Original Article

Comparison of selenium status between Japanese living in Tokyo and Japanese Brazilians in São Paulo, Brazil

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Selenium (Se) concentrations were determined in human serum, rice and wheat flour sampled in the city of São Paulo, Brazil, and compared with those sampled in Tokyo, Japan. Serum levels of Se were significantly lower in Japanese Brazilians than Japanese living in Tokyo. The samples of rice consumed by Japanese Brazilians in São Paulo contained 22.7 ng Se/g on average, which was about half the selenium level in rice consumed in Tokyo. Rice commonly consumed in São Paulo might be one of the factors to lower the serum level of Se.

Key words: Japan, Japanese Brazilian, rice, São Paulo, selenium, serum, Tokyo.

Introduction

Selenium (Se) is an essential trace element in humans, and blood measurement can be a useful measure of the biological nutritional Se status. Serum levels of Se fluctuate mainly due to differences in diet. In our previous study, dietary intake of Se in Japanese populations was indicated as adequate, but the serum Se concentration was much lower in Japanese Brazilians than in Japanese living inside Japan.[1]

About 250 000 Japanese immigrated to Brazil before 1978 and this is now the world's largest Japanese population outside Japan. Of Japanese descendants living in Brazil, it is estimated that one-fourth reside in the city of São Paulo. Lifestyle and dietary changes in this migrant population were reported in the previous cross-sectional surveys.[2,3]

The lower levels of serum Se in Japanese Brazilians in São Paulo may be attributed to Se levels in dietary components, as well as to changes in dietary patterns. Cereals were reported to be the primary sources of organic Se compounds and the differences in Se content depend on the regions producing them. In the present study we focused on Se concentrations contained in the raw materials of staple foods consumed most regularly in São Paulo and Tokyo, and possible contributors to Japanese Se status are discussed.

Materials and methods

Both rice and wheat flour samples were purchased in Tokyo and the Japanese residential quarter of the city of São Paulo. In Tokyo, 15 kinds of polished rice, grown in Akita, Niigata, Hokkaido, Miyagi, Ibaraki, Tochigi, Fukushima, Yamagata and Aomori in north-east Japan, and two kinds of wheat flour samples imported from the USA and Canada were obtained. In São Paulo, five kinds of polished rice produced in São Paulo and Rio Grande do Sol in southern Brazil, two kinds of wheat flour from São Paulo (in the city of Santos) and Ceara State (Fortaleza) in north-eastern Brazil were collected. These samples are most popularly consumed by Japanese living in São Paulo or Tokyo.

Subjects of this study were part of our cross-sectional epidemiological study described elsewhere.[2,4] Briefly, in the city of São Paulo, subjects were randomly selected on the condition that they were first-generation Japanese immigrants or second-generation Japanese descendants; both parents were Japanese. The subjects were aged 40–69 years. In the Tokyo metropolis, subjects aged 40–49 years were randomly selected from residents of the Public Health Center district of Katsushika-kita. Blood was obtained by venipuncture after the subjects had abstained from food for at least 5 h. Serum samples were obtained from a total of 116 men in São Paulo (47 men aged 40–49 years), and 118 men in Katsushika-kita, Tokyo. Information on dietary patterns was collected through a questionnaire given by a trained nurse or nutritionist. The study was conducted in accordance with the internationally agreed ethical principles for the conduct of medical research.

The Se concentrations were determined by Watkinson's method using fluorometry.[5] All the rice and wheat samples were analysed in triplicate, and serum samples in duplicate. The reference materials were measured simultaneously and confirmed that the mean values were within the certified limits. Precision, as a coefficient of variation, of Se determination was 3.2%. The test of difference between Japanese Brazilians and Japanese in Tokyo was done by means of *t*-tests and Mann–Whitney *U*-test for continuous variables and Fisher's exact test for categorical variables.

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Results

As shown in Table 1, the amount of Se in rice consumed in São Paulo was found to be 22.7 ± 5.9 ng/g (range: 13.6–28.4), which was significantly lower than the level of 45.2 ± 15.4 Se ng/g (range: 24.8–67.3) in rice consumed in Tokyo. The Se levels in wheat flour in São Paulo and Tokyo did not differ significantly. Wheat flour sampled in São Paulo and Tokyo contained 36.5 and 32.3 ng Se/g, respectively.

Serum Se levels were found to be significantly higher in male Japanese living in Tokyo (146 ± 18 ng/mL) than those in São Paulo (96 ± 19 ng/mL), as shown in Table 1. The grand mean of serum Se in the subjects aged 40–69 years in São Paulo was 93 ± 21 ng/mL (n = 116). Although no significant difference was observed between their rice eating frequencies, there was a significant difference between São Paulo and Tokyo in the average number of bowls of rice consumed per day. More frequent consumption of bread was observed in Japanese Brazilians in São Paulo.

Discussion

The present study showed that rice produced in Japan was found to contain higher concentrations of Se than that produced in Brazil. The dietary Se intake principally depends on the region of origin of the foodstuffs. Soils deficient in Se are particularly prevalent in parts of Scandinavia, China and New Zealand, and the relationship of Keshan disease to the low Se content of grains seemed clearly established in a Chinese province.[6] Rice produced in the Keshan disease area (mean plasma levels of Se: 24 ± 11 ng/mL) was reported to contain 11.7 ng Se/g, whereas rice produced in non-endemic areas in China ranged 29–83 ng Se/g.[7] The present study showed that the rice produced in Rio Grande do Sol in southern Brazil, which covers 44% of the rice consumed in Brazil (Gazeta Marcantil 1998), was found to contain only 22.7 ng Se/g.

The study of staple foods alone to assess Se intake is subject to limitations because some kinds of accompanying dishes such as seafood contain higher concentrations of Se. One of the methods to estimate the Se intake from the diet is duplicate portion sampling, the direct determination of the Se content in meals, but it is inconvenient for long-term studies, and in most cases a definitive conclusion cannot be reached due to wide variation in food consumption. Another alternative would be to use food composition tables for calculating the Se supply based on individual food records. Nevertheless, this procedure is inadequate for studies in which the food sources are geographically widely distributed.

Preferably, the daily intake of cereal products has been demonstrated to be well correlated to the daily intake of Se, due to the high daily intake of foodstuffs from this group.[8] Cereal products are not very rich in Se, but they are staple items in the diet and hence confer a substantial contribution to the Se intake.

Furthermore, bioavailability of Se varies considerably depending on the different chemical forms. Selenium consumed in foods exists in a number of organic and inorganic forms including selenomethionine, selenocysteine, selenate and selenite. The major chemical form of Se in both rice and wheat is selenomethionine, which is reported to have high nutritional availability. To be more precise, the Se present in most plants is highly available (85-100%), whereas seafood has a lower bioavailability for Se ranging from 20 to 50%,[9] and in meat products approximately only 15%.[10]

Taking bioavailability into consideration, the Se level in cereals is expected to correlate with that in human blood. Our study indicates that the mean serum level of Se was significantly lower in the Japanese residents of São Paulo than in those living in Tokyo. Most Japanese Brazilians still eat rice daily as a staple food, even though they have changed their dietary patterns gradually since immigration. Low Se content in rice produced in Brazil is probably reflected in their serum Se status. They eat bread more frequently than Japanese living in Tokyo; however, Se from wheat products may be insufficient to compensate for the lower intake of Se from rice.

In conclusion, the present study suggests that immigration to Brazil has led to a reduction in blood Se status, possibly from foods containing a lower level of Se. Further research is needed to determine exactly the potential factors causing low Se status in Japanese Brazilians in São Paulo.

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Table 1. Selenium (Se) content in rice and wheat flour samples consumed in São Paulo and Tokyo, Mean ± SD of serum Se levels, and frequency of eating staple foods by male Japanese aged 40–49 years in São Paulo and Katsushika-kita, Tokyo

	Brazil São Paulo	Japan Tokyo	Difference*
Se levels in raw food			
Rice (ng/g; n)	22.7 ± 5.9 (5)	45.2 ± 15.4 (15)	$P < 0.001$†
Wheat (ng/g; n)	36.5 (2)	32.3 (2)	*NS*†
Study subjects (n)	(47)	(118)	
Age (years)	44.2 ± 2.6	45.3 ± 2.8	*NS*
Length of residence (years)	25.9 ± 11.4	24.8 ± 14.6	*NS*
Se levels in serum (ng/mL)	96 ± 19	146 ± 18	$P < 0.001$
Eating frequency			
Rice ≥ 5/week (%)	94	92	*NS*‡
Bowls of rice/day	2.2 ± 0.9	3.0 ± 1.3	$P < 0.001$
Bread ≥ 5/week (%)	62	25	$P < 0.001$‡

*These were analysed by Student's t-test (no symbol), †Mann–Whitney U-test, and ‡Fisher's exact test. *NS*, not significant.

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