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Selenium in Plasma of Inhabitants of the Gdansk Region

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Abstract

The aim of this study was: (a) to estimate the concentration of selenium in plasma of 136 residents (59 men and 77 women) of the Gdansk region, northern Poland, aged 19-70; and (b) to compare the obtained results with data corresponding to healtly populations living in different European countries. Selenium in plasma was determined by atomic absorption spectrometry using the hydride generation method. The mean selenium concentration in plasma of the investigated persons was: 72.3 ± 14.1 μg/l, in men 75.9 ± 12.8 μg/l, in women 69.5 ± 14.7 μg/l. No age-dependent differences in plasma selenium were found in the investigated population. In 22% of the investigated persons the selenium level in plasma was lower than 60 μg/l. The obtained results indicate that a significant part of this population is deficient in selenium and should be supplemented with this element.

Keywords: selenium, humans, plasma, Gdansk region

Introduction

Selenium is an essential trace element. Because of the potential for producing adverse health effects from both selenium excess and from deficiency, risk assessment must include both possible effects. The margin for optimal selenium level and nontoxicity is relatively narrow [1]. The biological role of selenium in mammals including humans is attributed to its presence as an essential cofactor in glutathione peroxidase. This enzyme uses glutathione to reduce peroxides in cells and protects membrane lipids and possibly proteins and nucleic acids from damage by free radicals [2]. If the daily intake falls below 20-30 μg, there is a risk of selenium deficiency. The most extensively documented deficiency of selenium in humans is Keshan disease, whose symptoms include lesions of the heart and other striated muscles. A second disease is a degenerative osteoarthritis that affects mostly young children (Kashin-Beck disease). On the other hand, when the daily intake is continuously above 1000 μg there is a risk of selenium poisoning. Symptoms include gastrointestinal irritations, nail and skin lesions, hair loss, and in severe cases nerve damage [1, 3]. Epidemiological investigations have indicated a decrease in human cancer death rates correlated with an increasing selenium content in food [4].

The selenium level in plasma depends mainiy on its concentration in soil, which determines its level in foodstuffs.

The concentration of selenium in foodstuffs varies considerably (0.01-1.0 mg/kg), depending on the origin of the food. Grain grown in soil rich in selenium contains high concentrations. However, there are countries where the selenium level in soils is low (including Finland, Sweden, New Zealand, certain areas of China). Also, in Polish soils the selenium level is low and in the Gdansk region it is even lower 0.1-0.6 mg/kg d.w. (mean value 0.28 mg/kg) [5].

The aim of this study is to determine the selenium

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level in plasma of inhabitants of the Gdansk region and to compare the obtained results with data corresponding to healthy populations living in different European countries.

Materials and Methods

The concentration of selenium was determined in serum of 136 persons (59 men, 77 women) from the Gdansk region, aged 19-70. Blood samples (3 ml) were collected by venipuncture using Venoject II (Terumo) closed blood sampling system, containing potassium versenate. After centrifugation the obtained serum was placed into acid-washed poliethylene tubes, which were frozen immediately and stored at -20°C until analysis.

The method used was based on the procedure elaborated by Mestek et al. [6]. Samples of serum (1 ml) were combusted in a Uni Clever microwave mineralizer (Plazmatronika, Wroclaw, Poland) for 20 min. under a pressure of 42-45 atm. using 5 ml of concentrated nitric acid (Baker). Then 1 ml of 8% solution of urea (Merck) was added, and the sample was placed into a 20 ml beaker, then 0.8 ml of concentrated perchloric acid Suprapur (Merck) was added and heated in a thermostated mineralizer at 120-130°C for 90 min until the nitric acid was completely removed. The digested samples (0.6-0.8 ml) were diluted with redistilled water to 5 ml, then 5 ml of concentrated hydrochloric acid (Baker)was added and heated on a water bath at 80°C for 30 min.

After reduction of Se^{+4} to $Se^{+2}$with sodium borohydride in a automatic hydride generator with continuous flow generation system HG 3000, the final determination was performed on a Avanta Σ atomic absorption spectrometer (GBC).

Calibration lines for each set of determinations (in the range of 40-160 μg/l) were constructed. The accuracy of determinations was tested with the reference material Seronorm (Nycomed Pharma AS, Oslo, Norway). The recoveries of selenium from the plasma were 96.8%.

The coefficient of variation in samples of the plasma containing 77.5 + 5.3 μg Se/ml was ± 6.8%.

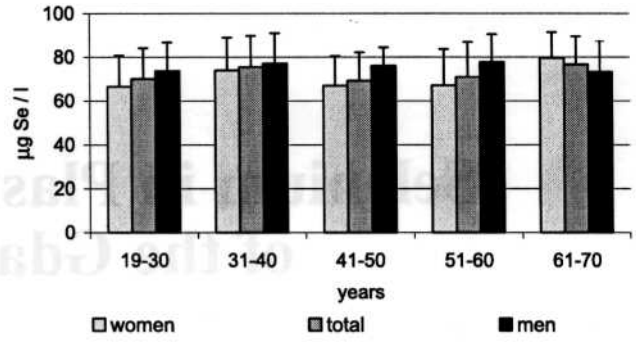

Fig. 1. Age-dependent selenium concentrations in plasma of residents of the Gdansk region.

Results and Discussion

Selenium concentrations in different age groups of men and women determined in this study are presented in Table 1. Age-dependent selenium levels in plasma in the investigated persons are given in Figure 1. The mean

Table 1. Selenium concentrations (μg/l) in plasma of residents of the Gdansk region (N. Poland).

Age (Years)		Men	Women	Total
19-30		n = 21 x = 73. 8 ± 12.9 Me = 72	n = 20 x = 66.6 ± 14.1 Me = 63.2	n = 41 x = 70.3 ± 13.8 Me = 65.9
31-40		n = 15 x = 77.2 ± 13.9 Me = 74.6	n = 15 x = 74.1 ± 14.9 Me = 72.9	n = 30 x = 75.6 ± 14.2 Me = 73.5
41-50		n = 6 x 76.1 ± 8.3 Me = 75.3	n = 18 x = 67.1 ± 13.4 Me = 63.7	n = 24 x = 69.3 ± 12.8 Me = 67.7
51-60		n = 9 x = 77.7 ± 12.8 Me = 78.9	n = 14 x = 67.2 ± 16.5 Me = 66.1	n = 23 x = 71.1 ± 15.8 Me = 67.7
61-70		n = 8 x = 73.4 ± 13.8 Me = 78.2	n = 10 x = 79.5 ± 11.9 Me = 82.7	n = 18 x = 76.7 ± 12.8 Me = 79.5
Total	n = 136 x = 40.5 ± 14.2 Me = 40 GM = 37.9	n = 59 x = 75.9 ± 12.8 Me = 76.8 GM = 74.3	n = 77 x = 69.5* ± 14.7 Me = 65.4 GM = 68.4	n = 136 x = 72.3 ± 14.1 Me = 71.6 GM = 70.9

N = number of subjects, x = arithmetic mean ± SD, Me = median value, GM = geometric mean, * = $p < 0.01$.

Table 2. Literature values for selenium levels in plasma in adult healthy populations.

Country	µg Se/l	Authors
Switzerland	96.0 ± 13.3 (men) 87.9 ± 14.4 (women)	Haldimann et al. (1996) [7]
Germany (Dresden)	86.0 ± 13.4	Meisner (1997) [10]
Spain (Valencia)	81.0 ± 1.8	Alegria et al. (1996) [11]
Poland (Łódź)	78.0 ± 17.9	Skłodowska et al. (1994) [8]
Poland (Gdańsk)	72.3 ± 14.1	This paper
Poland (North-western)	54.8 ± 10.9	Trzcinka-Ochocka et al. (2000) [9]
Slovakia (Bratislava)	56.2 ± 8.5	Madarić et al. (1994) [12]
Finland	50-60 (1970s) 125 (1990)	Wang et al. (1998) [13]
Yugoslavia	50.0 ± 18.0	Maksimovic et al. (1992) [14]

concentration of selenium in plasma of the population occupationally not exposed to this element amounts to 72.3 ± 14.1 µg/l.

Measurments of selenium in serum and blood are usually taken in order to identify a possible deficiency, rather than to demonstrate toxic effects. For populations receiving sufficient amounts of selenium in food, the selenium level in serum is usually between 60 and 120 µg/l [1]. Monitoring of selenium in blood provides information on selenium status. In cases of selenium deficiency, selenium concentrations in blood and plasma are low (<40 µg/l).

The mean selenium concentration in plasma of the investigated population was within the normal range, although about 22% of individual results were below this level. More results in the lower range were found in women (31.2%) than in men (11.8%). Plasma selenium in men is 8.5% higher than in women ($p < 0.01$) (Table 1). Similar relations found also Haldimann et al. [7]. No age-dependent differences in plasma selenium were found in the investigated population.

In Poland plasma selenium depends on geographical location. Results obtained in this study are similar to those obtained by Sklodowska et al. [8] and differ markedly from results derived from the population of north-western Poland by Trzcinka-Ochocka et al. [9], which amount to 54.8 ± 10.9 µg/l.

The mean selenium level in plasma in Poland is lower than in many other European countries (Table 2). This data indicate that a large part of the Polish population is deficient in selenium. The results obtained in this study indicate that there is a need to import of grain and other foodstuffs from countries with high selenium levels in soils. Also, it is necessary to supplement with selenium persons deficient in this trace element as well as periodical monitoring of selenium levels in plasma of the investigated population.

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