Relationships Between Blood Selenium Concentrations and Grasping Power, Blood Pressure, Hematcrit, and Hemoglobin Concentrations in Japanese Rural Residents

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INTRODUCTION

Selenium (Se) has been recognized as essential to animal species and Se deficiency causes many abnormalities such as skeletal and cardiac muscle degeneration\(^1\), decreased motility of smooth muscle\(^2\), anemia\(^3\) and so on. However, such Se deficiency is uncertain in man and little is known about the role of Se in human health, except that Se is a component of glutathione peroxidase\(^4\) which might function as a scavenger of peroxides generated in cells. Furthermore, there are few reports on blood Se levels in Japanese although Se contents of food products in Japan have been reported\(^5\)\(^-\)\(^8\).

Thus, the purpose of this study is to examine the blood Se levels in Japanese rural residents and to investigate the relationships between the blood Se levels and health indices such as grasping power, blood pressure and anemia, since grasping power and blood pressure are expected to reflect partially the skeletal, cardiac and smooth muscle conditions and anemia is often found in Japanese rural residents, especially in women.

METHODS

Subjects of this study were 693 rural residents (274 men of 20-83 years and 419 nonpregnant women of 20-82 years) living in the northeastern districts of Fukui Prefecture in Japan, whose major professions are agriculture or forestry. Their age distribution and the ratio of the subjects to the population (more than 20 years) are shown in Table 1.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Men</th>
<th></th>
<th></th>
<th>Women</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subjects</td>
<td>Population</td>
<td>Ratio (%)</td>
<td>Subjects</td>
<td>Population</td>
<td>Ratio (%)</td>
</tr>
<tr>
<td>20~29</td>
<td>22</td>
<td>164</td>
<td>13</td>
<td>22</td>
<td>119</td>
<td>19</td>
</tr>
<tr>
<td>30~39</td>
<td>35</td>
<td>127</td>
<td>28</td>
<td>41</td>
<td>114</td>
<td>36</td>
</tr>
<tr>
<td>40~49</td>
<td>42</td>
<td>116</td>
<td>36</td>
<td>83</td>
<td>138</td>
<td>60</td>
</tr>
<tr>
<td>50~59</td>
<td>68</td>
<td>177</td>
<td>38</td>
<td>124</td>
<td>196</td>
<td>63</td>
</tr>
<tr>
<td>60~69</td>
<td>57</td>
<td>102</td>
<td>56</td>
<td>83</td>
<td>124</td>
<td>67</td>
</tr>
<tr>
<td>70~</td>
<td>50</td>
<td>99</td>
<td>51</td>
<td>66</td>
<td>128</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>274</td>
<td>785</td>
<td>35</td>
<td>419</td>
<td>819</td>
<td>51</td>
</tr>
</tbody>
</table>

Venous blood samples were collected into plastic tubes containing ethylenediamine tetraacetic acid dipotassium salt at the same time the health survey was conducted in July 1982 and July 1983. Hemoglobin and hematcrit were measured by cyanmethemoglobin and microhematcrit methods. Selenium concentrations in whole blood were determined by spectrofluorometry\(^9\). Occult blood, sugar, urobilinogen and...
protein in urine were examined by testape. Grasping power and blood pressure were measured by a Smedley-type handdynamometer and a sphygmomanometer, respectively. Electrocardiograms (ECG) were recorded by the standard 12 leads and judged according to the Minnesota codes9).

In order to examine whether the relationships between blood Se levels and the health indices are changed under normal and abnormal health conditions, the subjects were divided into 3 groups as follows. Group A: normal subjects; Group B: subjects with positive findings in the urinalysis; Group C: subjects with abnormal cardiovascular findings (borderline hypertension and hypertension based on the criteria by WHO9) with or whithout abnormal traces in ECG such as Q•QS patterns (Minn. code 1-1~3), left axis deviation (2-1), high R waves (3-1, 3), ST segments (4-1~3), T waves (5-1~3), premature beats (8-1), atrial fibrillation (8-3), and so on.

RESULTS

Blood Se concentrations were in the range of 60~220 ng/ml both for men and women. They showed normal distribution curves as in Fig. 1, and even if the subjects were limited to the fifth decade, they also showed similar but slightly right-shifted curves. Mean blood Se concentrations for the men in each of the second to the sixth decades were significantly higher than those of the women in corresponding decades (p<0.05, respectively).

Blood Se levels decreased with aging (Fig. 2) and such a relationship did not change in Group A, Group B or Group C as shown in Table 2. There was no significant difference in the blood Se levels among the 3 groups if age was matched.

![Fig. 1 Cumulative curve for Se concentration in whole blood.](image)

![Fig. 2 Distribution of blood Se concentrations by age and sex.](image)

![Table 2 Correlations between age and blood Se concentrations.](image)
Since grasping power, blood pressure, hematocrit and hemoglobin concentrations were also related to age as shown in Table 3, the relationships between blood Se levels and grasping power, blood pressure, hematocrit and hemoglobin concentrations were examined by partial correlation coefficients with age factor fixed.

Table 3 Correlation coefficients between age and grasping power, blood pressure and anemia indices.

<table>
<thead>
<tr>
<th>Group</th>
<th>Grasping power</th>
<th>Blood pressure</th>
<th>Anemia indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L + −0.726***</td>
<td>D + −0.093</td>
<td>Ht + −0.384***</td>
</tr>
<tr>
<td></td>
<td>R + −0.692***</td>
<td>S + 0.080</td>
<td>Hb + −0.347***</td>
</tr>
<tr>
<td>A</td>
<td>L −0.583***</td>
<td>D 0.106</td>
<td>Ht 0.137*</td>
</tr>
<tr>
<td></td>
<td>R −0.605***</td>
<td>S 0.333***</td>
<td>Hb −0.016</td>
</tr>
<tr>
<td>Men</td>
<td>L −0.640***</td>
<td>D −0.115</td>
<td>Ht −0.530**</td>
</tr>
<tr>
<td></td>
<td>R −0.742***</td>
<td>S −0.017</td>
<td>Hb −0.419*</td>
</tr>
<tr>
<td>Women</td>
<td>L −0.582***</td>
<td>D −0.002</td>
<td>Ht −0.131</td>
</tr>
<tr>
<td></td>
<td>R −0.658***</td>
<td>S 0.452***</td>
<td>Hb −0.083</td>
</tr>
<tr>
<td>B</td>
<td>L −0.779***</td>
<td>D 0.059</td>
<td>Ht −0.312***</td>
</tr>
<tr>
<td></td>
<td>R −0.743***</td>
<td>S 0.409***</td>
<td>Hb −0.338***</td>
</tr>
<tr>
<td>Men</td>
<td>L −0.638***</td>
<td>D 0.045</td>
<td>Ht −0.194*</td>
</tr>
<tr>
<td></td>
<td>R −0.725***</td>
<td>S 0.404***</td>
<td>Hb −0.105</td>
</tr>
<tr>
<td>Women</td>
<td>L −0.760***</td>
<td>D 0.091</td>
<td>Ht −0.332***</td>
</tr>
<tr>
<td></td>
<td>R −0.739***</td>
<td>S 0.327***</td>
<td>Hb −0.370***</td>
</tr>
<tr>
<td>C</td>
<td>L −0.625***</td>
<td>D 0.233***</td>
<td>Ht −0.100*</td>
</tr>
<tr>
<td></td>
<td>R −0.681***</td>
<td>S 0.505***</td>
<td>Hb −0.088</td>
</tr>
</tbody>
</table>

As shown in Fig. 3, significant positive correlation was observed between blood Se levels and grasping power in men except for Group B. In Group A, the partial correlation coefficient for the men was significantly higher than that for the women (p<0.05) but such a sex difference was not significant either in Group B or in Group C.

Positive correlations were also observed between blood Se levels and blood pressure in the men of Group A (Fig. 4). In Group A, the partial correlation coefficient for the men was significantly higher than that for the women (p<0.05). However, such a sex difference was not significant in Group B or Group C.

On the contrary, weak but significant correlations were observed between blood Se levels and both hematocrit and hemoglobin concentrations only in the women of Group A (Fig. 5), in whom the best correlations were found for hematocrit at the third decade (r=0.460, n=36, p<0.01) and for hemoglobin concentrations at the latter half of the fifth decade (r=0.583, n=38, p<0.001).

DISCUSSION

As shown in Table 1, the response rate (the ratio of the subjects to the population) was relatively low, particularly in the men of the second to the fifth decades and in the women of the second and the third decades. The reason was probably that there were very few farmers in those generations and that many of the residents went to work in urban areas during the daytime when the health survey was
conducted. Thus, our subjects did not sufficiently represent the population. However, if it is true that environmental conditions have great effects on human blood Se levels, our subjects were expected to be affected enough by the rural environment since they had been living in the rural districts for more than 20 years and their major professions were agriculture or forestry.

The Se levels of our subjects were lower than those of American people (mean: 206 ng/ml) and higher than those of normal New Zealand people (mean: 68 ng/ml). According to the review by Thomson and Robinson, estimated human dietary intake of Se was in the same order as above. The age-related decrease in blood Se levels was also reported by Dickson and Tomlinson. Although sex differences in blood Se levels have not been significant in some reports, sex differences similar to ours were reported in white Georgians by McAdam et al.

As shown in Fig. 3 and 4, blood Se levels correlated more closely with grasping power and blood pressure in the normal men than in the normal women, but such a sex difference was not obvious in the subjects with abnormal health conditions such as Group B or Group C. This might indicate that Se is more important for muscle contractions in men than in women and that interactions between Se and muscle cells are not efficient under abnormal health conditions. The importance of Se for human muscle contractions was also suggested by Örndahl et al., who found that serum Se concentrations in myotonic dystrophy patients decreased in direct proportion to the progression of the illness. Although precise mechanisms are not known, it has been proposed that Se is essential for preservation of membrane integrity of muscle cells. Such a proposal may be partially supported by the fact that Se is a component of glutathione peroxidase which would protect cells against oxidative damage.

In animal species, Se is required for heme metabolism and Se deficiency causes anemia. However, little is known about the relation of Se and hemoglobin metabolism in man. In our subjects, blood Se levels were

Fig. 3 Correlations between blood Se concentrations and grasping power with age factor fixed. Open columns, shadowed columns and alphabets in the figure represent left hand, right hand and groups of the subjects categorized in Methods, respectively.

* $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Fig. 4 Correlations between blood Se concentrations and blood pressure with age factor fixed. Open columns, shadowed columns and alphabets in the figure represent diastolic blood pressure, systolic blood pressure and groups of the subjects categorized in Methods, respectively. * $p<0.05$.

Fig. 5 Correlations between blood Se concentrations and anemia indices with age factor fixed. Open columns, shadowed columns and alphabets in the figure represent hematocrit, hemoglobin concentrations and groups of the subjects categorized in Methods, respectively. * $p<0.05$, *** $p<0.001$. 
positively correlated with both hematcrit and hemoglobin concentrations at least in the normal women (Fig. 5). Thus, Se could play some role in human hemoglobin metabolism, but further studies are necessary.

In conclusion, blood Se concentrations were positively correlated with grasping power and blood pressure in the normal men and correlated with hematcrit and hemoglobin concentrations in the normal women. However, such correlations varied under abnormal health conditions such as positive urinalysis or hypertension.

SUMMARY

Relationships between blood selenium (Se) concentrations and grasping power, blood pressure, hematcrit and hemoglobin concentrations were investigated in Japanese rural residents (274 men of 20-83 years and 419 non-pregnant women of 20-82 years). The results are as follows.

1) Blood Se concentrations were more positively correlated with grasping power and blood pressure in the normal men than in the normal women.

2) Blood Se concentrations were positively correlated with both hematcrit and hemoglobin concentrations only in the normal women.

3) Such relationships, observed in the normal subjects, were not so clear in the subjects with positive urinalysis or with abnormal cardiovascular findings.

REFERENCES

農山村地区住民における血中セレン濃度と握力・血圧・ヘマトクリット・ヘモグロビン濃度との相関性

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福井県の農山村地区住民（男性：274名、20〜83歳、女性：419名、20〜82歳）における血中セレン（Se）濃度と握力・血圧・ヘマトクリット・ヘモグロビン濃度との相関性を検討し、次の結果を得た。

1）血中Se濃度は、正常女性よりも正常男性において、より強く正の相関性を握力や血圧に対して示した。
2）正常女性においてのみ、血中Se濃度はヘマトクリット及びヘモグロビン濃度の両方に対して正の相関性を示した。
3）正常者におけるこのような関係は、検尿陽性者や循環器所見者においては明瞭に認められなかった。

Key words: Selenium, Grasping power, Blood pressure, Hematcrit, Hemoglobin

セレン，握力，血圧，ヘマトクリット，ヘモグロビン

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