Vitamin Intake in Japanese Women College Students

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Summary The Standard Food Tables of Japanese Foods was newly revised in 2000, and contains information on all of the vitamins except biotin. Thus, we carried out a survey of vitamin intake in Japanese women who were university seniors majoring a dietitian course. The subjects (n=33) consumed self-selected foods, and food intake was recorded by the weight method. We calculated the vitamin intake except for biotin from the food records using the Standard Food Tables of Japanese Foods. In terms of daily intake, vitamin A was 705±435 μg (mean±SD), vitamin D 6±8 μg, vitamin E 7.7±3.0 mg, vitamin K 191±156 μg, vitamin B1 0.7±0.3 mg (0.43±0.15 mg/1,000 kcal), vitamin B2 1.1±0.4 mg (0.65±0.18 mg/1,000 kcal), vitamin B6 0.9±0.4 mg (0.017±0.005 mg/g protein), vitamin B12 4.4±4.1 μg, niacin equivalent 23±7 mg (14.4±4.9 mg/1,000 kcal), pantothenic acid 4.6±1.4 mg, folic acid 267±115 μg, and vitamin C 73±32 mg. All of these averages were around the Japanese Recommended Dietary Allowance (RDA) for level “III (preferable)” of physical activity. Major vitamin A resources were vegetables; vitamin D resources, fish; vitamin E resources, fats and oils and vegetables; vitamin K resources, vegetables; vitamin B1 resources, cereals and animal meats; vitamin B2 resources, various foods; vitamin B6 resources, cereals, vegetables, fish, and animal meats; vitamin B12 resources, fish; niacin equivalent resources, fish, animal meats, and cereals; pantothenic acid resources, various foods; folic acid resources, vegetables; and vitamin C resources, vegetables and potatoes. From this survey, it was found that Japanese women college students consumed many kinds of food, and therefore, their vitamin nutrition was good as compared to the RDA values for level III of physical activity; however, their energy intake (1,622±377 kcal) was lower than the RDA for level III (2,050 kcal/d). Their strength of physical activity would be level I. Therefore, in consideration of their lifestyle, their energy intakes is considered adequate. In conclusion, a problem for student lifestyle is a shortage of food intake due to lack of exercise.

Key Words 12 vitamins, intake per day, food resources, food behavior, young Japanese women

In 2000, the newly revised Standard Tables of Food Composition (5th edition) (1) was published and 12 vitamins (except for biotin) are described (in the former edition, only five vitamins were described). Although, a report regarding the nutritional survey conducted by the Ministry of Health, Labor and Welfare is published annually in Japan, in which the intakes of vitamins A, B1, B2, and C are described in term of the recommended dietary allowances (RDAs) from 1975 to present day (2), some Western nutritionists, especially in foreign countries, have noted that nutritional status surveys in Japan are limited and require a long period of time before the papers are published in English. Foreign nutritionists want to know Japanese food behavior because the lifetime of Japanese men and women are the longest in the world, and Western nutritionists still think that Asia is mysterious, including matters related to food behavior.

Thus, we carried out a nutritional survey in 2001. Of the several age groups, the survey on the nutritional status of college women is especially important because they will bear and nurse children in the near future, and these children will learn the lifestyles of their mothers. We studied the dietary intake of 12 vitamins in free-living young adults (aged 21–22 y) who were not taking vitamin supplements.

MATERIALS AND METHODS

Subjects. Thirty-three healthy young women served as subjects. They were senior students and majored in a university dietitian course. The food survey was carried out in June 2001. The subjects were fully informed of the survey objectives. The subjects were 20.9±2.1 y old (mean±SD, n=33), 158.6±4.5 cm in height, and weight 50.6±4.43 kg.

Calculation method for vitamin intake. The subjects consumed self-selected foods. Food intake was measured by the weight method. Nutrient intake was calculated based on the Standard Tables of Food Composition.
in Japan (5th edition) (1). Unregistered items in the food tables were substituted for using the mean of existing items in the same food groups. The niacin intake from tryptophan was calculated using the assumption that the tryptophan content is 1% of protein intake and 1 mg niacin is converted from 60 mg tryptophan (3). The added amount of niacin and the niacin converted from tryptophan was referred to as niacin-equivalent (NE) intake. The value of vitamin B1 was described as that of free thiamin, although the value in the Standard Tables is described as thiamin-HCl because the RDA mentions free thiamin. Hemorrhage from foods during cooking was not considered for the calculations.

Statistics. Linear regression analysis was carried out using a computer program (StatView, ver 5.0J, Heulinks Co., Tokyo, Japan). The regression line was calculated using the least squares method. Correlation coefficients were calculated using the method of Pearson product-moment correlation coefficient. The significance of the linear correlation coefficient was tested using Fisher’s transformation test.

RESULTS AND DISCUSSION

Energy intake and the energy ratio of protein:carbohydrate:fat

Table 1 summarizes the energy intake and energy ratio of protein:carbohydrate:fat. The average energy intake was lower than that prescribed by the Japanese RDA (1,800 kcal/d for women of age 18–29 y at level II of physical activity) (4), but was higher than the 1,550 kcal/d figure for women of age 18–19 y at level I of physical activity. The preferred physical activity is walking (1,550 kcal/d at level III). The present findings mean that the vitamin intake of Japanese women college students is excellent. Vitamin A sources were Japanese eel, carrot, spinach, and pumpkin. Vitamin D sources were fish such as salmon, mackerel, and pacific saury. The energy ratio is also an important thing for sustaining a high quality of life. The ideal pattern recommended for the energy intake ratio of protein:carbohydrate:fat is 12:63:25 (4). In the present survey, the ratio was 14:55:31. Major sources of energy were rice, noodles (udon in Japanese), and bread. The fat energy was higher than the proposed energy value, and the main sources were corn oil and animal meats. The subjects preferred vegetables that belong to low-energy categories. From this graph, it can be seen that the subjects preferred vegetables that belong to low-energy foods, and is a reminder that vegetables are a good source of vitamins A, E, K, B6, C, and folic acid. This is a desirable phenomenon from the nutritional standpoint, and a characteristic of the lifestyles of our students. A similar lifestyle has been reported in the annual report based on the nutritional survey (2), which would be a result for receiving a good nutritional education from the Ministry of Health, Labor and Welfare in Japan.

Vitamin A sources were Japanese eel, carrot, spinach, and pumpkin. Vitamin D sources were fish such as salmon, mackerel, and pacific saury. Vitamin E sources were vegetables such as pumpkin as well as fats and oils, and vitamin K sources were natto and green vegetables such as spinach. Vitamin B1 sources were cereals, animal meats such as pork, fish such as salmon, Japanese eel, and mackerel, and vegetables such as green soybean (edamame in Japanese) and drinking canned carrot juice. The present findings mean that the vitamin intake of Japanese women college students is excellent.

Figure 3 shows respective vitamin sources in food categories. From this graph, it can be seen that the subjects preferred vegetables that belong to low-energy foods, and is a reminder that vegetables are a good source of vitamins A, E, K, B6, C, and folic acid. This is a desirable phenomenon from the nutritional standpoint, and a characteristic of the lifestyles of our students. A similar lifestyle has been reported in the annual report based on the nutritional survey (2), which would be a result for receiving a good nutritional education from the Ministry of Health, Labor and Welfare in Japan.

Table 1. Daily intakes of energy and energy intake ratio of protein:carbohydrate:fat.

| Energy          | Protein | Carbohydrate | Fat            |
|-----------------|---------|--------------|----------------|
| 1,622±377 kcal  | 57.3±16.4 g | 217.9±46.3 g | 55.5±20.5 g    |
| 229±66 kcal     | 827±185 kcal | 14.3±0.4% of total energy intake | 54.5±11.6% of total energy intake | 31.2±11.5% of total energy intake |

Each value is mean±SD (n=33).

1 Calculated based on the Standard Tables of Food Composition in Japan (5th edition, revised, 2000).
2 Calculated based on the energy conversion factor of Atwater.
Fig. 1. Frequency of daily vitamin intake by Japanese women college students. Each value in each graph is mean intake ± SD (n = 33). Calculation is performed using the Standard Tables of Food Composition in Japan (5th edition; Resources Council, Science and Technology Agency, Japan). The others are described in Materials and Methods.

foods, especially milk and eggs. Vitamin B₆ sources were banana, pacific saury, and chicken (breast without skin). Vitamin B₁₂ sources were fish such as salmon, mackerel, and pacific saury. NE sources were cereals, fish and animal meats. Folic acid sources were vegetables such as cabbage, spinach, edamame, and beverages such as the infusion of gyokuro. Vitamin C sources were vegetables such as cabbage, spinach, and potatoes.

Correlation of intake between each of the two vitamins among the 12 vitamins

The correlation between each of two vitamins among the 12 vitamins was calculated as shown in Table 2. Moderate correlations were observed for the following: vitamins B₁ and B₆ (the coefficient was 0.572; this was dependent on the intake of bonito, mackerel, yellow tail, broccoli, and spinach), vitamin B₁ and pantothenic acid (0.550; mackerel, salmon, yellow tail, and milk), vitamin B₂ and folic acid (0.508; natto, spinach, and broccoli), vitamin B₆ and NE (0.652; meats and fish such as beef, pork, pacific saury, mackerel, tuna, and yellow tail), vitamin B₆ and pantothenic acid (0.558; meats and fish such as beef, pork, pacific saury, and yellow tail), vitamin B₆, and folic acid (0.533; cabbage), vitamin B₁₂ and NE (0.532; meats and fish such as beef, pork, pacific saury, mackerel, and yellow tail), NE and vitamin D (0.527; fish such as salmon, pacific saury, and mackerel), vitamin K and folic acid (0.497; natto).

High correlations were observed in the following: folic acid and vitamin C (0.706; colored vegetables such as spinach, and broccoli), vitamin B₂ and pantothenic acid (0.828; pacific saury, milk, egg, and natto), B₁₂ and D (0.749; fish such as salmon and pacific saury).

These results mean that vitamin intakes generally correlated, and that specific vitamin deficiency seldom occurs if humans consume cereals, animal meats, fish, vegetables, and milk. In terms of characteristics, the intake of fruits was extremely low in our students. The following is a very old phrase, but it is very important:
Correlation between macronutrients and vitamin intake

Table 2 also shows the correlation between macronutrients and vitamin intake. The relationship between macronutrients and micronutrients is very important because the primary role of macronutrients is energy production through the metabolism of glycolysis, TCA cycle, β-oxidation, and amino acid catabolism, in which metabolism micronutrients, especially water-soluble vitamins, play a fundamental role as coenzymes.

A significant correlation was observed between energy intake and each of vitamin B1, vitamin B2, vitamin B6, vitamin B12, NE, pantothenic acid, folic acid, vitamin D, and vitamin E (Table 2). The entire vitamin B group was significantly correlated with energy intake. This finding is reasonable because these vitamins are involved in the energy production metabolisms.

As is shown in Table 2, a significant correlation was observed between fat intake and each of vitamin B1, vitamin B2, vitamin B6, vitamin B12, NE, pantothenic acid, folic acid, vitamin D, and vitamin E. Especially, the relationship between fat intake and vitamin E was high. Although vitamin A and vitamin K belong to fat-soluble vitamins, correlation between each of these vitamins and fat intake was low because the sources of these vitamins were vegetables.

Table 2 shows a correlation between protein intake and vitamin intake. A significant correlation was observed between protein intake and intake of each of the following: vitamin B1, vitamin B2, vitamin B6, vitamin B12, NE, pantothenic acid, vitamin D, vitamin E, and vitamin K. Especially, the relationships between protein intake and vitamin B1, vitamin B2, vitamin B6, NE, pantothenic acid, and vitamin D were high. Although the RDA for vitamin B6 is based on the value per g protein intake, the coefficient value was not so high. Therefore, when much more protein is consumed, it is important to heed the intake of vitamin B6. Potatoes are a good source of vitamin B6.

Table 2 also shows the correlation between carbohydrate intake and vitamin intake. A significant correlation was observed between carbohydrate intake and the intake of each of the following: vitamin B1, vitamin B2, vitamin B6, pantothenic acid, vitamin C, and vitamin E. Especially, the relationship between carbohydrate intake and pantothenic acid was high. Although it has been noticed that the fundamental role of vitamin B1 is in the metabolism of carbohydrate, the coefficient value between carbohydrate intake and vitamin B1 intake was not so high. Therefore, we have to heed vitamin B1 intake. However, the energy ratio of carbohydrate over total energy intake seems to have declined recently in Japan, especially in young people.

As has been reported previously (5–9), the average energy intake was lower than the Japanese RDA (1,800 kcal for women aged 18–29 y at level II of physical activity) (4), but was higher than that of 1,550 kcal for women aged 18–19 y at level I of physical activity. Nevertheless, all vitamin intake except for vitamin K...
intake, which was much higher than the RDA in terms of mean value, were near that recommended by the RDAs for level III of physical activity. Although vitamin losses occur during food processing and cooking, we did not consider such hemorrhages. Furthermore, the bioavailability of vitamins in foods is not 100%; for example, the bioavailability of niacin in corn is low (10). We did not consider bioavailability for decisions against the sufficiency of each vitamin. However, evaluation of the hemorrhages and the bioavailability of vitamins in foods are very important matters in nutritional assessment. We plan to conduct such experiments in the future.

A nutritional survey of Japanese women college students by Yasuda’s group (5–7) reported that the daily energy intake was 1,568 ± 321 kcal, and the daily intakes of vitamins B6, B12, A, C, and E were 1.35 ± 0.53 mg, 4.79 ± 3.55 mg, 587 ± 262 μg retinol equivalent, 128 ± 137 mg, and 7.2 ± 2.2 mg, respectively, and the intakes of niacin equivalent and folic acid were 24.0 ± 5.9 mg and 190.6 ± 70.0 μg, respectively. Similar values have also been reported by Hiraoka (9). Therefore, the present data are no exception and represent the typical food habits of Japanese women college students.
students. On the contrary, from the data of Japan's national nutritional survey in 2000 (2), the average daily intake of energy, protein, fat, carbohydrate, vitamins A, B₁, B₂, and C in women ages 20–29 y was 1,977 kcal, 76.2 g, 62.6 g, 265 g, 747 μg retinol equivalent, 1.17 mg, 1.32 mg, and 114 mg, respectively. The energy intake, including protein, fat, and carbohydrate, and vitamin intake are lower in college women students than in young women in general. But, there is one reason: the survey conducted by Yasuda's group (5–7) and Hiraoka (9) were done in April, and the present survey was done in June (the period from April to July opens normal class in Japan). On the contrary, the national nutritional survey is conducted in November every year. Therefore, the differences between women college students and young women in general might be dependent on seasonal change. But, we did not account for these variations because various foods can be obtained independent of the season in Japan. Therefore, the nutritional problem is that the food intake is lacking for Japanese women in college, which seems to reveal erroneous feminine psychology; they believe that a lean body is more beautiful. On the contrary, their energy ratio of fat was over 30%. This finding reflects that they like food fried in oil.

For vitamin status, folic acid intake is very important in young women. For the prevention of neural tube defects, it is noted that a folic acid intake of 400 μg/d should be taken (11). In Japan, the committee for RDA did not recommend a folic acid supplement. McPartlin et al. (12) revealed that dietary folic acid is not efficiently used in the human body; the so bioavailability would be around 50%. If so, the available folic acid intake would be only 130 μg/day, which suggests that folic acid supplement must be also recommended for young women in Japan.

In their food selection on behavior, they ate a lot of vegetables including colored vegetables such as spinach and edamame, indicating that their intake of vitamins A, C, and K and folic acid were excellent. Their intake of vitamins B₁₂ and D was dependent on the behavior of eating fish such as pacific saury, salmon, and mackerel. In Japan, pork is also an excellent source of vitamin B₁, and “tonkatsu,” (i.e., typical cooking style for pork) is the number one source of vitamin B₁. For vitamin B₂ and pantothenic acid intake, the correlation between the intake of the two vitamins was very high. Therefore, the sources of the two vitamins were the same: cereals, vegetables, fish, animal meats, eggs, and milk. These findings indicate that the food selection behavior of Japanese college women, who will give birth and nurse their babies in the near future as well as teach lifestyle to their children and become leaders in the community, was good except that energy intake was low. This is because young women have a strong aversion to becoming fat. The nutritional problem in Japanese college women is a shortage of food intake. Their level of physical activity is around “1.” Therefore, in consideration of their lifestyle, their energy intake is adequate.

In conclusion, the choice among various foods is
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good, and the vitamin sources for Japanese women college students were cereals for vitamin B1 and pantothenic acid; vegetables for vitamin A, vitamin K, folic acid, and vitamin C; animal meats for niacin and vitamin B1; fish for niacin, vitamin D, and vitamin B12; fats and oils for vitamin E; and milk and eggs for vitamin B2 and pantothenic acid. However, the intake of energy, namely food intake, is lacking as compared to the value for recommended physical activity (level III, 2,050 kcal/d). For Japanese women college students (5–9), the problem related to lifestyle would be that of lack of exercise.

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