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The Distribution of Selenium in Human Blood Samples of Israeli Population—Comparison between Normal and Breast Cancer Cases

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ABSTRACT

A preliminary study was carried out in order to compare the selenium concentration in breast cancer patients and healthy subjects (controls) in Israel. Blood serum samples were obtained from 32 breast cancer patients and 36 controls and were analyzed for selenium by the XRF method. A weighted mean of 0.076 ± 0.014 ppm Se in the blood serum of breast cancer patients, as compared to 0.119 ± 0.023 ppm Se for controls, was obtained. These results indicate that the concentration of selenium in breast cancer patients is significantly lower than in controls. The relationship between selenium concentration and malignancy stage shows an inverse dependence, i.e., the concentration decreases with stage number.

INTRODUCTION

The element selenium is an essential nutrient. Pure selenium deficiency has been produced in experimental animals (*1*), and for decades, producers of poultry and livestock have understood the practical importance of adequate selenium intake (*2*).

The human requirement for selenium is not precisely known, but the amount of dietary selenium needed to maintain adults in selenium balance is influenced by habitual selenium intake. In Israel, the uptake is of the order of 77.3 mg/y/person (*3*).

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Lately, selenium has been shown to have antitumorigenic effects in experimental animals. Significant reductions in hepatic, colon, and mammary tumors have been observed in animals supplemented with selenium, and a decrease in tumor incidence was reported (*4–6*).

Recent research has drawn attention to the possible role of selenium as a nutritional anticancer agent (*4*). It was reported that an inverse relationship exists between selenium concentration in the population of a particular area and the cancer mortality in the same area (*3,7*). Therefore, it has become the practice in the last few years, to determine selenium levels in blood and other tissue samples of patients with oncological conditions. The results were compared with normal levels in order to find a possible correlation between the selenium concentration in normal and tumoral conditions (*8–14*).

This work presents the results of a preliminary study on a population of breast cancer cases, as compared to normal controls, in order to investigate the possible relationship between the selenium levels in these two groups in Israel.

MATERIALS AND METHODS

Subjects and Samples

A total of thirty-two breast cancer patients treated at the Elias Sourasky Medical Center, Tel-Aviv, participated in this study. Thirty-six apparently healthy workers from the Soreq Nuclear Research Centre, Yavne, served as controls.

Blood samples were obtained by venapuncture, centrifuged and the serum separated. Samples for the determination of selenium were prepared by introducing 0.75 μL serum into polyethylene cups with a mylar bottom and drying in air for about 24 h.

Selenium Analysis

The determination of selenium was carried out by the XRF method based on excitation with a Mo X-ray tube. The 11.2 keV Kα X-ray of selenium was measured with a Si(Li) detector with an energy resolution (FWHM) of 160 eV for the 6.4 keV Fe Kα X-ray.

Selenium standards, in the range of 0.5–5 ppm, were prepared by dissolving SeO_2 in diluted nitric acid and mixing the obtained solution with serum. The precision of the standards, comprising preparation and measurement, was checked for 4 different concentrations, 3 replicates each, and found to be $\pm 3\%$ (1σ).

The minimum detection limit (M.D.L.), defined as $3\sqrt{B}$, where B is the number of background counts in the region of interest, is 0.05 ppm selenium for 100 s counting time.

A typical X-ray energy spectrum of a serum sample, in comparison with a blank (empty sample container), is given in Fig. 1. It is clearly shown that the Se Kα peak is well resolved and can be evaluated.

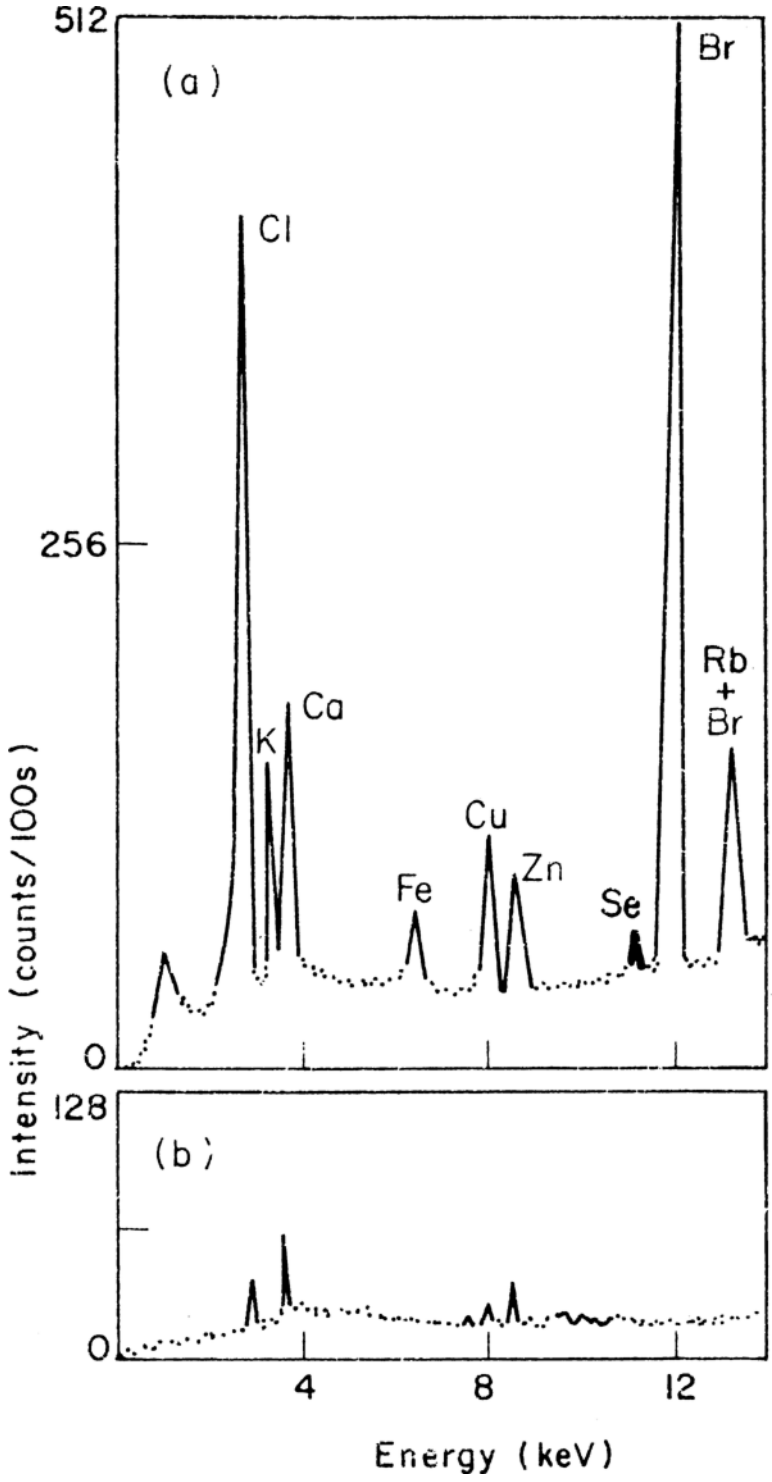

Fig. 1. X-ray energy spectra, a, serum sample (0.14 ppm Se); b, blank (empty container).

RESULTS AND DISCUSSION

The relevant data of the cases studied are shown in Table 1. As can be seen, there is a difference between the range of ages in the controls and the patients (28–61 and 41–80, respectively). This difference is graphically expressed in Fig. 2a which depicts the age distribution of the cases studied.

However, as can be seen in Fig. 2b, the selenium concentration in blood serum is not dependent on age and remains practically constant in each group of patients and controls. Therefore, it is possible to compare the results obtained for selenium in the blood serum of the two groups in spite of the difference in the range of ages.

The results of the selenium analyses in blood serum show that the weighted mean of the selenium concentration in the group of breast cancer patients is 0.076 ± 0.014 ppm (for 32 cases). This value is significantly lower than the weighted mean of 0.119 ± 0.023 ppm obtained for the group of controls (36 cases).

The results obtained for selenium in blood serum for the breast cancer patients and the control were divided into two subgroups, "high" and "low" selenium concentration, where the borderline between the two subgroups was taken as 0.10 ppm (*see* Fig. 3). This value represents the weighted mean of the 36 controls minus one standard deviation (1σ). The aim of this subdivision was to present the data in a form which will show clearly the difference between the selenium concentration in the serum of patients and controls.

Figure 3 shows the selenium concentrations in the "low" (<0.10 ppm) and the "high" (≥ 0.10 ppm) subgroups for patients and controls as well as the mean value for each subgroup. As can be seen, 86% of the controls are in the "high" subgroup with a mean of 0.130 ± 0.023 ppm Se and only 14% of the cases are in the "low" subgroup with a mean of 0.074 ± 0.015 ppm Se. On the other hand, 62.5% of breast cancer patients are in the "low" subgroup with a mean of 0.068 ± 0.015 ppm and

Table 1
Characteristic Data of the Subjects Studied

	Breast cancer patients	Controls
No. of subjects	32	36
Mean age (years)	59.9	46.8
Median age (years)	60.5	50.0
Range of ages	41–80	28–61
Stage number (Ref. 15)	No. of cases	
I	12	—
II	5	—
III	9	—
IV	6	—

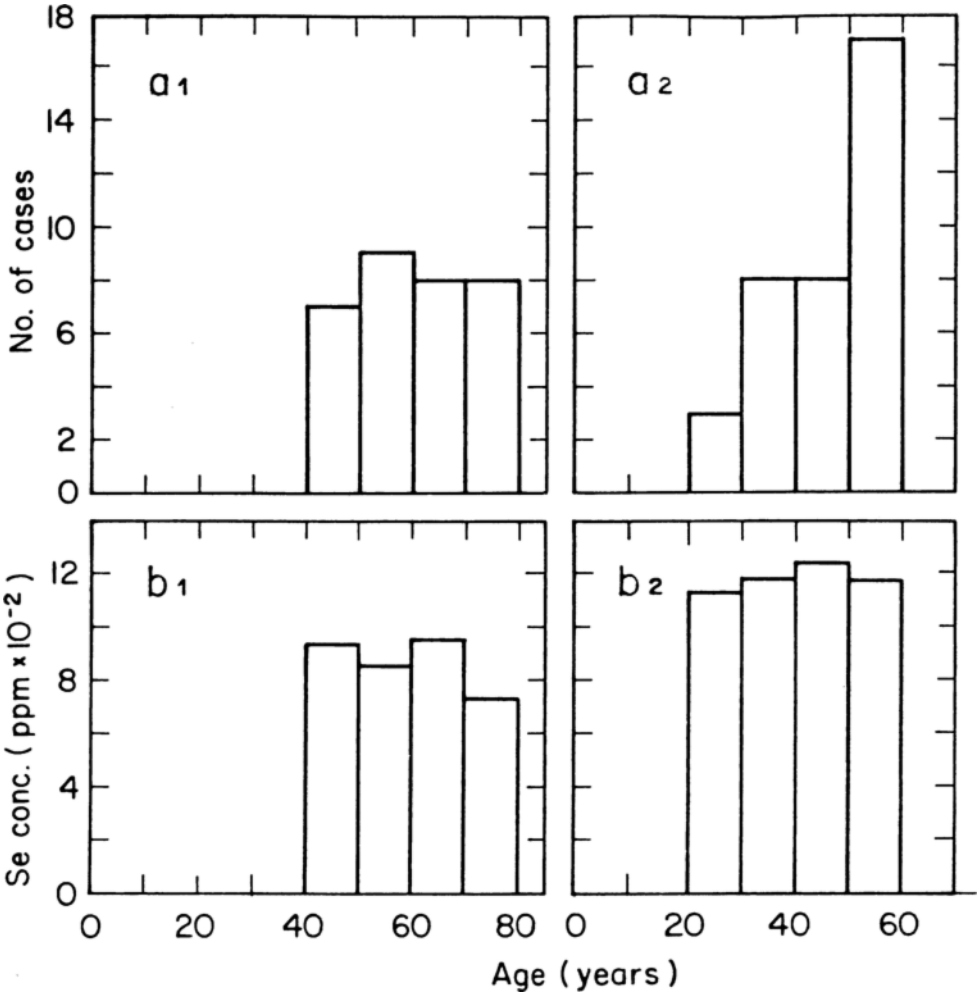

Fig. 2. a, Number of cases as a function of age; 1, breast cancer cases, 2, controls; and b, Selenium concentration as a function of age; 1, breast cancer cases, 2, controls.

37.5% are in the "high" subgroup with a mean of 0.119 ± 0.015 ppm. The difference between the mean of the "low" subgroup of the breast cancer patients and the mean of the "high" subgroup of the controls is 3 to 4 standard deviations (3-4σ). Therefore, it may be concluded that this difference is real and the two subgroups are distinct. This validates the finding that the selenium level in blood serum of breast cancer patients is significantly lower than in controls.

The selenium concentration in the serum of breast cancer patients was studied as a function of breast cancer stage (*15*). The results are shown in Fig. 4. The straight line obtained was calculated according to the least squares method and the linearity is expressed by the high correlation coefficient. It appears that there is a significant inverse relation between selenium concentration in blood serum and the stage of malig-

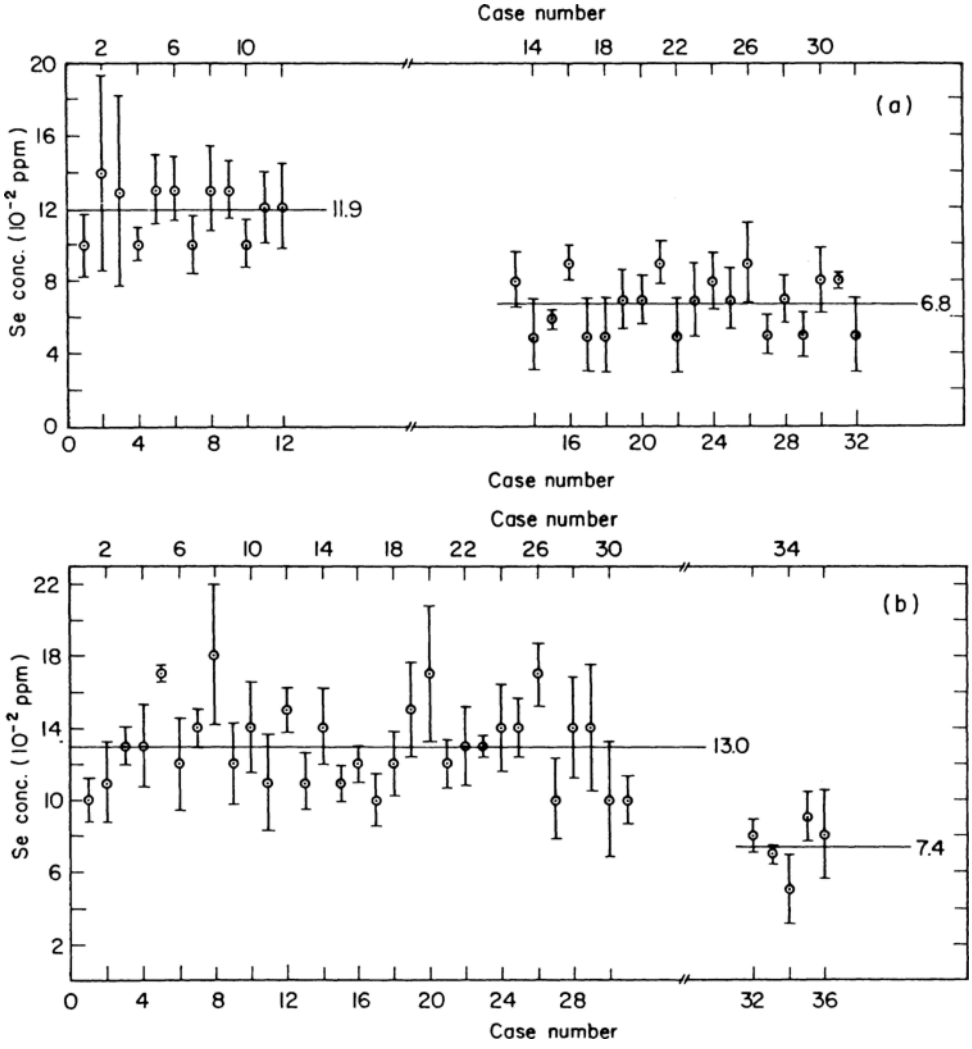

Fig. 3. Selenium concentration in serum, divided into "high" and "low" subgroups (borderline = 0.10 ppm); a, patients; b, controls.

nancy, namely, the selenium concentration decreases with increasing stage number.

CONCLUSIONS

The results of the selenium concentration in blood serum obtained in the present study for controls (0.119 ± 0.023 ppm) are in very good agreement with results reported previously by Schrauzer for the Israeli population: 0.17 ppm for whole blood (*3*). This value corresponds to 0.13 ppm in serum (*16*). The agreement indicates the reliability of the method of selenium analyses used in this study and of the results obtained.

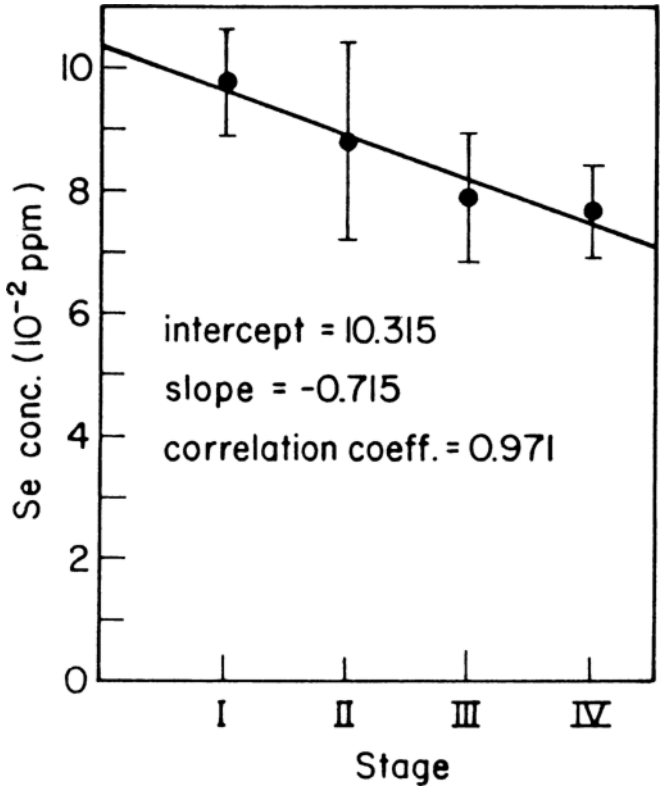

Fig. 4. Selenium concentration as a function of breast cancer stage.

The major observation of the present work is the low selenium concentration in breast cancer patients with a mean value of 0.076 ± 0.014 ppm as compared to a relatively high mean value of 0.119 ± 0.023 ppm for healthy individuals (controls). This observation is in accordance with the findings reported in the literature (*3*).

Another conclusion is the linear decrease of the selenium concentration in the blood serum of breast cancer patients as a function of the stage of malignancy. This relationship agrees well with previous findings which show the inverse trend of selenium concentration in blood serum vs mortality (*3,7*).

Being a preliminary study, the present work was based on a relatively small number of cases. It is intended to broaden the scope of the investigation in order to validate the results and the conclusions. Breast cancer cases in advanced stages, prior to any medical treatment, will be studied.

In addition, two groups of the Israeli population will be studied: kibbutz (agricultural settlement), a homogeneous community, whose members live a uniform way of life (nutrition, environment, and so on); and urban population, a heterogeneous community.

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