. There were no statistically significant differences among the four groups of children distinguished in the Materials section. The only exception was Miasteczko Śląskie, which differs significantly from any other site. In many sites belonging to neighboring groups in the diagram (Fig. 1), there were also no significant differences.

Table 1
Zn Concentrations in Children's Scalp Hair, (ppm)

Location	Arithmetic Mean	SD	Range
Kraków, Skawina	171.5	48.6	51.6–373.2
Tarnów, Czechowice-Dziedzice	185.0	50.3	69.7–413.4
Rural areas	244.6	109.2	63.1–648.1
Upper Silesia	248.2	122.6	143.1–572.9

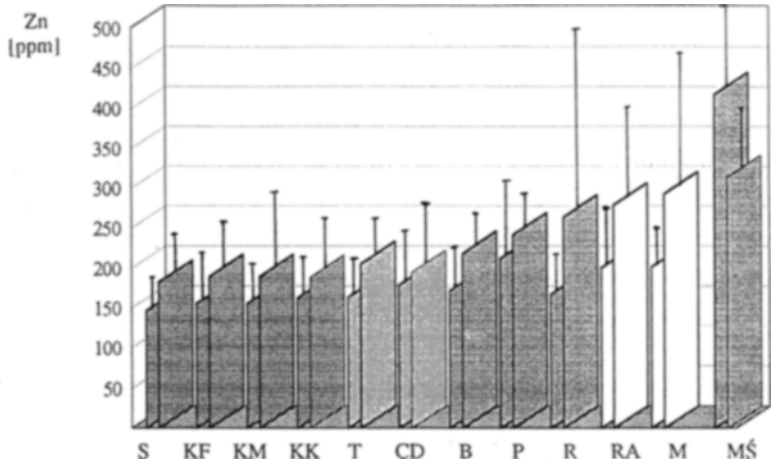

Fig. 1. Mean levels of zinc in the hair groups of children (boys, girls) living in different sites of Southern Poland ($p > 0.05$, *first block boys, second girls*). S, Skawina; KF, Fika Street in Kraków; KM, Św. Marka Street in Kraków; KK, Kolorowe District in Kraków; T, Tarnów; CD, Czechowice-Dziedzice; B, Boleslaw; P, Piekary Śląskie; R, Ruda Śląska; RA, Rabka; M, Modlnica; MŚ, Miasteczko Śląskie.

In general, the hair of girls accumulate much more Zn than that of boys. This observation is in agreement with the results given by Prucha *(5)* and follows the tendency found for other metals *(3)*. However, few exceptions were encountered. In the case of children from Kraków-Św.Marka Str. and from Piekary Śląskie, no statistically significant difference was found. A striking observation was that in the case of children from Miasteczko Śląskie, the relation was inverse. Moreover, average Zn content was very high (416.7 ppm in boys and 313.3 ppm in girls). A similar phenomenon was observed during our studies on Cd *(6)*, in the areas where industry has a considerable impact on the environment.

Table 2
Comparison of Zn Contents (ppm) in Hair Given by Different Authors

Age, yrs	Zn	Remarks[a]	Ref. and country
< 25	170.3 (148.1–196.0)	GM and 95% confidence interval	Germany (*7*)
6–14	169 ± 105	AM ± SD; urban setting	USA (*8*)
	121 ± 40	AM ± SD; rural setting	
	157 ± 82	AM ± SD; suburban setting	
6–12	157 ± 39	AM ± SD	Brazil (*9*)
11–15	126 ± 27	AM ± SD; boys	
	148 ± 71	AM ± SD; girls	Panama (*10*)
11–15	192 ± 13	AM ± SD; boys	
11–25	167 ± 12	AM ± SD; girls	Turkey (*11*)
10–12	200.4 ± 93.5	AM ± SD; boys	This work,
10–12	227.4 ± 98.4	AM ± SD; girls	Poland

[a]GM—geometric mean, AM—arithmetic mean.

Although contributions from different sources of Zn to human hair are not known exactly, the metal content in hair of selected population does reflect total environmental exposure. This is apparent in our study and confirms findings presented in other papers (*3,7,8*). On the other hand, the elevated Zn level in hair is not a sufficient indicator to assess the health risk from heavy metals toxicity. The comparison of our data with those from literature is shown in Table 2. It should be kept in mind that Zn content depends also on age, and therefore only approximate conclusions can be drawn from Table 2, but results from Poland revealed a considerably higher Zn level, which is probably because of bigger environmental contamination.

CONCLUSIONS

The place of residence does affect the Zn content in children's hair depending on the degree of environmental pollution in the given areas. The differences between boys and girls were apparent. For most cases, they were statistically significant and roughly the same.

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