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ZINC IN HAIR OF THE MIDDLE POMERANIA HUMAN POPULATION (POLAND)

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Abstract

The aim of this work was the assessment of the age, sex, way of nutrition, environment and health state influence on zinc content in hair of population living in the Middle Pomerania. Within years of 2005-2007 hair coming from 416 persons from a ten months old child to a 75 years old person was analyzed. All people were divided into four age groups: children (0-15 years), youth (16-25), adults (26-50) and the elderly (51-75). 3-centimeters long hair (counting from the skin) were put to chemical analyze. Then dried samples were weighed and mineralized with mixture of nitric and tetraoxochloric acides (mixed in proportion of 5:1). Zink determination was done by method of atomic absorption spectrophotometry using spectrometer ASA-3. Average zinc content in hair of researched population amounted to 167±58 $\mu g\ g^{-1}$. Least of all zinc was ascertained in children hair (av. 125 $\mu g\ g^{-1}$), and most of all in youth (194 $\mu g\ g^{-1}$). In all age groups females had more of this metal (av. 180 $\mu g\ g^{-1}$) than males (156 $\mu g\ g^{-1}$). Average value of zinc for people living in a village was 147 $\mu g\ g^{-1}$, and living in towns and cities 181 $\mu g\ g^{-1}$. The least of zinc we have found at persons being on the meat- or milk-free diet (av. 157 $\mu g\ g^{-1}$) and the most at persons that did not restrict in eating meat and milk products (197 $\mu g\ g^{-1}$). The persons suffering from cardiovascular disease or hyperplasia prostate had adequately 221 and 195 $\mu g\ g^{-1}$ Zn, considerably above the level in hair of without symptoms diseases persons (156 $\mu g\ g^{-1}$). Smaller content of this element had persons suffering from atherosclerosis or hypertension (adequately 132 and 142 $\mu g\ g^{-1}$).

Key words: zinc, hair, age, environment

INTRODUCTION

Among elements being part of alive organisms there are specified microelements i.e. elements whose quantity in biological environment is lower than 0.01%. Their concentration is characterised by significant variability. Besides specific ability to absorb great amounts of some mineral ingredients, important are also environmental factors. The zones, which chemical constitution of geological formations and of water environment stray from average proportion, distinguish with long-lasting disturbance connected to ontogeny of some plants and animals. It has also significant influence on human health. High or low content of specified element or complex of elements in the trophic chain causes different changes in physiology and morphology, which consolidate by inheritance. In this connection checking up of microelements in environment and organisms has enormous meaning for health.

One of elements like that is zinc. This metal is one of trace elements necessary to right growth and ontogeny. It has multidirectional action as enzymes activator which takes part in synthesis and degradation of proteins, lipids, carbohydrates and nucleic acids. It is of importance in stabilisation of DNA and RNA structures (Borzęcka et al. 1999). Increased concentration of zinc in organisms causes reduction of lead and cadmium absorption and their negative biochemical effect (Hornowska et al. 1996). However zinc excess in diet causes copper reduction in organism – its deficiency can be a reason of many disorders, for example increase of cholesterol concentration (Łukasiak et al. 1998). On the other hand, zinc deficiency manifests itself by skin and mucous membrane changes or makes the wounds difficult to heal. It causes even disturbance of senses functioning (taste, sight and smell), reduces intellectual efficiency and can lead to prostate gland hypertrophy at men (Kałuża et al.). The reason for these deficiencies can be insufficient consumption of zinc, some diseases and applied medicines.

Some elements, for the sake of their specific and physiological functions, have ability to cumulate themselves in specified parts of plants, animal and human organs. In this connection, chemical composition of individual tissue sorts differs many times from average content of given element in other parts of organisms. So far, the material most often used for evaluation of macro- and microelements concentration in structure has been blood. However obtained results have not ever informed of disturbances in element composition. Therefore we have been searching other methods and materials for evaluation of bioelements management in human body.

There has been shown that a very interesting material to determine content of bio elements (especially metals) and mineral state assessment of organism can be human hair (Harkins and Susten 2003, Paschal et al. 1989, Radomska et al. 1991, Swift 1996). Metal content is significantly higher in hair than in blood or urine (Goullé et al. 2005, Lech 1991, Szucki and Kurys 1982, Teresa et al. 1997). The content of metals which is 10 to 200 times higher in hair is a significant advantage of the material and increases the sensitivity of analyzed bioelements determination (Kłos et al. 1990, Kozielec et al. 1996, Solarska et al. 1995, Stępniewska et al. 1996). Hair is then the biological material that in analysis can be used as sensitive indicator of nutrition state evaluation (Chojnacka et al. 2006a, Kałuża et al. 2001, Skorkowska-Zieleniewska 1995) and environmental exposure due to toxic element like mercury, cadmium, lead and arsenic (Benco 1995, Borzęcka et al. 1999, Lech 1991, Pereira et al. 2004, Strzelczyk et al. 2001). However obtained results cannot be used entirely because we do not know precise mechanisms of bioelements embodying into hair structure (Coello and Khan 1998).

Hair in contradistinction to other tissues grows very fast and next is excreted out of skin surface and merely in metabolic processes of organism. A hard, outer and creatine envelope of hair prevents from loss of internal ingredients and penetration of external pollutants, what assures a constant chemical constitution. External pollutants can be easily removed. It assures reliability and repeatability of analytic results. Research works of many authors confirm a diagnostic usefulness of hair analysis. They have shown existence of correlation between content of elements occuring in hair and their content in organisms in cases of physiological balance but also during different pathological disturbances (Aleksandrowicz 1991, Bermejo-Barrera et al. 2002, Contiero and Folin 1994, Forte et al. 2005, Kozielec et al. 1996, Radomska et al. 1993).

The aim of this work was the assessment of the age, sex, way of nutrition, environment and health state influence on zinc content in hair of population living in the Middle Pomerania.

MATERIALS AND METHODS

Within years of 2005-2007 hair coming from 416 persons from the Middle Pomerania was analyzed. These persons represented vast spectrum of age, from a ten months child to a 75 years old person. People were selected at random. Every person was interviewed according to earlier prepared analyze card including personal data, place of residence, profession (children – parent's profession), way of nutrition, health state and colour of hair. In case of children the interview was lead with their parents. All people were divided into four age groups: children (0-15 years), youth (16-25), adults (26-50) and the elderly (51-75).

The material used to analyze was not exposed to hairdresser's procedure. Samples of hair were cut close to the skin from six different places of the head. 3-centimeters long hair (counting from the skin) were put to chemical analyze. Total mass of hair, from one person, amounted from 0.3 to 0.5 g. Hair samples were rinsed with acetone and then three times with deionized water and acetone again. Clear hair were dried at temperature of 105° C to solid mass. Then dried samples were weighed and mineralized with mixture of nitric and tetraoxochloric acides (mixed in proportion of 5:1). Zink determination was done by method of atomic absorption spectrophotometry using spectrometer ASA-3. All measurements were lead with analytic long wave of 213.9 nm, lamp current – 6 mA, the gap – 7 mm and the flame of air-acetylene. Results were read from earlier made analytical curve and represented in μm g^{-1} of dry matter. We have also examined precision and repeatability of method (using ten unified samples) and zinc recovery (by addition of well known amount of standard solution to ten samples and simultaneously and investigating zinc contents in samples without the standard). The correlation factor of the standard curve amounted to 0.998. The coefficient of variation concerning repeatability of used method amounted to 6.58%, average recovery – 99.7% and average error of method – 7.9%.

Obtained results were statisticaly elaborated by the t-Student test and the quantity of correlation factors.

RESULTS

Within years of 2005-2007 we put to the analyze hair of 210 female and 206 male in connection to zinc content. Obtained results are shown in Table 1 and Figures 1-4. Table 1 contains mean value, data range, standard deviation, index of variation and size in each age group and percent part in general size of population. In each age group there was observed high range of fluctuation of zinc content in hair (in whole population 15-422 μg g^{-1}) and high value of standard deviation which probably could come from considerable variability of results. Least of all groups were children that amounted to 19% of measured population. Amount of remaining age groups was more or less similar (over 25%).

Table 1

The content of zinc (in μg g^{-1}) in hair of respective age (in years) groups of the Middle Pomerania (Poland) human population

Age group	x*	x_{min}	x_{max}	S_x	V (%)	n	U (%)
0-15	125.4	15.1	308.0	76.3	58.2	80	19.3
16-25	193.8	22.0	416.8	87.2	37.1	106	25.5
26-50	178.0	30.1	365.0	91.3	47.6	109	26.3
51-75	163.9	31.8	421.7	83.8	50.6	121	28.9
Total	167.2	15.1	421.7	88.1	48.0	416	100.0

x* – average content of zinc, S_x – standard deviation, x_{min}, x_{max} – minimal and maximal values, V – changeability coefficient, n – number of persons, U – percentage part of all population

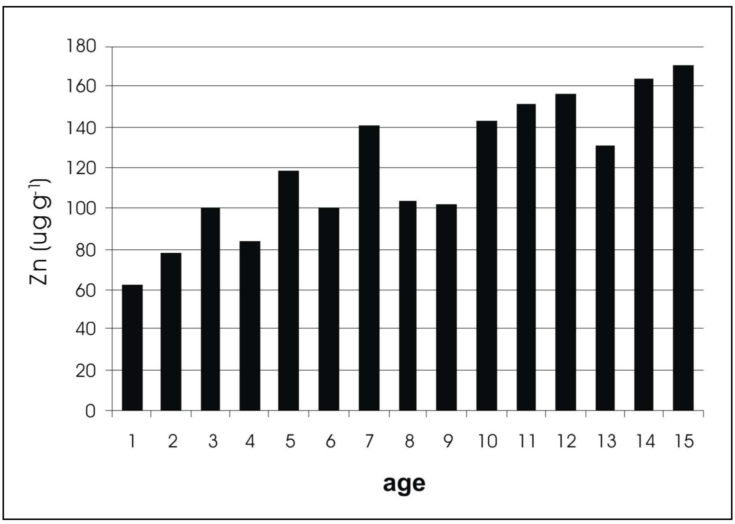

Fig. 1. Mean values of zinc (μg g^{-1}) in children hair (1-15 year) from the Middle Pomerania (Poland)

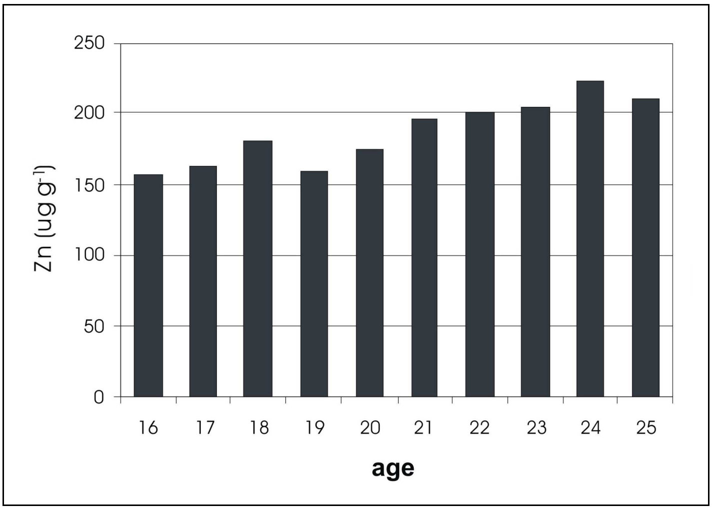

Fig. 2. Mean values of zinc (μg g^{-1}) in human hair (16-25 year) from the Middle Pomerania (Poland)

Table 2

Number of persons with definite quantity of zinc (in μg g^{-1}) content in hair of respective age (in years) groups (n – number of persons)

Age group	Range of zinc concentration								n
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	> 350	
0-15	12	18	23	12	8	4	3	-	80
16-25	3	7	26	27	14	12	12	5	106
26-50	3	17	25	26	16	12	7	3	109
51-75	19	27	21	12	13	10	9	10	121
Total	37	69	95	77	51	38	31	18	416

Average zinc content in hair of researched population in the Middle Pomerania, living in villages and towns amounted to 167±58 μg g^{-1}. Hair of most people (95 persons) amounted to 101-150 μg g^{-1}, and 77 persons: 151-200 μg g^{-1} (Tab. 2). Least of all zinc was ascertained in children hair (av. 125.4 μg g^{-1}), and most of all in youth (193.8 μg g^{-1}). In both age groups there was observed increasing trend along with the age of researched persons (Fig. 1 and 2). The dependence of zinc level in hair on the age is confirmed by correlation factors with very high values (age group: 0-15: r = 0.75; age group: 16-25: r = 0.81). Most people in the age of 22-35 had in hair over 200 μg g^{-1} of zinc. There were both, people from age group of youth (16-25) and adults (26-50), (Fig. 3). In the last age group there was observed decreasing trend of zinc content in hair from the average value of 200 μg g^{-1} to

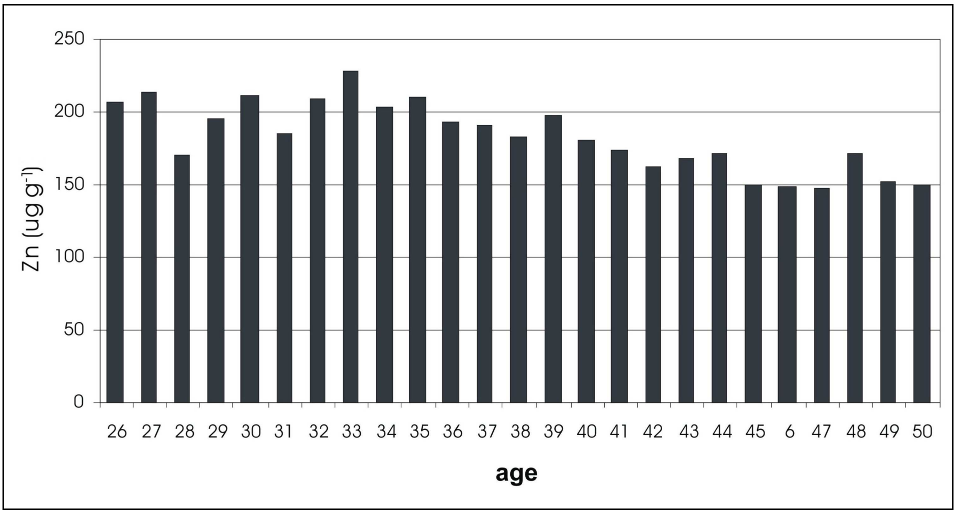

Fig. 3. Mean values of zinc (μg g^{-1}) in human hair (26-50 year) from the Middle Pomerania (Poland)

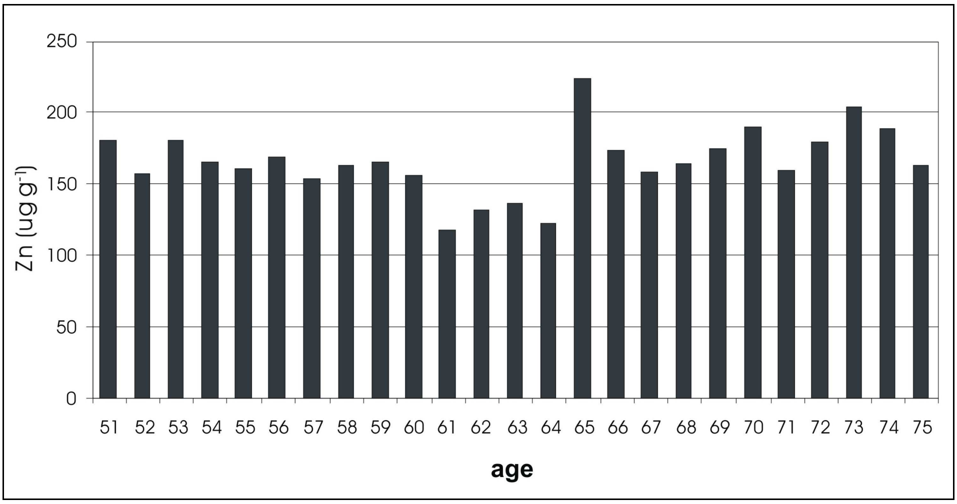

Fig. 4. Mean values of zinc (μg g^{-1}) in human hair (51-75 year) from the Middle Pomerania (Poland)

150 μg g^{-1}. Correlation coefficient characterizing that dependence showed high and significant value of 0.62.
In the age group of the elderly (51-75) content of zinc in hair was more or less on the same level (av. 163.9 μg g^{-1}, Tab. 1, Fig. 4). Only at persons at age of 61-64 there were observed the lowest values, average 126 μg g^{-1}, strayed away essentially from zinc content of the others.
Statistical and significant differences with zinc content in hair were affirmed be-

tween children and others age groups ($p < 0.001$), and between youth and the elderly group (Tab. 1). Differences connected to content of zinc in hair between youth group and adults as well between adults and the elderly group were not statistically significant.

Most people of tested population (58%) were characterized by content of zinc in hair from 51 to 200 $\mu g\ g^{-1}$ (Tab. 2). The most amount of persons (95) from this group had from 101 to 150 $\mu g\ g^{-1}$. Even great part of children (28.7%) had from 101 to 150 $\mu g\ g^{-1}$ of zinc. At 50% youth and adults the level of this metal contains in range of 101-200 $\mu g\ g^{-1}$. 38% of youth and 35% adults contain in their hair more than 200 $\mu g\ g^{-1}$ of zinc.

Among the elderly group, 27% had in hair from 51 to 100 $\mu g\ g^{-1}$ of zinc, and to 50 $\mu g\ g^{-1}$ and in the range of 101-150 $\mu g\ g^{-1}$ had about 17% of measured people from this age group. At the remaining people content of this element overdrew 150 $\mu g\ g^{-1}$.

Studying the dependence of zinc content in hair according to sex of researched persons it was affirmed that in all age groups females had more of this metal than males (Tab. 3). Statistically significant differences ($p < 0.001$) in this range we affirmed in all age groups except children. Among children most girls and boys had below 150 $\mu g\ g^{-1}$ of zinc. About 45% of women from youth and adults groups had content of this element over 200 $\mu g\ g^{-1}$. Meanwhile the greatest group of men (about 46%) from the same age groups had less than 150 $\mu g\ g^{-1}$ of zinc in their hair. As well most older women and men (over 50%) had similar content of this metal (below

Table 3

The influence of sex on the content of zinc (in $\mu g\ g^{-1}$) in human hair of respective age (in years) groups of the Middle Pomerania (Poland). Percentage part in respective age groups and in all population given in parenthesis*

Zn	Age group							
	0-15	16-25	26-50	51-75	0-15	16-25	26-50	51-75
	Number of women				Number of men			
<150	28 (63)	12 (23)	16 (31)	32 (53)	25 (69)	24 (45)	26 (48)	35 (56)
150-200	6 (14)	16 (31)	14 (26)	3 (5)	6 (17)	12 (22)	13 (24)	10 (16)
>200	10 (23)	24 (46)	24 (43)	25 (42)	5 (14)	18 (33)	15 (28)	17 (28)
Total	44 (11)*	52 (12)*	54 (13)*	60 (14)*	36 (9)*	54 (13)*	54 (13)*	62 (15)*
x*	132.3	211.7	187.2	176.8	121.4	176.6	169.0	151.0
S_x	48.2	56.7	48.8	49.5	39.5	42.2	35.9	40.7
x_{min}	15.1	56.2	32.1	31.9	21.0	22.0	30.1	31.8
x_{max}	308.0	416.8	357.1	411.8	251.2	384.9	365.0	421.7
V (%)	36.4	26.8	26.1	28.0	32.5	23.9	21.2	26.9

x* – average content of zinc, S_x – standard deviation, x_{min}, x_{max} – minimal and maximal values, V – changeability coefficient

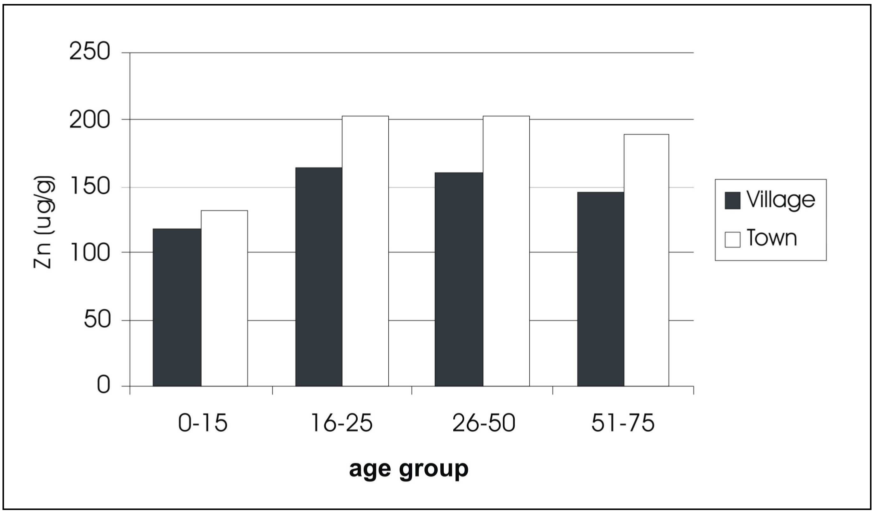

Fig. 5. The environment influence on the content of zinc (in µg g^{-1}) in human hair of respective age (in years) groups of the Middle Pomerania (Poland)

150 µg g^{-1}). We have to pay attention to the fact that great part of women (42%) in this age group was characterized by the zinc level over 200 µg g^{-1}. The greatest variation showed values obtained for girls and boys.

In Figure 5 there has been shown the influence of environment on zinc content in hair of reasearch people. Average value of this parameter for people living in villages was 147 µg g^{-1}, and for those living in towns and cities 181 µg g^{-1}. Difference between these values is statistically significant at significance level: 0.05. Considering particular studied age groups there was also ascertained statistically significant differences between persons coming from villages and cities, except for children.

Present study as well allowed to show that the nutrition method has also influence on zinc content in human hair. Being guided by the role played by particular groceries in supplying measured mineral elements for the purposes of this work we divided our population into four groups. Among tested people, 17% had been on some diet, mainly easy to digest and low fatty. They also had avoided meat and milk products (Tab. 4). For health reasons 204 persons had avoided some products. About 30% of general population had avoided meat and about 18% – milk products. The other part of people did not use any diet, did not avoid in menu neither meat nor milk products. The least of zinc we have found at persons using the diet and the most at persons who did not restrict in eating meat and milk products. The differences in zinc content between these population groups were very significant statistically. Comparing two remaining groups it seems that eating milk products is more conductive to the zinc concentration in hair than eating meat products, although we have not observed significant differences between them. In both cases we have observed bigger zinc content at the first group, but statistically significant difference was only in the second group of people who avoided the meat products but not avoided milk ones.

Table 4

The influence of nutrition on the content of zinc (in μg g^{-1}) in human hair of respective age (in years) groups of the Middle Pomerania (Poland)

Menu with		n	x*	x_{min}	x_{max}	S_x	V (%)
meat products	milk products						
-	-	69	157.5	15.1	207.3	60.4	38.8
-	+	127	174.1	44.3	355.0	70.3	40.4
+	-	77	162.3	30.1	284.8	58.8	36.2
+	+	143	197.5	65.7	421.7	82.0	41.5

x* – average content of zinc, S_x – standard deviation, x_{min}, x_{max} – minimal and maximal values, V – changeability coefficient, n – number of persons

Among tested population, 241 persons suffered from chronic disease. There were first of all persons from age group of adults and the elderly. The most people had suffered from hypertension and atherosclerosis, fever – cardiovascular disease, hyperplasia prostate and diabetes mellitus type II. Other chronic diseases were not taken into account because population density of sick persons had been too few to results could be reliable. Assuming the zinc content in hair in range of 160-200 μg g^{-1} as reference values (Wilhelm et al. 2002), persons suffering from atherosclerosis had it at upper limits of these values (Tab. 5). It seems that the other diseases are connected with zinc deficiency, especially in case of diabetes mellitus, cardiovascular disease and hyperplasia prostate.

Table 5

The of state health influence on the zinc content (in μg g^{-1}) in human hair of respective age (in years) groups of the Middle Pomerania (Poland)

Disease	n	x*	x_{min}	x_{max}	S_x	V (%)
Hyperplasia prostate	38	130.8	62.4	221.7	53.5	24.4
Progress of atherosclerosis	59	195.4	125.2	337.3	61.3	31.4
Diabetes mellitus type II	32	123.9	30.1	216.0	50.3	40.6
Hypertension	85	131.7	22.0	218.6	42.8	32.5
Fever–cardiovascular disease	47	142.1	39.6	209.8	45.3	31.9
Healthy	175	156.5	15.1	309.3	38.4	31.9

x* – average content of zinc, S_x – standard deviation, x_{min}, x_{max} – minimal and maximal values, V – changeability coefficient, n – number of persons

DISCUSSION

From different literature reports it follows that the mineral substance level in hair is repeatedly higher than in blood and urine (Eltayeb and Van Grieken 1990, Gordon et al. 1994, Maugh 1978, Radomska et al. 1993, Wilhelm et al. 1996). Therefore the hair analyse makes easier the searching procedure according to content of these substances in organism and decreases analytic errors. Moreover, a very important feature of this method is non-invasiveness. Taking into account that hair as chemical is built of protein with cysteine that thanks to sulphide groups has properties to combine ions of metals, so hair analyse near precisely determines their content in organism (Borzęcka et al. 1999, Contiero and Folin 1994, Harkins and Susten 2003, Zaborowska and Wierciński 1997).

Presented research results show that average content of zinc in hair of the Middle Pomerania population at age 0-75 amounts to 167 μg g^{-1} and oscillate in range of 15-422 μg g^{-1}. This zinc level should be compared to optimal concentration of this metal in hair, that is to its physiological value to ascertain whether it is proper, in excess or in deficiency. However optimal concentration of these metals depends on geographic zone and even country region. Moreover, it changes, as it shows an improving research methods that allow to precisely establish the physiological optimum. In connection with that it is proper to compare obtained results with literature data where the range in case of zinc (31-450 μg g^{-1}, Tab. 6) is similar to obtained and showed in this study. Present values obtained from the bottom level of the range result from the fact that in tested population we have taken into account children, that the youngest was ten months old. As well average content is similar to literature data (Tab. 6).

Among tested population zinc content in hair had been increasing systematically along with the age and had reached the highest level at 25 years. This level had been kept to 35 years, oscillating around 200 μg g^{-1}. Similar changes among children

Table 6

Literature data relating to the zinc content (μg g^{-1}) in human hair

Range	Average value	Literature
94-300	165	Brzozowska and Sulkowska 1996
91.0-265.3	174.1	Chojnacka et al. 2006b
150-190	-	Garry and Gordon 1985
143.2-205.8	178.7	Goullé et al. 2005
-	150	Kłos et al. 1990
91-450	-	Nowak 1998
31.3-220.0	137	Paschal et al. 1989
48-330	171	Radomska et al. 1991
49-460	163.4	Senofonte et al. 2000

(5-18) were observed by Kozielec et al. (1996), Teresa et al. (1997) and Garry and Gordon (1985) testing population at age 11-100 years. Those later researchers established that maximum zinc content in hair was observed in age of 25 and then along with time decreased to about 80. Similar relationship observed Nowak (1998). In our case average maximum zinc concentration we observed at adults in age of 33 (226 µg g^{-1}), then gradually it was decreasing to the value of 150 µg g^{-1} in age of 50. At people older than 50 years content of this metal in hair remained more or less on the same level (av. 164 µg g^{-1}), and only some minimum was observed in age of 61-64 years (about 130 µg g^{-1}). The same zinc level and similar behaviour in this group was observed by Radomska et al. (1993), Sturaro et al. (1994) and Chojnacka et al. (2006b). Eltayeb and Van Grieken (1990), testing Sudan residents found out that older people had more zinc than 25 years old youth. On the basis of literature news and data in presented study we can assume that normative zinc concentration in hair of people older than 15 years oscillates from 150 to 200 µg g^{-1} (Druyom et al. 1998, Senofonte et al. 2000), although Goullé et al. (2005) give vaster range of reference values (129-209 µg g^{-1}).

Average zinc concentration in hair of tested children in age of 10 months – 15 years amounted to 125 µg g^{-1} and was lower at children from Szczecin (163 µg g^{-1}) tested by Kozielec et al. (1996) or at children from industry regions (over 180 µg g^{-1}, Borzęcka et al. 1999). Pereira et al. (2004) testing hair of Portugal children affirmed similar value (132 µg g^{-1}) to our results. It is possible that our results come from the fact that in research took part children younger than 6 years. However according to Zaborowska and Wierciński (1997) the zinc level in hair at children fundamentally depends on living place. Average values obtained by them oscillated from 101 to 201 µg g^{-1}. Results we have obtained included in that range, nevertheless in our opinion children from the Middle Pomerania had lower level of zinc in their hair than children from other regions of our country. From the other hand average level of zinc (194 µg g^{-1}) among tested group of youth (16-25) is similar to other tested people by other researchers in Poland and all over the world (Garry and Gordon 1985, Radomska et al. 1993, Radomska et al. 1991). In seems that normative concentration of zinc in youth hair is probably value 188.7 µg g^{-1}, obtained by Łukasiak et al. (1998) among 17 healthy students from the Medical Academy of Gdańsk.

Obtained average values of zinc in hair of adults group (26-50) – 178 µg g^{-1} and the elderly (51-75) – 164 µg g^{-1} did not differ significantly from the level given in literature (Chojnacka et al. 2006a, Nowak 1998, Radomska et al. 1993, Strzelczyk et al. 2001). Only Kałuża et al. (2001) and Pereira et al. (2004) obtained values considerably higher for the elderly group.

Taking into consideration sex of tested population we have observed important and higher average concentration of zinc in hair of women from the youth group and the elderly (Tab. 3). Insignificant differences in this respect were observed between girls and boys, although girls had more zinc in hair than boys. Observed differences of this element concentration depending on sex were confirmed in literature by other researchers (Borzęcka et al. 1999, Brzozowska and Sulkowska 1996, Chojnacka et al. 2006b, Garry and Gordon 1985). Gordon et al. (1994) and Sturaro et al. (1994) as well have given that women's hair had more zinc than men.

Both women and men from age range of 16-25 had higher content of zinc. Average concentration at persons of both sex from further groups gradually decreased (Tab. 3). Content of zinc was exceeded in the hair of about 45% of women from youth and adults (over 200 μg g^{-1}) in comparison to reference values. However among the elderly group 53% of women had lowered values (below 150 μg g^{-1}), and 42% overstated. Yet men in all age groups proved lowered zinc level.

Many agents have influence on the content of different metals in issues and organs, also in hair among other things: content of elements in the soil, drunk water and food products. Among food products important is the way of nutrition. Content of metals in food and the way of nutrition decide of these elements supply in daily diet. Most of metals received along with the food is absorbed mainly in small intestine. All chronic diseases of alimentary canal restrict or even preclude their absorption. From the other hand chronic stress as well decreases organism ability of metals absorption (Chojnacka et al. 2006b, Radomska et al. 1993).

Evaluating influence of nutrition way on the content of zinc in hair of tested people we observed its statistically higher concentration at persons that did not avoid consumption of any food products in comparison to rest using some diet limits. In all cases when people avoided eating of meat or milk products it was leading to low content of zinc in hair in opposite to these who did not avoid those products. Tsukada and Sugahara (1996) also showed influence of using diet on element content of hair. Results obtained in this study confirm that eating of milk products causes increasing of zinc content although calcium included in milk is an agent that makes difficult to assimilate zinc. Similar results obtained in other studies Kałuża et al. (2001). On the other hand, Contiero and Folin (1994), Gibson et al. (1985) and Greger et al. (1978) did not ascertain relations between sorts of food products and zinc concentration in hair of tested people.

The way of nutrition has significant influence on content of zinc in hair, so as well in organism. It relates also to other metals (Kałuża et al. 2001). General life standard, as well as environment can have a significant influence on content of metals in human organism. In connection with this, hair is a very good material to evaluate environmental exposure on metals (Bencko 1995, Nowak 1998, Nowak and Chmielnicka 2000, Prasad 1996), including also on zinc. In this study kind of environment reflects living place (village or city) of persons in tested population. Inhabitants of town are more open to the risk of contact with metals in different forms that is why the level of zinc in hair of tested people was at the top of reference values, and at persons living in villages – at the bottom (Fig. 5). Only among children we did not observe significant difference between children living in villages and the ones in cities. Borzęcka et al. (1999) also did not affirm significant differences in connection to content of this metal in hair of children living in agricultural region and children living in region of high risk of zinc contamination. Both groups came from Zamość Province, Poland (currently Lublin Province). However Zaborowska and Wierciński (1997) showed significant differences between children from selected agricultural terrains of Lublin Province. Depending on tested terrain average concentration of zinc in hair oscillated from 101 to 201 μg g^{-1}. It seems that in country regions with similar risk of zinc compounds contamination differences in content of this metal in children's hair are not big but between regions with great differences of zinc content in environment concentration of zinc in hair is significantly different. This conclusion confirms literature news. Radomska et al. (1993) estimated that average content of zinc in children's hair from Poland amounted to 102 μg g^{-1}. However data relating to children coming from different country regions are extremely different. Average content of zinc in hair of children from Szczecin amounted to 161.7 μg g^{-1} (Kozielec et al. 1996), from Lublin – 121.0 μg g^{-1} (Zaborowska and Wierciński 1997), from area of Lublin Province – 101.1-201.4 μg g^{-1} (Zaborowska and Wierciński 1997), from Krakow – 175.5 μg g^{-1} (Zachwieja et al. 1995), from area of Zamość – 188 μg g^{-1} (Borzęcka et al. 1999), and our data from the Middle Pomerania – 125.4 μg g^{-1}.

Both overflow and deficiency of zinc in organism are conducive to many diseases. This problem is the subject of studies of many researchers (Forte et al. 2005, Łukasiak et al. 1998, Prasad 1996, Tsukada and Sugahara 1996). Within the confines of present study we have analysed even influence of some chronic diseases on content of zinc in hair (Tab. 5). It is possible that relationship is inversely too. It is affirmed that deficiency of zinc conduces to progress of diseases like: diabetes mellitus type II, hyperplasia prostate, hypertension, fewer – cardiovascular disease, and from the other hand – overflow heightens progress of atherosclerosis. Results of researches of Łukasiak et al. (1998) confirmed it.

CONCLUSIONS

1. Average content of zinc in hair of population from the Middle Pomerania amounts to 167 μg g^{-1}. Average values of concentration of this metal in children's hair clearly differ from the others age groups and are contained in limits characteristic for children in Poland.
2. Content of zinc in hair undergoes a change along with age. The highest content of this metal was observed at persons at age of 21-36.
3. We have observed more zinc in hair of tested women than in men's ones. Differences between concentration of this metal in hair of boys and girls have been significantly lesser.
4. The way of nutrition has a significant influence on content of zinc in hair. People using in their menu milk and meat food have had high content of zinc in hair, whereas those who limited products mentioned above, have had concentration of zinc at the bottom of reference values.
5. There was observed some influence of environment on the concentration of zinc at tested population. People living in villages have had less and those living in cities – more zinc in their hair. Only among children we have not observed significant differences.
6. State of health is also connected with the zinc level in hair. Among tested diseases – hyperplasia prostate, diabetes mellitus type II, hypertension and cardiovascular disease have accompanied lower concentration, and in case of atherosclerosis – higher one.

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CYNK WE WŁOSACH MIESZKAŃCÓW POMORZA ŚRODKOWEGO

Streszczenie

Celem pracy było określenie zależności między wiekiem, płcią, sposobem odżywiania, środowiskiem i stanem zdrowia a zawartością cynku we włosach ludzi zamieszkujących Pomorze Środkowe. W latach 2005-2007 poddano badaniom 416 osób w wieku od 10 miesięcy do 75 lat. Wszystkich podzielono na cztery grupy wiekowe. Zawartość cynku we włosach badanych osób wynosiła średnio 167±58 μg g^{-1}. Najmniej cynku stwierdzono we włosach dzieci (0-15 lat), średnio 125 μg g^{-1}, a najwięcej we włosach młodzieży (16-25 lat) – 194 μg g^{-1}. We wszystkich grupach wiekowych włosy osób płci żeńskiej zawierały więcej tego

metalu (śr. 180 μg g^{-1}) niż osób płci męskiej (156 μg g^{-1}). Zawartość cynku we włosach mieszkańców wsi była mniejsza (147 μg g^{-1}) niż u mieszkańców miast (181 μg g^{-1}). Znacznie mniejszy poziom tego metalu (śr. 157 μg g^{-1}) wykazywały włosy osób, które w swoim odżywianiu stosowały bezmięsną lub bezmleczną dietę, niż włosy osób, których jadłospis zawierał zarówno produkty mięsne, jak i mleczne (197 μg g^{-1}). Osoby chorujące na miażdżycę lub prostatę miały we włosach znacznie wyższy poziom cynku (odpowiednio 221 i 195 μg g^{-1}) niż osoby zdrowe (156 μg g^{-1}). Najmniej tego pierwiastka we włosach znaleziono u osób chorujących na artretyzm i nadciśnienie (odpowiednio 132 i 142 μg g^{-1}).