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Magnesium concentration in hair of young healthy women with different body mass indexes

Stężenie magnezu we włosach zdrowych młodych kobiet a wskaźnik BMI (Body Mass Index)

INTRODUCTION

Nutrition plays undoubtedly a key role as a determinant of human health – either in terms of physiology or as a means of prevention and treatment of many disorders. Consequently, assessment of proper nutritional status becomes of special importance. It could be carried out by means of specialized dietary approach, such as dietary questionnaires or body composition determinations [11]. However, in everyday practice of a primary care physician or nurse, simpler but still accurate methods are used to determine nutritional status. Anthropometric measurements – height and body weight, waist and hip circumference, and their derived indexes – body mass index (BMI) or waist to hip ratio (WHR) are widely applied for quantitative assessments of nutritional status [3].

BMI is common indicator of malnutrition and overweight or obesity. It is used not only by primary care physicians – its application as an additional diagnostic parameter spreads to other medical specialities as well [3].

Qualitative aspects of nutrition, i.e. dietary content and bioavailability of nutrients, including elements, should also be considered in the course of nutritional status assessment. Elements play an important role in body metabolism, among others by regulation of various enzyme activities [3-6]. Of that group, calcium, copper, iron, magnesium, potassium and zinc are considered as essential for human body [10].

Magnesium (Mg) has several body functions, including participation in carbohydrate and lipid metabolism [2,17]. Either excess or deficiency of this element is manifested by numerous disorders [6,14,16,19,20,22,25,28].

For years, hair has been used as a biomarker in forensic and environmental medicine. However, its application for the analysis of nutritional status has been questioned [21]. Nonetheless, determination of concentration of elements in hair undoubtedly predominates the measurements of their serum levels. The latter reflect concentrations of bioelements at single points of time and are strongly affected by their current dietary level [21,24,26,27]. Furthermore, bioelement analysis of hair is non-invasive, and the experimental material is easy to obtain and store [7,12].

There are many reports on magnesium content in hair of healthy individuals [1,7,15,18]. However, literature data on the association between hair levels of this element and BMI are limited [2,6,17,26]. Results of these scant studies suggest a decrease in magnesium level with increasing BMI values. However, studies of that type were not performed in Polish population thus far.

The aim of this study was to assess the concentrations of magnesium in hair of young healthy women and verify the relationship between this parameter and body mass index.

MATERIAL AND METHODS

Two-hundred and fifty-eight healthy women aged 19 to 24 years were subjected to the study. On the day of the survey, their health status was verified based on triplicate measurements of arterial blood pressure, pulse and blood glucose determinations as well as participants' self-assessment.

Individuals who were previously diagnosed with any chronic diseases were excluded from further analysis. Supplementation of elements and vitamin preparations during 6 months before the study and/or use of any hair-dressing treatments that may affect natural properties of hair constituted other exclusion criteria.

BMI of all participants was calculated based on their height and body mass measurements [3] and hair concentrations of magnesium were determined. Hair samples were obtained in accordance with analytical standards. Samples of 200-300 mg and 3-4 cm length (as measured from the skin surface) were collected from 6 different points of scalp. Magnesium concentrations were determined by the Laboratory of Environmental Analyses in Gniezno. The measurements were taken in ppm by means of atomic absorption spectrometry with AAS-3 spectrometer [1] with air-acetylene stoichiometric flame, wave length of 285.2 nm, and 0.5 mm aperture.

Hair magnesium concentration was presented as descriptive statistics (arithmetic mean, standard deviation and range). Association between BMI (<18.4 kg/m^2 vs 18.5-24.9 kg/m^2 vs >25.0 kg/m^2) and mean hair magnesium level was tested by means of ANOVA and post-hoc Tukey test. Calculations were performed using Statistica 7 (StatSoft®, Poland) software, and statistical significance was defined as $p \leq 0.05$.

RESULTS

The BMI of the study group ranged from 16.8 to 29.9 kg/m^2. Normal values of this parameter were observed in 163 (63.2%) out of 258 women analyzed. Overweight or underweight conditions were found in 60 (23.3%) or 35 (13.6%) subjects, respectively.

Table 1. Mean magnesium concentrations in hair of young healthy women (n=258) depending on their BMI

BMI (kg/m^2)	Hair magnesium concentration (ppm)		
	mean	SD	p
<18.4	78.331	28.08	<0.001
18.5-24.9	86.882	26.05	
>25.0	68.703	23.82	

1-3significant differences ($p \leq 0.05$, Tukey post-hoc test)

Mean magnesium concentration in hair of study participants amounted to 75.9±27.3 ppm (range 22.9-129.0 ppm).

Analysis of variance revealed significant differences in mean hair magnesium concentrations depending on BMI levels (Table 1). Magnesium concentration was found to be the lowest in hair of overweight women and the highest – in subgroup of women with normal body weight.

DISCUSSION

This study showed that nearly 40% of healthy young women have improper body weight – in most cases overweight. However, no cases of obesity were identified based on body mass index assessment. Similar incidence of overweight among young Polish women was revealed in the epidemiologic study Pol-Monica [23], which included the inhabitants of Warsaw, inter alia, and the study of Zatońska et al. carried out in the Lower Silesian population [29]. According to the WOBOSZ study, performed between 2003 and 2005, overweight or obesity is found in 50% of Polish females from the age of 20 to 74 years old [5].

Hair magnesium concentration in women studied ranged from slightly less than 23 ppm to 129 ppm. The results of previous studies on the tissue magnesium concentration in Polish population also were within a similar range [1,7,15,18], but variability of individual values was not as high as in our study.

Non-homogeneity of the sample studied in terms of hair magnesium concentration was further proved by the analysis of variance of this parameter depending on BMI level. Similar to previous studies performed in other countries [2,6,17,26], the level of magnesium was significantly lower in overweight women. Our study group lacked women with obesity but the results by other authors suggest that in this subpopulation significant decrease of Mg in hair also occurs compared to subjects with normal weight [6].

The aforementioned observations suggest that some of the women we tested were simultaneously exposed to at least two risk factors of cardiovascular diseases. Established harmful effects of overweight plausibly summed up with the negative consequences of magnesium deficiency. Low level of this element in the body was proved to disturb carbohydrate and lipid metabolism. Furthermore, magnesium supplementation was revealed to decrease total cholesterol and LDL and increase HDL level in a study on type-2 diabetes patients [17]. Consequently, synergic effects of overweight and magnesium deficiency seem to be associated with an elevated risk of dyslipidemia and resulting cardiovascular pathologies. On the other hand, the overweight condition found in some

of our subjects could also be of secondary origin and result from disturbances in carbohydrate and lipid metabolism being caused by magnesium deficiency.

In contrast to previous studies [2,6,17], our experiment showed that magnesium level in hair is also significantly decreased in underweight women. Although other authors claimed that tissue magnesium concentrations in the latter group could be lower compared to subjects of normal weight, the differences they have found were insignificant [6]. Decreased magnesium concentration in hair of healthy women with underweight is plausibly of primary origin and could be associated with direct or indirect dietary deficiencies of that element.

CONCLUSION

Our study revealed significant relationship between magnesium concentration in hair and nutritional status expressed in terms of BMI. In view of this relationship determination of magnesium in hair should be considered as an additional marker of nutritional status in health population. This test is non-invasive and its results are not confounded by a current dietary intake of magnesium [7,21,24,26,27]. Potential prognostic value of magnesium in hair is further supported by the significant differences in values of this parameter we observed among subgroups of both clinically and subjectively healthy persons. Consequently, individuals who were identified with decreased magnesium concentration in hair and abnormal BMI could be timely subjected to primary prevention of cardiovascular diseases.

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SUMMARY

Studies on the relationship between hair magnesium concentration and the level of body mass index (BMI) have not been performed in Polish population thus far. The aim of this study was to assess this relationship in the group of young healthy women. Women (n=258) aged 19 to 24 years were subjected to the study. They underwent anthropometric measurements and their magnesium concentrations in hair were taken by means of atomic absorption spectrometry. Normal values of BMI were recorded in 163 (63.2%) participants, whereas overweight and underweight occurred in 60 (23.3%) and 35 (13.6%) subjects, respectively. Average magnesium concentration in hair amounted to 75.9±27.3 ppm. This value was the lowest in overweight women and the highest in the subgroup of subjects with normal body weight ($p \leq 0.05$). In conclusion, determination of magnesium levels in hair seems to be useful as an additional marker of nutritional status in the healthy general population.

Keywords: women, hair, magnesium concentration

STRESZCZENIE

W populacji polskiej, dotychczas nie dokonano oceny stężenia magnezu we włosach w porównaniu z wartościami wskaźnika BMI. Celem badań było określenie zależności pomiędzy tymi markerami w grupie młodych zdrowych kobiet. Do badania zostały wytypowane kobiety (n = 258) w wieku od 19 do 24 roku życia. W badanej grupie wykonano pomiary antropometryczne a do oznaczenia stężenia Mg we włosach zastosowano metodę absorpcyjnej spektrometrii atomowej. Prawidłowe wartości BMI zarejestrowano wśród 163 (63,2%) badanych, podczas gdy nadwagę i niedowagę odpowiednio w 60 (23,3%) i 35 (13,6%) przypadkach. Średnie stężenie magnesu we włosach wyniosło 75,9±27,3 ppm. Wartość ta, była najniższa w grupie kobiet z nadwagą i najwyższa wśród kobiet z prawidłową wagą ciała ($p \leq 0,05$). Podsumowując, stężenie magnezu we włosach wydaje się być przydatne jako dodatkowy marker oceny stanu odżywienia w zdrowej populacji.

Słowa kluczowe: kobieta, włosy, stężenie magnezu