Deficiencies of Trace Elements among the Aged and Clinical Aspects

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Abstract: A survey was conducted on the aged individuals at health care facility for the elderly to investigate problems associated with the intake of minerals and trace elements among the aged Japanese. In addition, the literature was reviewed to the effects of trace elements that are involved in diseases common among the aged. The results indicated that although aged individuals consume the same amount as young people, the plasma concentration of calcium of the former was lower, indicating that their capacity to utilize this metal (e.g., intestinal absorptive capacity) has been compromised. Furthermore, consumption of magnesium and zinc is very low among the aged and their plasma concentrations of these elements are frequently far below the normal threshold. These facts indicate that aged individuals suffer from a very poor nutritional state. A review of the literature revealed that magnesium and selenium are involved in circulatory diseases; and not only iron but also copper and zinc play a role in the development of anemia. Iron and zinc are related to the pathogenesis of decubitus ulcers; zinc and lithium in psychiatric disorders; and chromium and vanadium related to the cause of diabetes mellitus. Generally speaking, aged individuals consume less than optimum amounts of trace elements and their capacity to utilize them is limited. Thus it is possible that the lack of an adequate supply of these trace elements may explain why many of the diseases normally attributed to old age develop.

Key words: Trace elements; The aged; Nutritional status; Mineral

Introduction

Various physiological changes related to nutrition take place in old age. First, the deterioration in the capacity for digestion and absorption results in a need for intake of nutrients in excess of what an average adult requires per unit weight. In the aged, the capacity to retain nutrients in the body appears also to be reduced. Because the intracellular fluid volume is reduced, a large quantity of nutrients (e.g., potassium and magnesium) that...
have been dissolved in this fluid also tend to be lower. The gustatory sensation is compromised and the sensation for sweet or salty flavors becomes exaggerated in comparison with that they had when they were younger. The deterioration in the masticatory function results in a preference for softer food; and a reduced intake of dietary fibers may lead to the development of constipation.

The present study was conducted to investigate how the physiological changes and the status of mineral and trace element nutrition in the aged — such as that described above — are related to their health and affect the development of diseases.

**Status of Mineral Nutrition in the Aged**

First, a study was conducted to discover the status of mineral nutrition among the aged.\(^1\) For the subjects, 10 male and 10 female inpatients were selected (average age, 77.4 years). The prerequisites used for the selection were that they were suffering from conditions such as arteriosclerosis and osteoporosis (common among the aged) but were at a relatively mild stage of the disease; and they still retained a certain level of independence in their daily activities. For the controls, 10 male and 10 female students or hospital employees (average age, 24.6 years) were selected. The participants were asked to fill out a dietary survey sheet on 3 consecutive days. The amounts of calcium, magnesium, zinc, and copper consumed were computed by using a nutrient computing program prepared for use on a personal computer and which was based on a table of components of standard Japanese foods and several references. Blood specimens were collected from both patients and controls following fasting and their plasma mineral contents were computed. It was found that each of the 4 minerals cited exhibits a different pattern of consumption and absorption.

The amount of calcium consumed varied widely among individuals regardless of their age but the mean did not differ significantly between the two groups. However, the plasma calcium concentration of the aged individuals was significantly lower than that of the younger subjects, proving that although calcium consumption is similar in these two groups, its utilization is far less efficient among the elderly.

In Fig. 1, the relationship between magnesium intake and its concentration in the plasma is shown. The amount of magnesium consumed is evidently low and so is its plasma concen-
tration in the older population. Although the plasma magnesium concentration is not a sensitive indicator of magnesium balance in the body, the concentrations for 3 of the older individuals were below the normal level, suggesting that their state of magnesium deficiency was advanced.

Figure 2 shows the relationship between zinc intake and plasma zinc concentration. Zinc intake was generally low among the aged; the plasma zinc concentration was below the lower threshold of the normal level in many; and a correlation was noted between the intake of magnesium and zinc and their plasma concentrations.

Copper intake by the aged was very low, with an evident difference between the young and the aged. However, there was no difference in the plasma copper concentrations between these groups; neither was there any correlation between the intake and their plasma concentrations. It appears that there is a need to develop better evaluation indices for copper.

The study described above has a certain limitation — i.e., it was conducted on a unique group of aged individuals (e.g., inpatients). However, it is sufficient to suggest that among these older subjects, their intake of minerals and trace elements is reduced and their capacity to utilize them (e.g., their rate of intestinal absorption) has been compromised; thus their nutritional state vis-à-vis trace elements deteriorates as they grow older.

Diseases of the Aged and Trace Elements

1. Circulatory diseases

Although not included in the category of trace elements, magnesium is closely related to circulatory diseases. The antagonist-like action of magnesium prevents calcium from flowing into the vascular smooth muscle cells. Because of this action, magnesium has an effect to prevent myocardial and cerebral infarctions. As described above, its intake by the aged is low: special caution must be exercised in this area.

According to a report from China, Keshan disease, a heart disease prevalent there, is caused by a selenium deficiency. Starting around 1974, a special nutritional program was implemented to add selenium to the diet of inhabitants in those areas where this disease was endemic, which resulted in dramatic reductions in its mortality and prevalence. Selenium is incorporated in the form of a seleno-amino acid into glutathione-peroxidases, which plays an important role in preventing oxidation disorders. A selenium deficiency and a resultant increase in the lipid peroxide level invite the development of circulatory diseases such as arteriosclerosis. Known food sources of selenium include fish and grains, which are often favored by the aged. However, the overall intake of food decreases as one grows older and it is quite possible that some may suffer from a deficiency of this element.

2. Anemia

Figure 3 shows the frequency of the incidences of anemia at each age level, according to the National Nutrition Survey in Japan. Among women, peaks are noted in those in their 30s and 40s, which can be explained by heightened iron requirements due to menstruation. As men and women become older, the incidence of anemia also rises. However, aged individuals consume a greater amount of iron than their younger counterparts. One must look into other areas — e.g., a reduced capacity to utilize this element — to explain the causes for iron deficiency anemia.

In the relationship with trace elements, copper plays a role in supplying iron to various tissues in the body. Thus even when the iron intake is adequate, a copper deficiency may cause anemia. Furthermore, it was found recently that anemia may also be caused by a zinc deficiency. As stated earlier, copper and zinc intake is low among the aged and it is possible that a deficiency of either of these
elements is involved in the development of anemia among the aged population.

3. Decubitus ulcer
A decubitus ulcer causes extreme pain to the bed-ridden elderly and markedly deteriorates their QOL. Tanaka et al.\(^4\) divided bed-ridden inpatients over 65-years of age into those with a decubitus ulcer and those without (the controls) and studied their nutrient intake. There was no significant difference between the two groups in the intake of iron and zinc; but it was slightly higher for the group with decubitus ulcers. Yet the iron and zinc concentrations in the serum were significantly lower in this group, suggesting a reduced rate of utilization of these trace elements. It is probable that for these aged bed-ridden patients, supplementation with trace elements — such as zinc, which restores the immune and tissue repair capacities and iron, which prevents the development of anemia — will lead to prevent decubitus ulcers.

4. Psychiatric disorders
Among autopsy cases, Kimura et al.\(^5\) selected 10 patients with hebephrenia (schizophrenia) and 10 who succumbed from other diseases and measured the zinc content in their brains. It was found that the zinc concentration in the brain of the former was significantly lower. Nishigori et al.\(^6\) in another study, reported that when health foods containing zinc were given to patients with hebephrenia (schizophrenia) their psychiatric symptoms ameliorated.

Schrauzer et al.\(^7\) reported that there is an inverse relationship between the lithium concentration in drinking water and the incidence of suicides and violent crimes, such as homicide, robbery, and rape; and they proposed that lithium probably has a sedative effect.

There is a possibility that these trace elements have an effect on the psychiatric condition of the aged. This subject will be investigated further.

5. Diabetes mellitus
There are many reports on diabetes mellitus and trace elements, among which chromium and vanadium are particularly worthy of attention. It has been reported that chromium restored glucose tolerance in young children who had been rendered glucose intolerant due to a nutritional disorder. In another report, glucose tolerance was reduced in patients who had been fed intravenously with an infusion fluid without the addition of chromium: the condition was refractory to insulin treatment and improved only when chromium was added to the infusion fluid. There are a number of reports on the beneficial effects of chromium...
on diabetes mellitus. Vanadium has frequently been cited for its contribution to improving glucose tolerance in rats with experimental diabetes mellitus. However, no detailed mechanisms by which these two elements act in combating diabetes mellitus have been given.

When these mechanisms are thoroughly explained and the safety and efficacy of these trace elements are established, it is possible that they will be used increasingly for the prevention and treatment of diabetes mellitus.

**Conclusion**

There are few studies that elucidate the metabolic state of trace elements in the aged; and only a limited number have been introduced to explain the effects of these elements on diseases. The present study was conducted on these limited data but one can be readily convinced that aged individuals take in reduced amounts of trace elements and their capacity to utilize them are also compromised. The aged suffer from diverse forms of illnesses, some of which are most likely to be caused by inadequate intake of these trace elements.

One hopes that progress will be made in studying this area so that many trace elements may be used to prevent and treat the diseases that afflict aged patients.

**REFERENCES**