

Original Article

Personal behaviors including food consumption and mineral supplement use among Japanese adults: a secondary analysis from the National Health and Nutrition Survey, 2003-2010

Yoko Sato PhD, Megumi Tsubota-Utsugi PhD, Tsuyoshi Chiba PhD,
Nobuyo Tsuboyama-Kasaoka PhD, Hidemi Takimoto MD, Nobuo Nishi MD,
Keizo Umegaki PhD

National Institute of Health and Nutrition, National Institutes of Biomedical Innovation, Health and Nutrition, Shinjuku-ku, Tokyo, Japan

Background and Objectives: A daily mineral supplement is useful for those who are at risk of a deficiency. Some Western reports suggest that mineral supplement users have healthy behaviors and are not mineral-deficient. It is unknown whether the same phenomenon is observed in Japan where there is a different dietary culture. The aim of this study was to examine the characteristics of personal behaviors including food consumption nationwide among mineral supplement users from the National Health and Nutrition Survey in Japan 2003-2010. **Methods and Study Design:** Data were obtained from 16,275 adults aged 20-59 years who completed socio-demographic, health status, and 1-day household dietary assessments. Supplement users were compared with non-users. Logistic regression models were utilized to identify the characteristics of food consumption and calcium and iron supplement use, using the medium intake group as a reference. **Results:** Overall, 2.1% and 1.4% of adults reported using calcium supplements and iron supplements, respectively. Calcium supplement users were more likely to be physically active, non-smokers, and eat less fat compared with non-users. Furthermore, they were more likely than non-users to consume a higher intake of calcium from foods such as tea, vegetables, seaweeds, and fruits. Iron supplement users were more likely than non-users to be non-smokers. These individuals tended to have a high intake of seaweeds and fruits. **Conclusions:** Japanese adults who had healthier behaviors were more likely to use mineral supplements, especially calcium. Mineral supplement users tended to choose healthy foods such as seaweeds and fruits, without considering their overall mineral consumption.

Key Words: Japanese adults, mineral supplements, personal behavior, food, National Health and Nutrition Survey in Japan

INTRODUCTION

Dietary supplement use is prevalent among adults in many countries.¹⁻⁵ It is reported that dietary supplement users tended to be women, older age, non-smokers, more physically active, and leaner compared with non-users in the United States National Survey.¹ It has also been shown that dietary supplement users have healthier eating habits than non-users.^{2,3,6} However, the exact opposite occurs as well: dietary supplement users tend to have unhealthy dietary habits.⁴ This inconsistency could be due to different cultures or dietary habits surveyed in the studies. Eating habits and dietary culture vary among different countries. Previous studies on the health related behaviors of Japanese supplement users are limited in their comprehensiveness because these studies were only regional.^{5,7,8} One study, which analyzed data from the National Health and Nutrition Survey (NHNS) in Japan, showed only the usage ratio of dietary supplements by sex and age categories.⁹ To our knowledge, there was no national survey report on dietary supplement use among Japanese adults

in relation to personal behaviors including food consumption.

The NHNS determined the usage of vitamin (Vitamins B-1, B-2, B-6, C, and E) and mineral (calcium and iron) supplements from 2003. Vitamin and mineral supplements are effective in improving the nutritional condition from insufficiency, because human dietary requirements have been defined.¹⁰ In the US survey, it has been shown that vitamin and mineral supplement use were not only helpful to improve poor nutrition, but also caused detri-

Corresponding Author: Dr Yoko Sato, National Institute of Health and Nutrition, National Institutes of Biomedical Innovation, Health and Nutrition, 1-23-1 Toyama, Shinjuku-ku, Tokyo 162-8636, Japan.

Tel: +81-3-3203-5721; Fax: +81-3-3202-3278

Email: satoyoko@nih.go.jp

Manuscript received 08 December 2014. Initial review completed 20 March 2015. Revision accepted 23 April 2015.

doi: 10.6133/apjcn.2016.25.2.20

mental effects due to unnecessary use and excessive dependency.^{1,11,12} Calcium and iron intakes have been shown to be low among Japanese adults, and health risks may be associated.¹³⁻²⁰ For this reason, calcium and iron supplement use would be helpful to assure adequate intake of these minerals in the Japanese population. Conversely, some reports showed that supplemental calcium^{21,22} and heme iron²³ increased cardiovascular risk, and supplementation of the two minerals caused overdose toxicity.²⁴⁻²⁶ Therefore, understanding the characteristics of Japanese mineral supplement users, especially those who consume excess or very few foods, is important to promote proper use and attenuate harmful effects caused by dietary supplements.

In the present study, we examined the sociodemographics, health status, nutrition intake, and mineral dietary supplement use among adults, based on the data from the NHNS in Japan 2003-2010. We also examined the association between mineral supplement use and mineral intake and food choices focusing on both high and low food intake.

MATERIALS AND METHODS

Study population

The present study used the NHNS data from 2003 to 2010 with permission from the Ministry of Health, Labour and Welfare, Japan. The NHNS is conducted every November as a cross-sectional survey of a nationally representative sample of the non-institutionalized Japanese population. It includes physical examination, a dietary survey, and questionnaires on health-related behaviors.²⁰ Details of NHNS study protocol, data collection design, and other documentation are available online (in Japanese).¹³⁻²⁰ The quality assurance of data processing has been described elsewhere.²⁷ The sample included 38,421 adults aged 20-59 years. Among the samples, we excluded pregnant and/or lactating women (n=672), participants who provided incomplete answers (n=18,402), and participants whose calcium or iron intake from foods were statistical outliers between the top and bottom 5% (n=3,072). The final sample for analyses was 16,275 adults.

Sociodemographics and health status

In the NHNS, sociodemographic and health status data were obtained by questionnaire. The sociodemographic items included sex (men/women), age, residential area based on regional block (Hokkaido, Tohoku, Kanto, Hokuriku, Tokai, Kinki, Chugoku, Shikoku, and Kyushu and Okinawa), residential area according to population size (Metropolises, cities with populations $\geq 150,000$, cities with populations 50,000-150,000, cities with populations $< 50,000$, and towns and villages), and size of household (one/multiple). Health status included height, weight, current medication (antihypertensive, antiarrhythmic, antihyperglycemic, antihypercholesterolemic drugs; yes/no), exercise habit (more or less than 30 minutes \times 2 days/week), sleep duration per night (< 6 hours, 6-7 hours, ≥ 7 hours), smoking habit (current, past/never), and drinking habit (current, past/never). Body mass index (BMI) was calculated as weight (kg)/height (m²).

Food and nutrient intake

A semi-weighed, 1-day household dietary record with approximate proportions by which family members shared each dish was used.²⁷ All food recorded in the survey was categorized into 99 food groups in a small class, 34 food groups in a middle class, and 18 food groups in a large class. In the present study, we used characteristic food groups of the typical Western or Japanese dietary patterns. Namely, tea was in the small class, rice products and soy products were in the middle class, and vegetables, fruits, mushrooms, seaweeds, fish and shellfish, meats, dairy products, oils and fats were in the large class. Nutrient intake for each family member was estimated based on the Standard Tables of Food Composition in Japan, Fifth Revised (NHNS 2003-2004), and Fifth Revised and Enlarged Edition (NHNS 2005-2010).¹⁰ We used the energy, protein, fat, calcium, iron, and intake data.

Dietary supplement use

Dietary supplement intake containing seven vitamins (vitamins B-1, B-2, B-6, C, and E) and minerals (calcium and iron) was also collected using the 1-day dietary record in the NHNS. There is no clear definition of dietary supplements in Japan. Therefore, in the present study dietary supplements were defined as "supplements, including drugs or quasi-drugs, intended for ingestion in pill, capsule, tablet, powder, or liquid form", as per the NHNS definition.¹³⁻²⁰

Statistical analysis

Nutrient and food intakes were categorized into three groups by quartiles to determine the characteristics of lowest or highest intake groups; i.e., Q1 was the lowest group, Q2 and Q3 made up the medium group, and Q4 was the highest group. Categorical variables were described using percentage; continuous variables were described using mean \pm SD.

The sociodemographic, health status, and nutrition intake (energy, protein, fat) were compared between dietary supplement users and non-users of calcium and iron supplements. The chi-square test and *t*-test were performed for categorical and continuous variables, respectively.

Logistic regression models were used to identify the association between calcium or iron supplement use and mineral and food consumption, using the medium intake group as a reference and adjustment for significant factors with univariate analysis.

All statistical analyses were performed using PASW statistics for Windows (version 18.0J, 2009; SPSS Inc, Chicago, IL, USA), and the level of significance was set at $p < 0.05$.

RESULTS

Characteristics of calcium supplement users

The calcium supplement users were 2.1% (n=336) of adults (Table 1). The calcium supplement users were more likely to be women, living in the Kanto area or a metropolis, in a single-person household, and older in age compared with non-users. Health statuses of users were: greater amount of exercise, more likely to be non-smokers, shorter height, and lower weight and BMI. Also, calcium supplement users tended to eat less fat than non-

Table 1. Characteristics of calcium and iron supplement users and non-users among Japanese adults, from the National Health and Nutrition Survey 2003-2010

	Calcium supplement		<i>p</i> -value	Iron supplement		<i>p</i> -value
	User (%) n=336	Non-user (%) n=15939		User (%) n=221	Non-user (%) n=16054	
Total	2.1	97.9		1.4	98.6	
Sex						
Men	27.4	40.0	<0.001	24.0	39.9	<0.001
Women	72.6	60.0		76.0	60.1	
Age (mean±SD)	46.1±10.0	43.4±10.8	<0.001	43.6±10.2	43.5±10.8	0.863
Residential area based on regional block						
Hokkaido	3.9	3.5	0.012	3.6	3.5	0.118
Tohoku	3.9	8.3		3.2	8.3	
Kanto	33.6	27.0		31.2	27.1	
Hokuriku	3.6	6.4		4.1	6.4	
Tokai	13.4	13.9		13.1	13.9	
Kinki	18.8	16.4		19.9	16.4	
Chugoku	7.4	7.1		5.9	7.1	
Shikoku	3.3	4.3		4.1	4.2	
Kyushu/Okinawa	12.2	13.2		14.9	13.1	
Residential area according to population size						
Metropolises	27.7	15.9	<0.001	22.6	16.1	0.024
≥150,000 people	34.2	32.9		35.7	32.9	
50,000-150,000 people	22.6	24.1		22.2	24.1	
<50,000 people	3.9	8.3		5.9	8.3	
Towns and villages	11.6	18.7		13.6	18.6	
Household						
One person	13.4	6.3	<0.001	14.9	6.4	<0.001
Multiple persons	86.6	93.7		85.1	93.6	
Energy intake [†]						
Lowest (Q1)	54.2	49.9	0.197	52.9	50.0	0.576
Medium (Q2 and Q3)	24.7	25.0		24.9	25.0	
Highest (Q4)	21.1	25.1		22.2	25.0	
Protein intake [†]						
Lowest (Q1)	53.3	49.9	0.200	52.0	50.0	0.090
Medium (Q2 and Q3)	25.9	25.0		29.0	24.9	
Highest (Q4)	20.8	25.1		19.0	25.1	
Fat intake [†]						
Lowest (Q1)	55.4	49.9	0.032	50.2	50.0	0.980
Medium (Q2 and Q3)	25.6	25.0		25.3	25.0	
Highest (Q4)	19.0	25.1		24.4	25.0	
Exercise habit						
≥30 minutes×2 days/week	27.4	21.0	0.005	24.9	21.1	0.182
<30 minutes×2 days/week	72.6	79.0		75.1	78.9	
Sleep duration						
<6 hours	33.0	33.5	0.412	37.6	33.5	0.387
6-7 hours	44.0	40.9		39.8	40.9	
≥7 hours	22.9	25.6		22.6	25.6	
Smoking status						
Current	30.1	39.0	0.001	29.4	38.9	0.005
Past/Never	69.9	61.0		70.6	61.1	
Drinking status						
Current	54.5	55.5	0.740	50.7	55.5	0.153
Past/Never	45.5	44.5		49.3	44.5	
Height (mean±SD)	160±7.3	162±8.6	<0.001	160±7.3	162±8.6	0.001
Weight (mean±SD)	56.7±10.3	59.7±11.9	<0.001	57.0±9.9	59.7±11.9	<0.001
BMI (mean±SD)	22.1±3.2	22.8±3.6	<0.001	22.3±3.6	22.8±3.6	0.034
Antihypertensive drug						
Yes	5.1	7.5	0.119	4.1	7.5	0.076
No	94.9	92.5		95.9	92.5	
Antiarrhythmic drug						
Yes	1.8	0.9	0.076	1.4	0.9	0.448
No	98.2	99.1		98.6	99.1	
Antihyperglycemic						
Yes	0.9	2.0	0.227	0.5	2.0	0.137
No	99.1	98.0		99.5	98.0	
Antihypercholesterolemic drug						
Yes	4.5	3.7	0.467	1.8	3.8	0.152
No	95.5	96.3		98.2	96.2	

SD: standard deviation. *p*-value was calculated using the χ^2 test for categorical variables and *t*-tests for continuous variables.[†]Categorized into quartiles of intake.

Table 2. Likelihood of calcium supplementation across calcium and food intake quartiles among Japanese adults, from the National Health and Nutrition Survey 2003-2010

		Quartiles of dietary intake		
		Medium (Q2 and Q3) (Reference)	Lowest (Q1) OR (95% CI)	Highest (Q4) OR (95% CI)
Food calcium (mg)	Range	334-607	181-334	607-973
	Crude	1	0.95 (0.71-1.27)	1.70 (1.34-2.18)
	Adjusted [†]	1	0.97 (0.72-1.30)	1.64 (1.27-2.10)
All calcium (mg)	Range	335-613	181-335	613-3840
	Crude	1	0.50 (0.31-0.79)	5.02 (3.93-6.43)
	Adjusted [†]	1	0.46 (0.29-0.74)	5.31 (4.12-6.84)
Rice products (g)	Range	220-451	0.0-220	451-1720
	Crude	1	1.27 (1.00-1.62)	0.64 (0.47-0.87)
	Adjusted [†]	1	1.12 (0.88-1.43)	0.85 (0.62-1.18)
Soy products (g)	Range	0.1-81.0	0.0-0.0	81.1-1090
	Crude	1	1.11 (0.85-1.44)	1.20 (0.92-1.55)
	Adjusted [†]	1	1.09 (0.84-1.43)	1.13 (0.87-1.47)
Tea (g)	Range	0.1-500	0.0-0.0	500-4080
	Crude	1	1.02 (0.79-1.32)	1.47 (1.13-1.91)
	Adjusted [†]	1	1.17 (0.90-1.52)	1.35 (1.03-1.75)
Vegetables (g)	Range	170-360	0.0-170	360-1628
	Crude	1	0.92 (0.70-1.22)	1.30 (1.01-1.67)
	Adjusted [†]	1	0.91 (0.69-1.21)	1.30 (1.01-1.68)
Fruits (g)	Range	0.1-150	0.0-0.0	150-1292
	Crude	1	0.54 (0.41-0.71)	1.18 (0.92-1.52)
	Adjusted [†]	1	0.63 (0.48-0.84)	1.04 (0.80-1.34)
Mushrooms (g)	Range	0.1-23.3	0.0-0.0	23.4-372
	Crude	1	0.80 (0.62-1.04)	1.21 (0.92-1.60)
	Adjusted [†]	1	0.80 (0.62-1.05)	1.22 (0.93-1.61)
Seaweeds (g)	Range	0.1-13.5	0.0-0.0	13.6-420
	Crude	1	1.07 (0.82-1.39)	1.45 (1.10-1.90)
	Adjusted [†]	1	1.07 (0.82-1.39)	1.40 (1.06-1.85)
Fish and shellfish (g)	Range	20.1-117	0.0-20.0	117-753
	Crude	1	1.39 (1.08-1.79)	1.08 (0.82-1.42)
	Adjusted [†]	1	1.41 (1.10-1.82)	1.12 (0.85-1.47)
Meats (g)	Range	37.6-125	0.0-37.5	125-618
	Crude	1	0.95 (0.74-1.23)	0.66 (0.49-0.89)
	Adjusted [†]	1	0.89 (0.68-1.16)	0.80 (0.59-1.10)
Dairy products (g)	Range	0.1-163	0.0-0.0	163-886
	Crude	1	0.69 (0.53-0.90)	1.05 (0.81-1.36)
	Adjusted [†]	1	0.79 (0.60-1.04)	1.00 (0.77-1.30)
Oils and fats (g)	Range	4.1-16.1	0.0-4.0	16.2-115
	Crude	1	1.26 (0.98-1.63)	1.05 (0.80-1.38)
	Adjusted [†]	1	1.23 (0.94-1.60)	1.15 (0.87-1.53)

OR: odds ratio calculated by Logistic regression analysis; CI: confidence interval.

[†]Adjusted for sex, age, residential area based on regional block, residential area according to population size, household, fat intake, exercise habit, smoking status, height and weight.

users.

Table 2 shows the odds ratio associated with calcium supplement use for calcium intake and food consumption. The highest group (Q4) of calcium intake from foods was the most likely to use calcium supplements. Also, the highest intake groups of tea, vegetable, and seaweed consumption, and the lowest group (Q1) of fish and shellfish consumption were most likely to use calcium supplements. Conversely, the lowest group of fruit consumption was the least likely to use calcium supplements.

Characteristics of iron supplement users

The iron supplement users were 1.4% (n=221) of adults,

and 1.0% (n=161) adults were also calcium supplement users. Their sociodemographic and health status characteristics were similar to those of calcium supplement users, but other characteristics, which included age, residential area based on regional block, exercise habit, and fat intake, were not associated with iron supplement use (Table 1).

The odds ratios associated with iron supplement use for iron intake and food consumption are shown in Table 3. The association between iron intake from foods and iron supplement use was not significant. Iron supplement use was high in the highest group of seaweed consumption, and low in the lowest group of fruit consumption.

Table 3. Likelihood of iron supplementation across iron and food intake quartiles among Japanese adults, from the National Health and Nutrition Survey 2003-2010

		Quartiles of dietary intake		
		Medium (Q2 and Q3) (Reference)	Lowest (Q1) OR (95% CI)	Highest (Q4) OR (95% CI)
Food iron (mg)	Range	6.1-9.2	4.0-6.0	9.3-14.0
	Crude	1	1.08 (0.78-1.50)	1.18 (0.86-1.62)
	Adjusted [†]	1	1.01 (0.73-1.40)	1.26 (0.91-1.73)
All iron (mg)	Range	6.2-9.3	4.0-6.1	9.4-317
	Crude	1	0.25 (0.10-0.63)	9.16 (6.48-12.9)
	Adjusted [†]	1	0.23 (0.09-0.58)	9.98 (7.05-14.1)
Rice products (g)	Range	220-451	0.0-220	451-1720
	Crude	1	1.14 (0.84-1.55)	0.78 (0.55-1.11)
	Adjusted [†]	1	0.99 (0.73-1.35)	1.09 (0.75-1.59)
Soy products (g)	Range	0.1-81.0	0.0-0.0	81.1-1090
	Crude	1	1.11 (0.80-1.53)	1.14 (0.82-1.57)
	Adjusted [†]	1	1.04 (0.75-1.44)	1.11 (0.81-1.54)
Tea (g)	Range	0.1-500	0.0-0.0	500-4080
	Crude	1	0.91 (0.67-1.25)	1.14 (0.82-1.58)
	Adjusted [†]	1	0.96 (0.70-1.31)	1.09 (0.78-1.53)
Vegetables (g)	Range	170-360	0.0-170	360-1628
	Crude	1	1.05 (0.75-1.46)	1.28 (0.93-1.75)
	Adjusted [†]	1	1.00 (0.72-1.40)	1.32 (0.96-1.81)
Fruits (g)	Range	0.1-150	0.0-0.0	150-1292
	Crude	1	0.52 (0.38-0.73)	1.04 (0.76-1.43)
	Adjusted [†]	1	0.58 (0.41-0.81)	0.97 (0.71-1.33)
Mushrooms (g)	Range	0.1-23.3	0.0-0.0	23.4-372
	Crude	1	1.01 (0.74-1.38)	0.86 (0.60-1.25)
	Adjusted [†]	1	1.00 (0.73-1.36)	0.88 (0.60-1.27)
Seaweeds (g)	Range	0.1-13.5	0.0-0.0	13.6-420
	Crude	1	1.23 (0.89-1.69)	1.46 (1.03-2.06)
	Adjusted [†]	1	1.19 (0.86-1.65)	1.45 (1.03-2.06)
Fish and shellfish (g)	Range	20.1-117	0.0-20.0	117-753
	Crude	1	1.37 (1.01-1.87)	0.99 (0.70-1.39)
	Adjusted [†]	1	1.30 (0.95-1.77)	1.09 (0.77-1.53)
Meats (g)	Range	37.6-125	0.0-37.5	125-618
	Crude	1	1.15 (0.85-1.56)	0.66 (0.46-0.96)
	Adjusted [†]	1	1.10 (0.81-1.49)	0.75 (0.52-1.09)
Dairy products (g)	Range	0.1-163	0.0-0.0	163-886
	Crude	1	0.76 (0.55-1.05)	1.09 (0.80-1.50)
	Adjusted [†]	1	0.87 (0.63-1.21)	1.04 (0.76-1.43)
Oils and fats (g)	Range	4.1-16.1	0.0-4.0	16.2-115
	Crude	1	1.29 (0.94-1.78)	1.32 (0.96-1.82)
	Adjusted [†]	1	1.25 (0.90-1.72)	1.35 (0.98-1.86)

OR: odds ratio calculated by Logistic regression analysis. CI: confidence interval.

[†]Adjusted for sex, age, residential area based on regional block, residential area according to population size, household, fat intake, exercise habit, smoking status, height and weight.

DISCUSSION

This cross-sectional study of a representative sample of the Japanese population revealed that mineral supplement users were more likely to be non-smokers and consume a higher intake of healthy foods such as seaweeds and fruits.

In our study, dietary mineral supplement use based on the national survey in Japan showed results similar to those previously reported by US research¹ and some Japanese regional surveys.^{5,7,8} Specifically, mineral supplement users tended to be women, older age, living alone, and in a metropolis, as compared with non-users. It is speculated that supplement users were likely to have more interest in health, feel more uneasy about their health, and have easier access to information of interest.

Energy and protein intakes were not significantly different between mineral supplement users and non-users. However, supplement users had lower fat intake and BMI, and were more physically active than non-users, suggesting that adult Japanese mineral supplement users have healthier behaviors than non-users, similar to the US adults surveyed.¹

Because Japanese adults tend to consume less dietary calcium and iron than the recommended levels,²⁰ there are several advertisements from supplement manufactures suggesting dietary mineral supplements are beneficial. Mineral supplement users, however, seemed to be interested in health and spent their efforts on a health related behaviors, and they were expected to take higher amounts

of minerals from foods. In the present study, calcium users showed this expected finding, while iron users did not. This difference may be due to small group size (1.4%) for analysis of iron supplement users. The tolerable upper intake level (UL) of calcium is 2,300 mg and that of iron is 55 mg among males aged 30–49, whose UL is the highest among adults in The Dietary Reference Intakes for Japanese 2010.¹⁰ In the present study, no adults exceeded the UL of calcium or iron when their intake was calculated from food alone. However, some supplement users exceeded the UL when the mineral intake was calculated from both foods and supplements. The highest intake groups in calcium or iron took the respective minerals from food alone in amounts close to the recommended dietary allowance.¹⁰ For this reason, mineral supplements are probably not necessary for the highest group; nevertheless, these groups seemed to use mineral supplements more. These results showed that supplement usage could lead to excessive mineral consumption and adverse effects. On the contrary, the lowest intake groups of each mineral from foods were not likely to use mineral supplements. These were the people who should actually consider supplementing their diet with minerals. This suggests that mineral supplementation is not an effective tool for getting adequate amounts of each mineral in the average Japanese adult.

Among several countries, one report showed that adult dietary supplement users have high vegetable and fruit intake,² but another did not.⁴ The present Japanese study showed that mineral supplement users tended to consume more tea, vegetables, and seaweeds. Conversely, the people who didn't eat fruit were less likely to use mineral supplements. These results suggest that adults who generally make health-conscious food choices use mineral supplements more, and these attitudes are unrelated for each nutrient. In other words, an individual's consumption of dairy and meat products, which include rich sources of calcium and iron, respectively, were unrelated to their respective mineral supplement use. These results suggested that Japanese adults used dietary supplements without considering their own diet and the amount of nutrients they consumed. The consumption of characteristic foods categorized as part of Western dietary patterns (meats, dairy products, oils, and fats) or as Japanese dietary patterns (rice products, soy products) were not associated with mineral supplement use. Therefore, the food choice of supplement users cannot be explained by the dietary patterns of the Western or Japanese cultures.

The present study had several limitations. First, the NHNS was a cross-sectional survey and did not allow for determination of causal effects. Second, as the NHNS was a 1-day survey, intake results of dietary supplements and foods may not reflect habitual intake of the individual. Furthermore, seasonal variation may influence the results. Nutrient intakes were not exact, but estimated by calculation. Further, brand names of specific dietary supplements were not reported. Thus, the data presented in this study should be interpreted with these limitations in mind.

In conclusions, this study showed that adult Japanese dietary supplement users have healthier behaviors. Moreover, mineral supplement users tend to make more health-conscious food choices: they ate more tea, vegetables,

seaweeds, and fruits without specifically choosing foods high in each nutrient. It is clear that mineral supplements are helpful if the respective mineral intakes are deficient, but can be harmful if taken in excess. It is necessary to advise consumers that mineral supplements should only be used if the mineral content from foods is considered.

ACKNOWLEDGMENTS

This work was supported by a Health and Labour Sciences Research Grants (Research on Food Safety) from the Ministry of Health, Labour and Welfare, Japan.

AUTHOR DISCLOSURES

The authors have no conflict of interest to declare.

REFERENCES

- Dickinson A, MacKay D. Health habits and other characteristics of dietary supplement users: a review. *Nutr J*. 2014;13:14. doi: 10.1186/1475-2891-13-14.
- Beitz R, Mensink GB, Hintzpeter B, Fischer B, Erbersdobler HF. Do users of dietary supplements differ from nonusers in their food consumption? *Eur J Epidemiol*. 2004;4:335-41. doi: 10.1023/B:EJEP.0000024698.76843.3b.
- Touvier M, Kesse E, Volatier JL, Clavel-Chapelon F, Boutron-Ruault MC. Dietary and cancer-related behaviors of vitamin/mineral dietary supplement users in a large cohort of French women. *Eur J Nutr*. 2006;4:205-14. doi: 10.1007/s00394-006-0587-x.
- van der Horst K, Siegrist M. Vitamin and mineral supplement users. Do they have healthy or unhealthy dietary behaviours? *Appetite*. 2011;3:758-64. doi: 10.1016/j.appet.2011.08.020.
- Imai T, Nakamura M, Ando F, Shimokata H. Dietary supplement use by community-living population in Japan: data from the National Institute for Longevity Sciences Longitudinal Study of Aging (NILS-LSA). *J Epidemiol*. 2006;6:249-60. doi: 10.2188/jea.16.249.
- Footo JA, Murphy SP, Wilkens LR, Hankin JH, Henderson BE, Kolonel LN. Factors associated with dietary supplement use among healthy adults of five ethnicities: the Multiethnic Cohort Study. *Am J Epidemiol*. 2003;10:888-97. doi: 10.1093/aje/kwg072.
- Kishimoto M, Fujita H, Takahashi H, Okubo I. Relationship between health behavior and lifestyles/health status among Japanese adults. *The Japanese Journal of Health and Human Ecology*. 2006;4:141-52. doi: 10.3861/jshhe.72.141.
- Ishihara J, Sobue T, Yamamoto S, Sasaki S, Tsugane S. Demographics, lifestyles, health characteristics, and dietary intake among dietary supplement users in Japan. *Int J Epidemiol*. 2003;4:546-53. doi: 10.1093/ije/dyg091.
- Tsubota-Utsugi M, Nakade M, Imai E, Tsuboyama-Kasaoka N, Nozue M, Umegaki K, Yoshizawa T, Okuda N, Nishi N, Takimoto H. Distribution of vitamin E intake among Japanese dietary supplement and fortified food users: a secondary analysis from the National Health and Nutrition Survey, 2003-2009. *J Nutr Sci Vitaminol (Tokyo)*. 2013;6: 576-83. doi: 10.3177/jnsv.59.576.
- Ministry of Health, Labour and Welfare. Dietary Reference Intakes for Japanese, 2010. 2014/7/10 [cited 2009/5/29]; Available from: <http://www.mhlw.go.jp/shingi/2009/05/s0529-4.html>. (In Japanese)
- Bailey RL, Fulgoni VL, 3rd, Keast DR, Dwyer JT. Dietary supplement use is associated with higher intakes of minerals from food sources. *Am J Clin Nutr*. 2011;5:1376-81. doi: 10.3945/ajcn.111.020289.
- Bailey RL, Fulgoni VL, 3rd, Keast DR, Dwyer JT. Examination of vitamin intakes among US adults by dietary

- supplement use. *J Acad Nutr Diet*. 2012;5:657-63.e4. doi: 10.1016/j.jand.2012.01.026.
13. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2003. 2014/11/20 [cited 2005/8]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou-chosa2-01/index.html>. (In Japanese)
 14. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2004. 2014/11/20 [cited 2006/9]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou06/01.html>. (In Japanese)
 15. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2005. 2014/11/20 [cited 2007/12]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou07/01.html>. (In Japanese)
 16. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2006. 2014/11/20 [cited 2009/1]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou08/01.html>. (In Japanese)
 17. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2007. 2014/11/20 [cited 2010/3]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou09/01.html>. (In Japanese)
 18. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2008. 2014/11/20 [cited 2011/1]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou/h20-houkoku.html>. (In Japanese)
 19. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2009. 2014/11/20 [cited 2011/10]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou/h21-houkoku.html>. (In Japanese)
 20. Ministry of Health, Labour and Welfare. Annual Report of the National Health and Nutrition Survey in 2010. 2014/11/20 [cited 2012/5]; Available from: <http://www.mhlw.go.jp/bunya/kenkou/eiyou/h22-houkoku.html>. (In Japanese)
 21. Li K, Kaaks R, Linseisen J, Rohrmann S. Associations of dietary calcium intake and calcium supplementation with myocardial infarction and stroke risk and overall cardiovascular mortality in the Heidelberg cohort of the European Prospective Investigation into Cancer and Nutrition study (EPIC-Heidelberg). *Heart*. 2012;12:920-5. doi: 10.1136/heartjnl-2011-301345.
 22. Bolland MJ, Avenell A, Baron JA, Grey A, MacLennan GS, Gamble GD, Reid IR. Effect of calcium supplements on risk of myocardial infarction and cardiovascular events: meta-analysis. *BMJ*. 2010;341:c3691. doi: 10.1136/bmj.c3691.
 23. Hunnicutt J, He K, Xun P. Dietary iron intake and body iron stores are associated with risk of coronary heart disease in a meta-analysis of prospective cohort studies. *J Nutr*. 2014; 3:359-66. doi: 10.3945/jn.113.185124.
 24. Ohtake T, Kobayashi S, Negishi K, Moriya H. Supplement nephropathy due to long-term, high-dose ingestion of ascorbic acid, calcium lactate, vitamin D and laxatives. *Clin Nephrol*. 2005;3:236-40. doi: 10.5414/CNP64236.
 25. Kimura M, Suzuki K. A case of hypercalcemia due to the supplement intake. *Practice*. 2003;2:205-07.
 26. Barton JC, Lee PL, West C, Bottomley SS. Iron overload and prolonged ingestion of iron supplements: clinical features and mutation analysis of hemochromatosis-associated genes in four cases. *Am J Hematol*. 2006;10:760-7. doi: 10.1002/ajh.20714.
 27. Iwaoka F, Yoshiike N, Date C, Shimada T, Tanaka H. A validation study on a method to estimate nutrient intake by family members through a household-based food-weighing survey. *J Nutr Sci Vitaminol (Tokyo)*. 2001;3:222-7. doi: 10.3177/jnsv.47.222.

Original Article

Personal behaviors including food consumption and mineral supplement use among Japanese adults: a secondary analysis from the National Health and Nutrition Survey, 2003-2010

Yoko Sato PhD, Megumi Tsubota-Utsugi PhD, Tsuyoshi Chiba PhD,
Nobuyo Tsuboyama-Kasaoka PhD, Hidemi Takimoto MD, Nobuo Nishi MD,
Keizo Umegaki PhD

National Institute of Health and Nutrition, National Institutes of Biomedical Innovation, Health and Nutrition, Shinjuku-ku, Tokyo, Japan

日本成人食物消费和矿物质补充剂使用的个人行为： 2003-2010 年全国健康和营养调查的二次分析

背景与目的：每天补充矿物质对有缺乏风险的人是有用的。一些西方的报告表明：矿物质补充剂使用者拥有健康的行为，并且没有矿物质缺乏。但在有不同饮食文化的日本，是否也存在同样的现象还不知道。本研究的目的是探讨2003-2010年全国健康与营养调查中矿物质补充者食物消费的个人行为特点。**方法与研究设计：**从16275名年龄为20-59岁完成社会人口学、健康状况和一天家庭膳食评估的成人中获得资料。补充剂使用者与未使用者进行比较。采用logistic回归模型确定食物消费、钙和铁补充剂使用的特点，以中等摄入量组作为参考。**结果：**总体而言，分别有2.1%和1.4%的成人使用钙和铁补充剂。钙补充剂的使用者比不用者更倾向于锻炼身体、不抽烟和少吃脂肪。此外，他们比不补充者更可能从茶叶、蔬菜、海藻和水果等食物中摄入更多的钙。铁补充者比不补充者更可能不吸烟，这些人往往摄入大量的海藻和水果。**结论：**日本有健康行为的成人更可能使用矿物质补充剂，尤其是钙。不论矿物质补充剂使用者总矿物质的消费量是多少，他们更倾向于选择海藻和水果等健康的食物。

关键词：日本成人、矿物质补充剂、个人行为、食物、日本国家健康与营养调查