Japan, and overall population aged 30 and greater in these areas was 10 956 people. Accordingly, the participation rate was over 75%, and the participants of these surveys represent general Japanese population. Of the 8342 residents, 7404 participants (3099 men and 4305 women) who were free from past history of renal diseases were included in the present study.

Nutritional surveys

A house-hold food weighing method was used in the National Nutrition Survey in 1990 (NNSJ90). The details of the estimation for individual nutrient intakes by calculating proportional distribution are described in another paper.[15] Briefly, nutrient intakes of each household member were estimated by dividing household intake data of NNSJ90 proportionally using average intakes by sex and age groups calculated for NNSJ95 conducted in 1995. Protein intake was calculated as g/day, and protein intake per body weight (g/kg/day) was calculated as protein intake (g/day) divided by body weight (kg).

Risk factor surveys

Public health nurses obtained information on smoking, alcohol drinking, past history of renal diseases and diabetes, and medication for hypertension. Blood pressure was measured by trained observers using a standard mercury sphygmomanometer on the right arm of seated participants after a sufficient period of rest. Non-fasting blood samples were obtained and the serum was separated and centrifuged soon after blood coagulation. Plasma samples were also obtained in a siliconized tube containing sodium fluoride. These samples were shipped to 1 laboratory (SRL, Tokyo, Japan) for blood measurements. Serum creatinine (mg/dl) was measured using the alkaline picric acid method (Jaffe). GFR (ml/min per 1.73 m^2) was calculated using the abbreviated equation developed at the Cleveland Clinic laboratory for the Modification of Diet in Renal Disease (MDRD) study: $186 \times$ [serum creatinine (mg/dl)] $- 1.154 \times$ [age (years)] $- 0.203 \times$ [0.742 if female].[16] Imai et al recommend to multiply the value calculated using the abbreviated MDRD equation by 0.881 for Japanese.[17] Accordingly, we calculated GFR by multiplying 0.881. Referring to the NKF classification of CKD,[18,19] the participants were classified into the 2 groups: GFR ≥ 60 and GFR < 60. The latter group was defined as CKD.

Statistical analysis

The statistical analyses were based on the data for sex-specific quartiles of total, animal, and vegetable protein intake per body weight (kg). To compare the characteristics, we used analysis of variance or t test for continuous variables and chi-square test for categorical variables. Age- and multivariate-adjustment was performed by analysis of covariance or logistic regression model.

We estimated age- and multivariate-adjusted GFR and odds ratios of quartiles of protein intake for the presence of CKD, compared to the lowest quartile of the protein intake. The confounding variables included age (linear), systolic blood pressure, serum total cholesterol, HbA1c, current smoking, and current alcohol drinking. The same analyses were performed after excluding the participants with past history of hypertension and diabetes.

The statistical package SPSS 15.0J for Windows (SPSS, Tokyo, Japan) performed these analyses. All probability values were 2-tailed and the significance level was established at $P < 0.05$.

RESULTS

In men, the mean GFR was 83.7 ml/min per 1.73 m^2, and the mean protein intake was 1.49 g/kg/day in total, 0.76 g/kg/day in animal, and 0.73 g/kg/day in vegetable protein. In women, the mean GFR was 84.4 ml/min per 1.73 m^2, the mean protein intake was 1.44 g/kg/day in total, 0.73 g/kg/day in animal, and 0.71 g/kg/day in vegetable protein.

Table 1 shows the total, animal, and vegetable protein intake according to the age groups by sex. There were significant differences in protein intake among the age groups both in men and women. In men, the protein intake was the highest in 50–59 age group, and the lowest in 80– age group except for protein intake per body weight (g/day/kg). In women, the protein intake was the highest in 40–49 or 50–59 age groups except for vegetable protein intake, and the lowest in 80– age group except for protein intake per body weight (g/day/kg). In addition, we present the sex-specific mean total protein intake (g/kg/day) according to the presence of CKD. In men, the mean (± standard deviation) total protein intake was 1.49 ± 0.36 among the individuals without CKD, and 1.46 ± 0.36 among those with CKD ($P = 0.35$). In women, it was 1.45 ± 0.35 among the individuals without CKD, and 1.35 ± 0.36 among those with CKD ($P < 0.001$) (data not shown in the table).

Table 2 shows the age- and multivariate-adjusted GFR and the odds ratio for CKD according to the quartiles of total protein intake (g/kg/day). There were positive significant relationships between the total protein intake and the multivariate-adjusted GFR in both sexes. And there were significant negative relationships between the quartiles of total protein intake and the odds ratios for CKD in women.

Table 3 shows the age- and multivariate-adjusted GFR and the odds ratio for CKD according to the quartiles of animal protein intake (g/kg/day). There were positive significant relationships between the quartiles of the animal protein intake and the multivariate-adjusted GFR in both sexes. In women, there was a significant decrease of the odds ratio for CKD in the highest animal protein intake group.

Table 4 shows the age- and multivariate-adjusted GFR and the odds ratio for CKD according to the quartiles of vegetable

Table 1. Total-, animal-, vegetable protein intake according to age group: NIPPON DATA90

	Age						*P* value
	30–39	40–49	50–59	60–69	70–79	80–	
Men (*n* = 3099)							
n	582	741	712	633	350	81	
Total protein intake (g/day)	88.8 ± 18.3	93.2 ± 18.2	97.1 ± 20.7	87.4 ± 18.3	79.0 ± 18.1	73.9 ± 16.1	<0.001
Total protein intake per body weight (g/day/kg)	1.39 ± 0.32	1.46 ± 0.34	1.60 ± 0.38	1.52 ± 0.37	1.44 ± 0.38	1.44 ± 0.33	<0.001
Animal protein intake (g/day)	46.0 ± 13.5	49.2 ± 13.9	50.5 ± 15.6	43.6 ± 13.5	38.8 ± 13.1	36.3 ± 12.5	<0.001
Animal protein intake per body weight (g/day/kg)	0.72 ± 0.22	0.77 ± 0.24	0.83 ± 0.26	0.76 ± 0.25	0.70 ± 0.25	0.71 ± 0.25	<0.001
Vegetable protein intake (g/day)	42.8 ± 8.7	43.9 ± 8.5	46.5 ± 9.5	43.9 ± 9.1	40.4 ± 9.0	37.7 ± 7.8	<0.001
Vegetable protein intake per body weight (g/day/kg)	0.67 ± 0.16	0.69 ± 0.16	0.77 ± 0.19	0.77 ± 0.19	0.74 ± 0.19	0.74 ± 0.17	<0.001
Women (*n* = 4305)							
n	938	1051	925	807	453	131	
Total protein intake (g/day)	71.9 ± 12.9	78.1 ± 14.9	78.1 ± 16.9	72.9 ± 16.4	64.6 ± 14.3	63.0 ± 13.6	<0.001
Total protein intake per body weight (g/day/kg)	1.39 ± 0.31	1.48 ± 0.34	1.49 ± 0.38	1.44 ± 0.37	1.37 ± 0.35	1.44 ± 0.41	<0.001
Animal protein intake (g/day)	37.1 ± 9.9	41.1 ± 11.2	39.7 ± 12.3	35.8 ± 11.6	31.1 ± 10.5	30.0 ± 9.5	<0.001
Animal protein intake per body weight (g/day/kg)	0.72 ± 0.21	0.78 ± 0.24	0.76 ± 0.25	0.71 ± 0.24	0.66 ± 0.23	0.69 ± 0.25	<0.001
Vegetable protein intake (g/day)	35.0 ± 6.4	37.0 ± 7.1	38.5 ± 8.1	37.2 ± 8.3	33.7 ± 7.2	33.1 ± 7.1	<0.001
Vegetable protein intake per body weight (g/day/kg)	0.67 ± 0.15	0.70 ± 0.16	0.73 ± 0.19	0.74 ± 0.20	0.71 ± 0.18	0.76 ± 0.21	<0.001

Data are presented as mean ± standard deviation.

Table 2. Age- and multivariate-adjusted GFR and Odds ratio for CKD according to the quartiles of total protein intake (g/day/kg): NIPPON DATA90

	Total protein intake (g/day/kg)				*P* value
	1 (low)	2	3	4 (high)	
Men (*n* = 3099)					
n	770	791	756	782	
Age (years)	52 ± 15	52 ± 14	53 ± 13	56 ± 12	<0.001
Mean total protein intake (g/day/kg)	1.07 ± 0.13	1.35 ± 0.06	1.57 ± 0.07	1.97 ± 0.26	<0.001
Body mass index (kg/m^2)	24.7 ± 3.1	23.3 ± 2.7	22.4 ± 2.7	21.3 ± 2.5	<0.001
Systolic blood pressure (mm Hg)	139 ± 20	137 ± 20	137 ± 21	137 ± 20	0.09
Diastolic blood pressure (mm Hg)	85 ± 12	84 ± 12	84 ± 12	82 ± 12	<0.001
Total cholesterol (mg/dl)	203 ± 38	199 ± 37	196 ± 36	196 ± 35	<0.01
HbA1c (%)	5.0 ± 0.7	5.0 ± 0.8	5.0 ± 0.7	5.0 ± 0.8	0.89
Alcohol drinking (%)	55.6	56.8	60.6	59.3	0.17
Current smoker (%)	55.6	54.4	56.0	55.9	0.91
GFR (age-adjusted)[a]	81.8 (80.7–82.8)	82.1 (81.0–83.1)	83.4 (82.3–84.5)	87.6 (86.5–88.7)	<0.001
GFR (multivariate-adjusted)[a]	82.1 (81.0–83.1)	82.1 (81.1–83.2)	83.2 (82.1–84.3)	87.4 (86.4–88.5)	<0.001
Odds ratio for CKD (age-adjusted)[b]	Reference	1.02 (0.64–1.64)	1.25 (0.79–1.98)	0.65 (0.39–1.08)	0.14
Odds ratio for CKD (multivariate-adjusted)[b]	Reference	1.00 (0.62–1.62)	1.31 (0.82–2.08)	0.70 (0.42–1.16)	0.25
Women (*n* = 4305)					
n	1070	1096	1072	1067	
Age (years)	53 ± 15	52 ± 14	52 ± 14	53 ± 13	<0.01
Mean total protein intake (g/day/kg)	1.03 ± 0.13	1.3 ± 0.06	1.52 ± 0.68	1.92 ± 0.25	<0.001
Body mass index (kg/m^2)	25.1 ± 3.5	23.2 ± 2.9	22.1 ± 2.8	20.9 ± 2.6	<0.001
Systolic blood pressure (mm Hg)	137 ± 22	134 ± 21	132 ± 20	131 ± 20	<0.001
Diastolic blood pressure (mm Hg)	82 ± 12	80 ± 12	79 ± 11	78 ± 11	<0.001
Total cholesterol (mg/dl)	209 ± 41	207 ± 40	205 ± 38	206 ± 36	<0.05
HbA1c (%)	5.0 ± 0.8	4.9 ± 0.7	4.9 ± 0.7	4.8 ± 0.6	<0.001
Alcohol drinking (%)	6.5	6.8	6.3	6.7	0.95
Current smoker (%)	11.0	7.8	9.3	9.2	0.08
GFR (age-adjusted)[a]	83.0 (82.0–84.0)	83.3 (82.4–84.3)	85.5 (84.5–86.4)	85.7 (84.7–86.6)	<0.001
GFR (multivariate-adjusted)[a]	83.2 (82.2–84.2)	83.4 (82.4–84.3)	85.4 (84.4–86.3)	85.5 (84.6–86.5)	<0.001
Odds ratio for CKD (age-adjusted)[b]	Reference	0.83 (0.61–1.13)	0.55 (0.39–0.78)	0.51 (0.36–0.72)	<0.001
Odds ratio for CKD (multivariate-adjusted)[b]	Reference	0.85 (0.62–1.16)	0.57 (0.41–0.81)	0.54 (0.38–0.77)	<0.001

Data are presented as mean ± standard deviation. Values in parentheses indicate 95% confidence interval.
Analysis of variance. [a]Analysis of covariance. [b]Logistic regression analysis.
Multivariate-adjustment: age, systolic blood pressure, serum total cholesterol, HbA1c, smoking (current or non-current), alcohol drinking (current or non-current) were adjusted.

Table 3. Age- and multivariate-adjusted GFR and Odds ratio for CKD according to the quartiles of animal protein intake (g/day/kg): NIPPON DATA90

	Animal protein intake (g/day/kg)				*P* value
	1 (low)	2	3	4 (high)	
Men (*n* = 3099)					
n	786	777	780	756	
Age (years)	54 ± 15	52 ± 14	53 ± 13	54 ± 12	<0.001
Mean total protein intake (g/day/kg)	0.49 ± 0.08	0.66 ± 0.04	0.81 ± 0.05	1.11 ± 0.18	<0.001
Body mass index (kg/m^2)	24.2 ± 3.3	23.2 ± 2.8	22.5 ± 2.7	21.8 ± 2.8	<0.001
Systolic blood pressure (mm Hg)	140 ± 20	138 ± 21	136 ± 20	137 ± 19	<0.01
Diastolic blood pressure (mm Hg)	85 ± 12	84 ± 12	83 ± 12	83 ± 11	<0.01
Total cholesterol (mg/dl)	198 ± 39	199 ± 37	196 ± 34	200 ± 37	0.33
HbA1c (%)	5.0 ± 0.7	5.0 ± 0.8	5.0 ± 0.7	5.0 ± 0.9	0.49
Alcohol drinking (%)	53.2	57.5	60.1	61.5	<0.01
Current smoker (%)	54.6	57.0	55.9	54.2	0.68
GFR (age-adjusted)[a]	82.7 (81.6–83.8)	83.0 (81.9–84.1)	83.6 (82.5–84.7)	85.6 (84.5–86.7)	<0.01
GFR (multivariate-adjusted)[a]	82.8 (81.7–83.9)	83.0 (82.0–84.1)	83.5 (82.4–84.5)	85.6 (84.5–86.7)	<0.01
Odds ratio for CKD (age-adjusted)[b]	Reference	0.81 (0.50–1.31)	0.96 (0.60–1.52)	0.90 (0.57–1.44)	0.80
Odds ratio for CKD (multivariate-adjusted)[b]	Reference	0.81 (0.50–1.31)	0.97 (0.61–1.54)	0.93 (0.58–1.48)	0.89
Women (*n* = 4305)					
n	1055	1076	1091	1083	
Age (years)	55 ± 15	52 ± 14	52 ± 14	51 ± 13	<0.001
Mean total protein intake (g/day/kg)	0.46 ± 0.08	0.63 ± 0.04	0.78 ± 0.05	1.05 ± 0.17	<0.001
Body mass index (kg/m^2)	24.5 ± 3.5	23.3 ± 3.1	22.3 ± 2.9	21.3 ± 2.8	<0.001
Systolic blood pressure (mm Hg)	138 ± 21	134 ± 21	133 ± 20	130 ± 20	<0.001
Diastolic blood pressure (mm Hg)	82 ± 12	80 ± 12	79 ± 11	78 ± 11	<0.001
Total cholesterol (mg/dl)	208 ± 41	206 ± 40	206 ± 37	206 ± 37	0.74
HbA1c (%)	5.0 ± 0.8	4.9 ± 0.7	4.9 ± 0.8	4.8 ± 0.6	<0.001
Alcohol drinking (%)	4.8	7.2	7.3	7.0	0.07
Current smoker (%)	8.9	9.0	9.3	10.1	0.79
GFR (age-adjusted)[a]	83.5 (82.5–84.5)	83.8 (82.8–84.7)	84.2 (83.2–85.2)	86.0 (85.0–86.9)	<0.01
GFR (multivariate-adjusted)[a]	83.5 (82.6–84.5)	83.8 (82.8–84.8)	84.2 (83.2–85.2)	85.9 (84.9–86.8)	<0.01
Odds ratio for CKD (age-adjusted)[b]	Reference	0.78 (0.57–1.07)	0.78 (0.57–1.07)	0.51 (0.35–0.73)	<0.001
Odds ratio for CKD (multivariate-adjusted)[b]	Reference	0.78 (0.57–1.08)	0.78 (0.57–1.57)	0.53 (0.37–0.76)	<0.01

Data are presented as mean ± standard deviation. Values in parentheses indicate 95% confidence interval.
Analysis of variance. [a]Analysis of covariance. [b]Logistic regression analysis.
Multivariate-adjustment: age, systolic blood pressure, serum total cholesterol, HbA1c, smoking (current or non-current), alcohol drinking (current or non-current) were adjusted.

protein intake (g/kg/day). In both men and women, the significant positive relationship between the vegetable protein intake and the multivariate-adjusted GFR was observed. In women, there was a significant decrease of the odds ratio for CKD in the highest vegetable protein intake group.

When we adjusted for age by 10-year increment or performed the same analyses in each groups divided by more than and under 65 years old, the above-mentioned results were not substantially affected.

DISCUSSION

In the present study, there were positive relationships between GFR and the quartiles of the total, animal, and vegetable protein intake in both men and women, and most of these relationships were statistically significant. And the odds ratio for the presence of CKD was significantly decreased in the higher quartile groups of each protein intake in women.

For the general characteristics of the nutrition data in the present study, the mean total protein intake was different among the age groups. In men, total protein intake per day was gradually reduced by approximately 11–23% by 70 year of age. This tendency was almost same with the results of the previous study performed in the United States population, which reported that there is a gradual reduction in absolute protein intake by approximately 15% by 70 yr age.[20] Additionally, some previous studies reported that protein intake is 30 to 50% lower in women than that in men.[21,22] In the present study, 17 to 36% reduction in the total protein intake of women compared to that of men in each age groups, although the percentage of the reduction in the present study was smaller than that in the United States. This sex difference of protein intake between the two countries is not explained by the sex difference of BMI, because the ratio of BMI (women/men) was almost the same in both countries according to the INTERMAP study (BMI ratio; the United States 98.6%, Japan 97.9%).[23] When we compared protein

Table 4. Age- and multivariate-adjusted GFR and Odds ratio for CKD according to the quartiles of vegetable protein intake (g/day/kg): NIPPON DATA90

	Plant protein intake (g/day/kg)				*P* value
	1(low)	2	3	4(high)	
Men (*n* = 3099)					
n	769	799	770	761	
Age (years)	50 ± 14	52 ± 13	54 ± 13	57 ± 13	<0.001
Mean total protein intake (g/day/kg)	0.52 ± 0.07	0.66 ± 0.03	0.77 ± 0.03	0.97 ± 0.14	<0.001
Body mass index (kg/m^2)	24.7 ± 3	23.5 ± 2.8	22.3 ± 2.6	21.2 ± 2.4	<0.001
Systolic blood pressure (mm Hg)	138 ± 19	138 ± 21	137 ± 20	138 ± 21	0.86
Diastolic blood pressure (mm Hg)	85 ± 12	84 ± 12	83 ± 11	82 ± 11	<0.001
Total cholesterol (mg/dl)	205 ± 38	199 ± 36	197 ± 37	192 ± 34	<0.001
HbA1c (%)	5.0 ± 0.7	5.1 ± 0.8	5.0 ± 0.8	5.0 ± 0.7	0.39
Alcohol drinking (%)	57.0	62.0	57.5	55.6	0.06
Current smoker (%)	55.4	55.9	53.6	56.8	0.65
GFR (age-adjusted)[a]	80.1 (79.0–81.2)	83.0 (82.0–84.19	83.8 (82.8–84.9)	88.0 (86.9–89.1)	<0.001
GFR (multivariate-adjusted)[a]	80.5 (79.4–81.6)	83.0 (82.0–84.1)	83.8 (82.8–84.9)	87.6 (86.5–88.7)	<0.01
Odds ratio for CKD (age-adjusted)[b]	Reference	0.89 (0.55–1.44)	0.86 (0.53–1.38)	0.63 (0.39–1.02)	0.06
Odds ratio for CKD (multivariate-adjusted)[b]	Reference	0.89 (0.55–1.44)	0.90 (0.56–1.45)	0.70 (0.42–1.14)	0.16
Women (*n* = 4305)					
n	1047	1073	1096	1089	
Age (years)	51 ± 14	51 ± 14	52 ± 14	55 ± 14	<0.001
Mean total protein intake (g/day/kg)	0.51 ± 0.06	0.64 ± 0.03	0.75 ± 0.03	0.95 ± 0.13	<0.001
Body mass index (kg/m^2)	25 ± 3.5	23.2 ± 2.9	22.2 ± 2.7	21 ± 2.6	<0.001
Systolic blood pressure (mm Hg)	135 ± 22	134 ± 21	133 ± 20	133 ± 21	0.08
Diastolic blood pressure (mm Hg)	81 ± 12	80 ± 12	79 ± 11	78 ± 11	<0.001
Total cholesterol (mg/dl)	210 ± 40	208 ± 41	205 ± 38	205 ± 37	<0.01
HbA1c (%)	5.0 ± 0.8	4.9 ± 0.8	4.9 ± 0.7	4.9 ± 0.6	<0.01
Alcohol drinking (%)	7.2	7.8	6.5	5.0	<0.05
Current smoker (%)	13.0	8.8	7.8	7.9	<0.001
GFR (age-adjusted)[a]	82.8 (81.8–83.8)	83.7 (82.7–84.6)	85.1 (84.2–86.1)	85.7 (84.8–86.7)	<0.001
GFR (multivariate-adjusted)[a]	83.0 (82.1–84.1)	83.8 (82.8–84.7)	85.0 (84.1–86.0)	85.5 (84.5–86.5)	<0.01
Odds ratio for CKD (age-adjusted)[b]	Reference	0.84 (0.60–1.18)	0.84 (0.60–1.17)	0.55 (0.39–0.77)	<0.01
Odds ratio for CKD (multivariate-adjusted)[b]	Reference	0.86 (0.61–1.20)	0.87 (0.62–1.22)	0.59 (0.41–0.83)	<0.01

Data are presented as mean ± standard deviation. Values in parentheses indicate 95% confidence interval.
Analysis of variance. [a]Analysis of covariance. [b]Logistic regression analysis.
Multivariate-adjustment: age, systolic blood pressure, serum total cholesterol, HbA1c, smoking (current or non-current), alcohol drinking (current or non-current) were adjusted.

intake per body weight (g/kg/day) by sex, the sex difference was 5.0–6.9% in the present study. The variation in protein intake parallels that in body composition, especially muscle mass, and factoring dietary protein intake by body weight does not make statistical adjustment for the variation related to age and gender.[24] The cause of variation in protein intakes among age and sex was not determined in the present study, however, it is important to take into account of age, sex and race when we consider the protein intake.

In the present study, among the participants without CKD, the mean total protein intake was 1.49 g/kg/day in men and 1.45 g/kg/day in women. Even among the individuals with CKD, the mean total protein intake among those in the present study was 1.46 g/kg/day in men and 1.35 g/kg/day in women. According to the clinical guideline,[25] the recommended protein intake is less than 0.8 g/kg/day among the individuals with normal kidney function (GFR ≥ 90), and 0.60–0.75 g/kg/day among those with decreased GFR without dialysis.[25–27] The Japanese Society of Nephrology recommended 0.60–0.80 g/kg/day protein intake for the individuals with CKD stage 3–5.[28] Accordingly, the community residents in Japan had more protein intake than that of the recommended level. The future study, such as cohort study, is needed to examine the recommended protein intake for Japanese community residents with normal kidney function to prevent CKD. In addition, we should continuously give information about the presence of the recommended protein intake for CKD patients.

Brenner et al postulated that protein intake increases renal plasma blood flow and GFR leading to glomerular hyperfiltration and hypertension, and over time, results in kidney injury.[29] It is well known that a high protein load acutely increases GFR, renal plasma flow, and proteinuria,[30] and the Kidney Dialysis Outcome Quality Initiative (KDOQI) Clinical practice guideline for Chronic Kidney Disease: Evaluation, Classification, and Stratification by the National Kidney Foundation suggested low protein intake.[18] In the MDRD Study, the effect of dietary protein restriction on the progression of CKD remains uncertain despite decades of study. Levey et al considered that one of the reasons for the uncertainty is that the MDRD Study may not have been of sufficient duration to observe a beneficial effect.[2] Indeed, with a 6-year follow up, they showed that the low protein diet with tight blood pressure control suggested a beneficial effect on delaying progression in CKD Stages 3 to 4.[2] As we mentioned, the high GFR in high total protein intake group might reflect hyperfiltration in kidneys in the present study. We need long-term follow-up studies to conclude this issue, because the progression of CKD may need long duration as Levey et al indicated.[2] However, we cannot conclude the higher GFR reflects hyperfiltration or just the better kidney function in the high protein intake group.

In the present study, the relationships between GFR and total, animal, and vegetable-protein intake were separately assessed. Kitazato et al reported that vegetable protein may be excluded from lists of restriction in low protein diet therapy in trials in which they added vegetable protein to animal protein and observed renal hemodynamics.[11] On the other hand, Orita et al reported that vegetable protein with the same amino-acid composition could enhance the GFR in healthy individuals as much as animal protein.[12] In the present study, both in men and women, there was a similar positive relationship between GFR and both animal and vegetable protein intake. From the result of the present study, both animal and vegetable protein might be associated with higher GFR.

The present study has several limitations. First, the present study is a cross-sectional study. Accordingly, the association between each protein intake and renal function does not prove causal relation. Second, the nutritional data is calculated by a combination method of household-based food weighing record and an approximation of proportions by which family members shared each dish or food in the household. Accordingly, the nutritional data might not accurately reflect the individual nutritional intake. However, we believe this method is the best available because the tendency of protein intake according to the age groups by sex was almost similar to the results in the recent National Nutrition Survey based on the individual data.[31]

In conclusion, there were positive relationships between GFR and total, animal, and vegetable protein. And the risk of CKD tended to be lower in higher protein intake groups. However, further cohort study with detailed nutrition survey is needed to conclude about the association between protein intake and renal function.

ACKNOWLEDGMENTS

This study was supported by the Grant-in-Aid of the Ministry of Health and Welfare under the auspices of Japanese Association for Cerebro-cardiovascular Disease Control, the Research Grant for Cardiovascular Diseases (7A-2) from the Ministry of Health, Labor and Welfare and a Health and Labor Sciences Research Grant, Japan (Comprehensive Research on Aging and Health: H11-Chouju-046, H14-Chouju-003, H17-Chouju-012, H19-Chouju-014).

REFERENCES

1. Klahr S, Levey AS, Beck GJ, Caggiula AW, Hunsicker L, Kusek JW, et al; Modification of Diet in Renal Disease Study Group. The effects of dietary protein restriction and blood pressure control on the progression of chronic renal disease. N Engl J Med. 1994;330:877–84.
2. Levey AS, Greene T, Sarnak MJ, Wang X, Beck GJ, Kusek JW, et al. Effect of dietary protein restriction on the progression of kidney disease: Long-term follow-up of the Modification of Diet in Renal Disease (MDRD) Study. Am J Kidney Dis. 2006;48:879–88.
3. Beck GJ, Berg RL, Coggins CH, Gassman JJ, Hunsicker LG, Schluchter MD, et al. Design and statistical issues of the Modification of Diet in Renal Disease Trial. The Modification of Diet in Renal Disease Study Group. Control Clin Trials. 1991;12:566–86.
4. Ihle BU, Becker GJ, Whitworth JA, Charlwood RA, Kincaid-Smith PS. The effect of protein restriction on the progression of renal insufficiency. N Engl J Med. 1989;321:1773–7.
5. Maschio G, Oldrizzi L, Tessitore N, D'Angelo A, Valvo E, Lupo A, et al. Effects of dietary protein and phosphorus restriction on the progression of early kidney failure. Kidney Int. 1982;22:371–6.
6. Rosman JB, ter Wee PM, Meijer S, Piers-Becht TP, Sluiter WJ, Donker AJ. Prospective randomized trial of early dietary protein restriction in chronic renal failure. Lancet. 1984;2:1291–6.
7. Locatelli F, Alberti D, Graziani G, Buccianti G, Redaelli B, Giangrande A. Prospective, randomized, multicenter trial of effect of protein restriction on progression of Study Group. Lancet. 1991;337:1299–304.
8. Nakamura H, Ito S, Ebe N, Shibata A. Renal effects of different types of protein in healthy volunteers subjects and diabetic patients. Diabetes Care. 1993;16:1071–5.
9. Kontessis P, Jones S, Dodds R, Trevisan R, Nosadini R, Fioretto P, et al. Renal, metabolic and hormonal responses to ingestion of animal and vegetable proteins. Kidney Int. 1990;38:136–44.
10. Waugh NR, Robertson AM, Protein restriction for diabetic renal disease (Cochrane Review) In: The Cochrane Library, Issue 2, Oxford: Update Software, 2000, CD002181.
11. Kitazato H, Fujita H, Shimotomai T, Kagaya E, Narita T, Kakei M, et al. Effects of Chronic Intake of Vegetable Protein Added to Animal or Fish Protein on Renal Hemodynamics. Nephron. 2002;90:31–6.
12. Orita Y, Okada M, Harada S, Horio M. Skim soy protein enhances GFR as much as beefsteak protein in healthy human subjects. Clin Exp Nephrol. 2004;8:103–8.
13. Okamura T, Hayakawa T, Kadowaki T, Kita Y, Okayama A, Ueshima H; NIPPON DATA90 Research Group. The inverse relationship between serum high-density lipoprotein cholesterol level and all-cause mortality in a 9.6-year follow-up study in the Japanese general population. Atherosclerosis. 2006;184:143–50.
14. Hozawa A, Okamura T, Kadowaki T, Murakami Y, Nakamura K, Hayakawa T, et al. Gamma-glutamytransferase predicts

cardiovascular death among Japanese women. Atherosclerosis. 2007;194:498–504.

15. Okuda N, Miura K, Yoshita K, Matsumura Y, Nakamura Y, Okayama A, et al. Integration of data from NIPPON DATA80/90 and National Nutrition Survey in Japan: for cohort studies of representative Japanese on nutrition. J Epidemiol. 2010;20 Suppl 3;S506–14.
16. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. A more accurate method to estimate glomerular filtration rate from serum creatinine: A new prediction equation: Modification of Diet in Renal Disease Study Group. Ann Intern Med. 1999;130:461–70.
17. Imai E, Horio M, Nitta K, Yamagata K, Iseki K, Hara S, et al. Estimation of glomerular fi ltration rate by the MDRD equation modified for Japanese patients with chronic kidney disease. Clin Exp Nephrol. 2007;11:41–50.
18. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: Evaluation, classification, and stratification. Am J Kidney Dis. 2002;39 Suppl 1:S1–266.
19. Levey AS, Coresh J, Balk E, Kausz AT, Levin A, Steffes MW, et al; National Kidney Foundation. National Kidney Foundation practice guidelines for chronic kidney disease: Evaluation, classification, and stratification. Ann Intern Med. 2003;139:137–147 (erratum: Ann Intern Med. 2003;139:605).
20. McGandy RB, Barrows CH Jr, Spanias A, Meredith A, Stone JI, Norris AH. Nutrient intakes and energy expenditure in men of different ages. J Gerontol. 1966;21:581–7.
21. U.S. Department of Health, Education, and Welfare. Findings of the Helath and Nutrition Examination Survey; Washington, DC: Department of Health, Education, and Welfare. Publication No. (PHS) 79-1221; 1979.
22. Munro HN, McGandy RB, Hartz SC, Russell RM, Jacob RA, Otradovec CL. Protein nutriture of a group of free-living elderly. Am J Clin Nutr. 1987;46:586–92.
23. Zhou BF, Stamler J, Dennis B, Moag-Stahlberg A, Okuda N, Robertson C, et al. Nutrient intakes of middle-aged men and women in China, Japan, United Kingdom, and United States in the late 1990s: The INTERMAP Study. J Hum Hypertens. 2003;17:623–30.
24. King AJ, Levey AS. Dietary protein and renal function. J Am Soc Nephrol. 1993;3:1723–37.
25. Beto JA, Bansal VK. Medical Nutrition Therapy in Chronic Kidney Failure: Integrating Clinical Practice Guidelines. J Am Diet Assoc. 2004;104:404–9.
26. National Kidney Foundation. K/DOQI Clinical Practice Guidelines for Nutrition in Chronic Renal Failure. New York: National Kidney Foundation; 2001.
27. Levey AS, Adler S, Caggiula AW, England BK, Greene T, Hunsicker LG, et al. Effects of dietary protein restriction on the progression of advanced renal disease in the Modification of Diet in Renal Disease Study. Am J Kidney Dis. 1996;27:652–63.
28. The Japanese Society of Nephrology. Clinical practice guidebook for diagnosis and treatment of chronic kidney disease 2009. 2nd ed. Tokyo: Tokyo Igaku-sha; 2009.
29. Brenner BM, Meyer TM, Hostetter TH. Dietary protein intake and the progressive nature of kidney disease: The role of hemodynamically mediated glomerular injury in the pathogenesis of progressive sclerosis in aging renal ablation and intrinsic renal disease. N Engl J Med. 1982;307:652–9.
30. Bernstein AM, Treyzon L, Li Z. Are high-protein, vegetable-based diets safe for kidney function? A review of the literature. J Am Diet Assoc. 2007;107:644–50.
31. http://www.mhlw.go.jp/houdou/2006/05/h0508-la.html (Accessed on July 23rd, 2009).

NIPPON DATA90 栄養ベースラインデータにおける脂肪摂取量に関する検討

研究分担者　中村　保幸　（京都女子大学家政学部生活福祉学科　教授）
研究分担者　奥田　奈賀子（財団法人結核予防会第一健康相談所　医員）
研究協力者　Tanvir C. Turin（滋賀医科大学社会医学講座公衆衛生学部門 特別研究員）
研究協力者　藤吉　朗　（滋賀医科大学社会医学講座公衆衛生学部門　特任助教）
研究分担者　岡村　智教　（国立循環器病センター予防検診部　部長）
研究分担者　早川　岳人　（福島県立医科大学衛生学・予防医学講座　准教授）
研究分担者　由田　克士　（国立健康・栄養研究所栄養疫学ﾌﾟﾛｸﾞﾗﾑ　ﾌﾟﾛｼﾞｪｸﾄﾘｰﾀﾞｰ）
研究分担者　三浦　克之　（滋賀医科大学社会医学講座公衆衛生学部門　教授）
研究代表者　上島　弘嗣　（滋賀医科大学生活習慣病予防センター　特任教授）

A. 目的

国民栄養調査（現在の国民健康・栄養調査）は戦後の貧困状態にあった1945年に海外からの食糧援助を受けるための基礎資料を得る目的で連合国軍司令部（GHQ）の指令に基づく調査を実施したことに端を発し、近年では毎年1回の調査が行われている。また循環器疾患基礎調査は国民栄養調査客体の一部を対象としてわが国における心臓病、脳卒中等の成人の循環器疾患及びその危険因子に関して、その現状を把握し、今後の予防対策の検討に資することを目的として1960年から10年ごとに実施されている。循環器疾患基礎調査を長期追跡コホート研究に昇華させたNIPPON DATA90のデータと個人別に推定された栄養素摂取量データを結合し、今回は性・年齢階級別の脂肪摂取量と飽和脂肪酸摂取濃度群別背景因子の検討をいった。

B. 方法

国民栄養調査で得られた世帯分の栄養素量を、世帯員の性・年齢を考慮して個人分に按分計算することにより按分推定量を求めた。さらに総摂取熱量当たりの按分推定量を計算して摂取濃度（単位は%kcal, mg/1000kcal など）を求めた。1990年の国民栄養調査結果として、飽和脂肪酸(SFA)、多価不飽和脂肪酸(PUFA)摂取量等は、すでに公表されているものであるが、詳細な脂肪酸摂取と健康指標との関連を検討するために、今回あらたに、INTERMAP 食品成分表を用いて SFA、PUFA、コレステロール摂取量を計算した。Keys 食事因子は $1.35\mathrm{x}(2\mathrm{x}\%\mathrm{SFA}-\%\mathrm{PUFA})+1.5\mathrm{x}\sqrt{\ }$ コレステロール(mg/1000kcal)により求めた（%SFA、%PUFA はそれぞれ総摂取熱量に占める SFA、PUFA の%）。次に性・年齢階級別の血圧、BMI、各脂肪摂取濃度、Keys 食事因子、血清脂質を求め平均値と標準偏差で示した。さらに SFA 摂取濃度別に男女を5群に分け、各群の血圧、BMI、各脂肪摂取濃度、Keys 食事因子、血清脂質を求め平均値と標準偏差で示した。いずれも差異と傾向の有意差を求めた。

C. 結果

Table 1 に性・年齢階級別の血圧、BMI、各脂肪摂取濃度、Keys 食事因子、血清脂質を示す。女性では収縮期血圧(SBP)は年齢が高くなるにつれ順次上昇し、拡張期血圧(DBP)、BMI、血清総コレステロール値、血清トリグリセリド値は 60 歳代までは年齢が高くなるにつれ順次上昇したが、70 歳以上群で少し低下した。一方 SFA 摂取濃度、PUFA 摂取濃度、コレステロール摂取濃度、Keys 食事因子、血清 HDL コレステロール値は年齢が高くなるにつれ順次低下していった。男性の SBP は女性と同様に年齢が高くなるにつれ順次上昇し、DBP も女性と同様には 60 歳代までは年齢が高くなるにつれ順次上昇したが、70 歳以上群で少し低下した。BMI、血清総コレステロール値、血清トリグリセリド値は 40 歳代で最も高く、その後齢が高くなるにつれ順次低下していった。SFA 摂取濃度、PUFA 摂取濃度、コレステロール摂取濃度はほぼ女性と同様に年齢が高くなるにつれ順次低下していった。血清 HDL コレステロール値は女性とは異なり年齢群による違いは認められなかった。

Table 2 に SFA 摂取濃度別に分けた各群の血圧、BMI、各脂肪摂取濃度、Keys 食事因子、血清脂質を示す。女性では SFA 摂取濃度が多くなるほど年齢、BMI、SBP、血清トリグリセリド値は低下していった。DBP もほぼ SFA 摂取濃度が多くなるほど低下していった。これらは年齢による影響と考える。PUFA 摂取濃度、コレステロール摂取濃度、Keys 食事因子、血清 HDL コレステロール値は SFA 摂取濃度が多くなるほど高くなっていった。血清総コレステロール値は群間に差が無かった。男性では SFA 摂取濃度が多くなるほど年齢、SBP、DBP が低下していった。これらも女性と同様に年齢による影響と考える。PUFA 摂取濃度、コレステロール摂取濃度、Keys 食事因子、血清総コレステロール値は SFA 摂取濃度が多くなるほど高くなっていった。血清トリグリセリド値は第 4 群で最も高かった。女性とは違って BMI、血清 HDL コレステロール値には群間差が無かった。

D. 考案

男女とも年齢が増加するほど脂肪各群の摂取濃度が低下していくことはこれまで報告されている結果と同様である。間接的ではあるが栄養摂取量推定に用いた按分法の妥当性を示唆していると考える。また女性では年齢が増加するほど血清 HDL コレステロール値低下するが、男性では血清 HDL コレステロール値に年齢差が認められないこともこれまで報告されている結果と同様であった。従って SFA 摂取濃度別に分けてみると男女とも SFA 摂取濃度が多くなると年齢が低下していった。このため背景因子の多くも年齢による影響を大きく受けたと考えられる。すなわち女性において SFA 摂取濃度が多くなると血清 HDL コレステロール値が上昇していったが、これには年齢による影響が想定される。今後多変量解析の手法を用いて検討していく必要がある。

J Epidemiol 2010;20(Suppl 3):S544-S548
doi:10.2188/jea.JE20090223

Fatty Acids Intakes and Serum Lipid Profiles: NIPPON DATA90 and the National Nutrition Monitoring

Yasuyuki Nakamura[1,2], Nagako Okuda[2], Tanvir Chowdhury Turin[2], Akira Fujiyoshi[2], Tomonori Okamura[3], Takehito Hayakawa[4], Katsushi Yoshita[5], Katsuyuki Miura[2], and Hirotsugu Ueshima[2], for the NIPPON DATA80/90 Research Group

[1]Cardiovascular Epidemiology, Kyoto Women's University, Kyoto, Japan
[2]Department of Health Science, Shiga University of Medical Science, Ohtsu, Japan
[3]Department of Preventive Cardiology, National Cardiovascular center, Osaka, Japan
[4]Department of Hygiene and Preventive Medicine, Fukushima Medical University, Fukushima, Japan
[5]National Institute of Health and Nutrition, Tokyo, Japan

Received December 28, 2009; accepted February 15, 2010; released online March 30, 2010

ABSTRACT

Background: The National Nutritional Survey in Japan (NNSJ) was initiated in 1946. Using the majority of the participants for NNSJ, the National Survey on Circulatory Disorders (NSCD) has been conducted every 10 year since 1960. We compared fatty acids intakes obtained from NNSJ and serum lipid profiles from NSCD conducted in 1990.

Methods: A total of 8344 community residents (4856 women and 3488 men, age ≥ 30) from 300 randomly selected districts participated in the both surveys in 1990. At baseline, history, physical, and blood biochemical measurement and a nutritional survey were performed. We estimated nutrient intakes of each household member by dividing household intake data proportionally using average intakes by sex and age groups calculated for NNSJ95.

Results: Total fat, saturated fatty acids (SFA), poly-unsaturated fatty acids (PUFA), dietary cholesterol, and Keys dietary lipid factor (KEYS) were inversely associated with age in both men and women (all $Ps < 0.001$). In women, age and body mass index (BMI) adjusted serum total cholesterol (TC), high-density lipoprotein cholesterol (HDLc), and low-density lipoprotein cholesterol (LDLc) were positively associated with SFA, total fat intakes (%kcal), and with KEYS ($P < 0.001$). In men, age-BMI adjusted HDLc was not associated with SFA, total fat intakes, and with KEYS factors unlike in women. Other associations were similar to those in women.

Conclusions: The total fatty acids, SFA intakes, and KEYS lipid factor obtained from NNSJ were significantly associated with serum total and LDL cholesterol from the National Survey on Circulatory Disorders conducted in 1990.

Key words: food frequency questionnaires; saturated fatty acids; polyunsaturated fatty acids; dietary cholesterol; Keys dietary lipid factor

The National Nutritional Survey in Japan (NNSJ) was initiated in 1946 under the direction of the supreme commander of the General Headquarters with the main purpose of obtaining factual information on the nutritional health and actual food consumption and food requirements in Japan for emergency food supplies from other countries.[1] Household-based food consumption data had been collected in order to fulfill the above initial purpose. Recently, the survey has been conducted once every year.

Using the majority of the participants for NNSJ, the National Survey on Circulatory Disorders has been conducted every 10 year in order to obtain cross-sectional data on cardiovascular disease prevalence and risk factors since 1960.[2] A cohort study based on the National Survey on Circulatory Disorders in 1990[3] has been names as the National Integrated Project for Prospective Observation of Non-communicable Disease and Its Trends in the Aged (NIPPON DATA90).[4]

In the present study, we compared the fatty acids intakes obtained from NNSJ and serum lipid profiles from the National Survey on Circulatory Disorders conducted in 1990.[3]

METHODS

Participants

A total of 8344 community residents (4856 women and 3488 men, aged 30 and greater) from 300 randomly selected districts participated in the National Survey on Circulatory

Address for correspondence. Dr. Yasuyuki Nakamura, Cardiovascular Epidemiology, Kyoto Women's University, 35 Imakumano Kitahiyoshi-cho, Higashiyama-ku, Kyoto 605-8501, Japan (e-mail: nakamury@kyoto-wu.ac.jp).

Table 1. Fat intake and serum lipid profiles by age group in 4856 women

Age	30–39		40–49		50–59		60–69		70–		Trend *P*	*P* diff
n	1031		1171		1035		915		704			
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
BMI (kg/m^2)	21.8	*3.0*	22.8	*3.2*	23.4	*3.2*	23.5	*3.6*	22.8	*3.4*	<0.001	<0.001
Total Fat (%kcal)	27.3	4.4	25.8	4.2	23.9	4.7	22.4	4.8	21.2	4.7	<0.001	<0.001
SFA (%kcal)	7.4	*1.4*	6.9	*1.4*	6.2	*1.4*	5.9	*1.4*	5.6	*1.5*	<0.001	<0.001
PUFA (%kcal)	6.5	*1.3*	6.3	*1.3*	6.1	*1.4*	5.7	*1.5*	5.4	*1.4*	<0.001	<0.001
Chol (mg/1000 kcal)	209.3	*55.8*	208.2	*55.4*	203.7	*59.5*	187.9	*61.4*	183.7	*60.9*	<0.001	<0.001
KeysF	32.8	*5.2*	31.5	*5.1*	29.5	*5.4*	28.5	*5.7*	27.9	*5.8*	<0.001	<0.001
TC (mg/dl)	185.7	*32.0*	199.9	*34.7*	218.1	*36.9*	222.4	*38.0*	214.5	*41.9*	<0.001	<0.001
TG (mg/dl)	94.8	*55.4*	108.3	*78.3*	134.5	*85.1*	142.7	*86.5*	134.9	*78.6*	<0.001	<0.001
HDLc (mg/dl)	59.9	*14.0*	58.9	*14.9*	56.6	*15.4*	54.0	*14.3*	52.6	*15.2*	<0.001	<0.001
LDLc (mg/dl)	106.8	*28.3*	119.3	*31.5*	134.5	*32.9*	139.8	*35.0*	134.9	*38.5*	<0.001	<0.001

Values are in mean and *standard deviation*. BMI = body mass index, SFA = dietary saturated fatty acid, PUFA = dietary poly-unsaturated fatty acid, Chol = dietary cholesterol, KeysF = Keys dietary lipid factor, TC = serum total cholesterol concentration, TG = triglycerides concentration, HDLc = high-density lipoprotein cholesterol concentration, LDLc = low-density lipoprotein cholesterol concentration, *P* diff = *P* for difference by analysis of variance.

Disorders in 1990. The overall population aged 30 and greater in all districts was 10 956, and the participation rate in this survey was 76.2%. Thus, these participants were thought to be representative of the Japanese population.

Baseline examination

At baseline, non-fasting blood samples were obtained. The serum was separated and centrifuged soon after blood coagulation. These samples were shipped to one laboratory (SRL, Tokyo) for blood chemistry measurements. Serum triglycerides (TG) and total cholesterol (TC) were measured enzymatically. High-density lipoprotein cholesterol (HDLc) was measured by the precipitation method using heparin-calcium. Lipid measurements were standardized by the Centers for Disease Control/National Heart, Lung, and Blood Institute (CDC-NHLBI) Lipids Standardization Program.[5]

Low-density lipoprotein cholesterol (LDLc) was calculated with the Friedewald formula as follows: LDLc (mg/dL) = TC (mg/dL) − HDLc (mg/dL) − 0.2 × TG (mg/dL).[6] Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m). Baseline blood pressures were measured by trained observers using a standard mercury sphygmomanometer on the right arm of seated participants.

Nutritional survey

Food intake survey by weighed food records in three consecutive representative days were conducted by specially trained dietary interviewers. Dietary interviewers visited participants' houses at least once during the survey. Weekends and holydays were avoided. Up-dated Standard Tables for Food Composition in Japan, 4th edition, with matched fatty acid values and micronutrients, were used to calculate Japanese nutrient intakes.

We estimated nutrient intakes of each household member by dividing household intake data of NNSJ90 conducted in 1990 proportionally using average intakes by sex and age groups calculated for NNSJ95.[7] The average intakes in NNSJ95 were calculated by a combination method of household-based food weighing record and an approximation of proportions by which family members shared each dish or food in the household. Detailed methods were described.[8]

For each person, means of the estimated individual nutrients from the three days records were used in the analyses. Data are presented as the contribution to total energy intake (%kcal) from total fat, saturated (SFA), polyunsaturated (PUFA), and dietary cholesterol (mg/1000 kcal). Keys dietary lipid score, predictive of serum total cholesterol, was calculated as $1.35 \times (2\text{SFA} - \text{PUFA}) + 1.5 \times C^{1/2}$, where SFA is the percentage of total kilocalories from saturated fatty acids; PUFA, percentage from polyunsaturated fatty acids; C dietary cholesterol in mg/1000 kcal.[9]

Data analyses

Data were analyzed in men and women separately. BMI, fatty acids intakes, Keys dietary lipid factor and serum lipid profiles were examined by age group. Next, age-BMI adjusted serum lipid profiles by quintile of SFA, Keys dietary lipid factor and total fat intakes using analysis of covariance. To detect differences in continuous variables in groups, analysis of variance was used. The "contrast" option for analysis of variance was used to detect deviation from linearity in the association between continuous variables and the five age groups, and trend *P* was obtained.

RESULTS

Fat intakes and serum lipid profiles by age group

Fat intakes, BMI and serum lipid profiles in 4856 women are shown in Table 1. BMI, TC, TG, HDLc and LDLc were significantly positively associated with age up to the 60s age group, then they became slightly lower in the highest age group (all Ps < 0.001). All the dietary lipid intake variables

Table 2. Fat intake and serum lipid profiles by age group in 3488 men

Age	30–39		40–49		50–59		60–69		70–		Trend *P*	*P* diff
n	660		836		793		708		491			
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
BMI (kg/m²)	22.9	*3.0*	23.4	*2.9*	23.3	*2.8*	22.6	*3.1*	22.0	*3.1*	0.025	<0.001
Total Fat (%kcal)	24.6	4.2	23.2	3.9	21.9	4.2	21.1	4.6	20.3	4.5	<0.001	<0.001
SFA (%kcal)	6.6	*1.2*	6.3	*1.3*	5.6	*1.3*	5.5	*1.3*	5.5	*1.4*	<0.001	<0.001
PUFA (%kcal)	6.0	*1.3*	5.6	*1.1*	5.7	*1.3*	5.4	*1.4*	5.2	*1.3*	<0.001	<0.001
Chol (mg/1000 kcal)	190.4	*52.9*	184.8	*48.1*	185.9	*52.9*	180.0	*56.0*	175.7	*58.0*	0.001	<0.001
KeysF	30.2	*4.9*	29.6	*4.7*	27.8	*4.9*	27.4	*5.0*	27.4	*5.6*	<0.001	<0.001
TC (mg/dl)	196.4	*35.2*	204.5	*36.6*	200.2	*36.6*	197.1	*37.7*	191.4	*36.7*	0.732	<0.001
TG (mg/dl)	150.2	*99.0*	164.1	*123.3*	147.4	*106.3*	143.7	*99.2*	123.1	*73.3*	0.049	<0.001
HDLc (mg/dl)	50.2	*15.2*	49.7	*14.3*	51.0	*14.7*	50.2	*16.0*	50.1	*15.6*	0.617	0.569
LDLc (mg/dl)	116.1	*32.2*	122.0	*33.8*	119.7	*34.8*	118.2	*34.8*	116.6	*33.2*	0.531	0.010

Values are in mean and *standard deviation*. BMI = body mass index, SFA = dietary saturated fatty acid, PUFA = dietary poly-unsaturated fatty acid, Chol = dietary cholesterol, KeysF = Keys dietary lipid factor, TC = serum total cholesterol concentration, TG = triglycerides concentration, HDLc = high-density lipoprotein cholesterol concentration, LDLc = low-density lipoprotein cholesterol concentration. *P* diff = *P* for difference by analysis of variance.

Table 3. Age-BMI adjusted serum lipid profiles by quintile of SFA, Keys dietary lipid factor and total fat intakes in 4856 women

SFA (%kcal)	1.35–5.15		5.16–6.04		6.05–6.82		6.83–7.71		7.72–14.75		*P*
n	971		970		970		968		975		
	Mean	*SE*	Mean	*SE*	Mean	*SE*	Mean	*SE*	Mean	*SE*	
TC (mg/dl)	198.4	*1.3*	204.8	*1.2*	209.2	*1.2*	209.3	*1.2*	212.8	*1.3*	<0.001
TG (mg/dl)	118.6	*2.6*	122.1	*2.5*	123.4	*2.5*	118.9	*2.5*	122.6	*2.6*	0.545
HDLc (mg/dl)	54.4	*0.5*	56.0	*0.5*	56.9	*0.5*	57.5	*0.5*	59.4	*0.5*	<0.001
LDLc (mg/dl)	120.3	*1.2*	124.4	*1.1*	127.5	*1.1*	128.0	*1.1*	128.9	*1.1*	<0.001
Keys Factor	**7.4–25.5**		**25.5–28.8**		**28.9–31.6**		**31.6–34.9**		**34.9–62.5**		
n	970		971		971		971		971		
TC (mg/dl)	200.7	*1.2*	204.6	*1.2*	207.4	*1.2*	210.0	*1.2*	211.9	*1.2*	<0.001
TG (mg/dl)	118.8	*2.6*	121.2	*2.5*	122.8	*2.5*	119.1	*2.5*	123.7	*2.6*	0.579
HDLc (mg/dl)	55.6	*0.5*	56.3	*0.5*	56.1	*0.5*	57.9	*0.5*	58.4	*0.5*	<0.001
LDLc (mg/dl)	121.3	*1.1*	124.1	*1.1*	126.8	*1.1*	128.3	*1.1*	128.7	*1.1*	<0.001
Total Fat (%kcal)	**3.8–20.2**		**20.2–23.1**		**23.1–25.7**		**25.7–28.7**		**28.7–46.1**		
n	970		971		971		971		971		
TC (mg/dl)	199.2	*1.3*	206.4	*1.2*	208.6	*1.2*	208.8	*1.2*	211.5	*1.2*	<0.001
TG (mg/dl)	122.8	*2.7*	124.7	*2.5*	119.8	*2.5*	120.9	*2.5*	117.2	*2.6*	0.326
HDLc (mg/dl)	54.0	*0.5*	55.8	*0.5*	57.3	*0.5*	57.7	*0.5*	59.4	*0.5*	<0.001
LDLc (mg/dl)	120.6	*1.2*	125.6	*1.1*	127.4	*1.1*	127.0	*1.1*	128.6	*1.1*	<0.001

Values are in mean and *standard error* obtained by age, BMI adjusted analysis of covariance. SFA = dietary saturated fatty acid, KeysF = Keys dietary lipid factor, TC = serum total cholesterol concentration, TG = triglycerides concentration, HDLc = high-density lipoprotein cholesterol concentration, LDLc = low-density lipoprotein cholesterol concentration.

(total fat, SFA, PUFA, dietary cholesterol intakes and Keys dietary lipid factor) were significantly inversely associated with age (all *P*s < 0.001).

Fat intakes, BMI and serum lipid profiles in 3422 men are shown in Table 2. BMI, TC, TG, and LDLc had their peaks at age 40s, then they became lower in the higher age groups. All the dietary lipid intake variables were significantly inversely associated with age (all *P*s < 0.001). No difference and trend were observed in HDLc among the age groups.

Age-BMI adjusted serum lipid profiles by quintile of SFA, Keys dietary lipid factor and total fat intakes

Age-BMI adjusted serum lipid profiles by quintile of SFA intake, Keys dietary lipid factor and total fat intake in 4856 women are shown in Table 3. TC, HDLc, and LDLc were significantly positively associated with SFA intake, Keys factor and total fat intake ($P < 0.001$). TG was not associated with SFA intake, Keys factor and total fat intake.

Age-BMI adjusted serum lipid profiles by quintile of SFA, Keys dietary lipid factor and total fat intake in 3488 men are shown in Table 4. TC and LDLc were significantly positively associated with SFA intake, Keys factor and total fat intake ($P < 0.001$). Unlike in women, HDLc was not associated with SFA, total fat intakes, and Keys factor. In men, HDLc was further adjusted for alcohol intake/day. Unlike in women, TG was associated with SFA intake ($P = 0.032$).

Table 4. Age-BMI adjusted serum lipid profiles by quintile of SFA, Keys dietary lipid factor and total fat intakes in 3488 men

SFA (%kcal)	1.15–4.73		4.74–5.53		5.54–6.19		6.20–7.00		7.01–13.03		P
n	971		970		970		968		975		
	Mean	*SE*	Mean	*SE*	Mean	*SE*	Mean	*SE*	Mean	*SE*	
TC (mg/dl)	193.1	*1.4*	195.8	*1.4*	199.7	*1.4*	200.6	*1.4*	204.1	*1.4*	<0.001
TG (mg/dl)	144.4	*4.0*	146.6	*3.9*	154.4	*3.9*	153.9	*3.9*	139.6	*4.0*	0.032
HDLc* (mg/dl)	49.2	*0.6*	49.7	*0.5*	50.4	*0.5*	50.8	*0.6*	51.0	*0.6*	0.134
LDLc (mg/dl)	113.8	*1.3*	117.3	*1.3*	117.4	*1.3*	122.8	*1.3*	122.8	*1.3*	<0.001
Keys Factor	5.8–24.2		24.3–27.1		27.1–29.7		29.7–32.6		32.6–52.7		
n	697		698		698		698		697		
TC (mg/dl)	192.9	*1.4*	196.6	*1.4*	200.2	*1.4*	199.3	*1.4*	204.3	*1.4*	<0.001
TG (mg/dl)	146.4	*3.9*	150.2	*3.9*	149.5	*3.9*	143.1	*3.9*	149.9	*4.0*	0.653
HDLc* (mg/dl)	50.0	*0.6*	49.9	*0.5*	50.7	*0.5*	49.7	*0.5*	51.0	*0.6*	0.403
LDLc (mg/dl)	113.4	*1.3*	116.7	*1.3*	119.4	*1.3*	121.0	*1.3*	123.8	*1.3*	<0.001
Total Fat (%kcal)	5.8–18.7		18.7–21.2		21.2–23.4		23.4–26.0		26.0–41.3		
n	697		698		698		698		697		
TC (mg/dl)	192.7	*1.4*	198.5	*1.4*	197.5	*1.4*	202.5	*1.4*	201.9	*1.4*	<0.001
TG (mg/dl)	146.8	*4.0*	156.5	*3.9*	148.2	*3.9*	145.8	*3.9*	141.6	*4.0*	0.104
HDLc* (mg/dl)	49.2	*0.6*	49.7	*0.5*	50.4	*0.5*	50.8	*0.6*	51.0	*0.6*	0.122
LDLc (mg/dl)	113.8	*1.3*	117.3	*1.3*	117.4	*1.3*	122.8	*1.3*	122.8	*1.3*	<0.001

Values are in mean and *standard error* obtained by age, BMI adjusted analysis of covariance. For HDLc*, values are further adjusted by alcohol intake/day. SFA = dietary saturated fatty acid, KeysF = Keys dietary lipid factor, TC = serum total cholesterol concentration, TG = triglycerides concentration, HDLc = high-density lipoprotein cholesterol concentration, LDLc = low-density lipoprotein cholesterol concentration.

DISCUSSION

One of the most influential ecological studies on diet and coronary heart disease (CHD) was the seven country study by Keys et al that related the mean intake of dietary factors of 16 defined populations in 7 countries to the incidence of CHD in those groups.[10] The study showed SFA intake as a percentage of calories was strongly correlated with CHD death rates. In another ecological study, a strong association was observed between the percentage of calories from total fat in 12 countries and prevalence of raised atherosclerotic lesions in autopsy cases from the same geographic area.[11] According to the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III),[12] total fat intake was not restricted strictly in order to reduce LDLc, provided SFA are reduced to goal levels (<7%). This guideline is based on that unsaturated fatty acids do not raise LDLc,[13] and also recommendations that emphasize lower total fat intakes (<30% of total energy) may have led to an overconsumption of carbohydrates, contributing to an increased prevalence of obesity.[14] Furthermore, very high intakes of carbohydrates (>60% of calories) in overweight/obese persons can aggravates some of the risk factors of the metabolic syndrome.[15,16] These latter responses have led some investigators to propose that population with a high prevalence of insulin resistance and the metabolic syndrome should avoid very high carbohydrate diets and should consume relatively more unsaturated fatty acids.[17] NNSJ90 showed that mean total fat intake was 25.3% of total energy consumed in 1990 in Japan. Mean SFA intake was 6.2% of total energy in our study. Therefore, more than half of Japanese in 1990 were taking SFA not exceeding the upper limit of SFA recommended by the Adult Treatment Panel III.

Age-specific changes in dietary fatty acids and cholesterol observed in the present study are consistent with previous studies.[7] The sex-specific differences in the associations of HDLc with SFA, total fat intakes and Keys factor observed in the present study appear to be unknown previously. These relations are needed for further analyses.

In conclusions, the total fatty acids, SFA intakes, and Key's dietary lipid factor obtained from NNSJ were significantly associated with serum total and LDL cholesterol from the National Survey on Circulatory Disorders conducted in 1990.

ACKNOWLEDGMENTS

This study was supported by the Grant-in-Aid of the Ministry of Health and Welfare under the auspices of Japanese Association for Cerebro-cardiovascular Disease Control, the Research Grant for Cardiovascular Diseases (7A-2) from the Ministry of Health, Labor and Welfare and a Health and Labor Sciences Research Grant, Japan (Comprehensive Research on Aging and Health: H11-Chouju-046, H14-Chouju-003, H17-Chouju-012, H19-Chouju-014), and by Japan Society for the Promotion of Science invitation fellowship programs for research in Japan. The authors thank all members of Japanese Association of Public Health Center Directors and all staffs of the public health centers that cooperated with our study. Investigators and members of the research group are listed in the appendix of reference 8.

REFERENCES

1. Yoshiike N, Matsumura Y, Iwaya M, Sugiyama M, Yamaguchi M. National Nutrition Survey in Japan. J Epidemiol. 1996;6:S189–200.
2. Ministry of Health and Welfare. The National Survey on Circulatory Disorders, 1990. Tokyo: Japan Heart Foundation; 1992 (in Japanese).
3. Ministry of Health and Welfare. The National Nutrition Survey in Japan, 1990. Tokyo: Daiichi Shuppan; 1992 (in Japanese).
4. Nakamura K, Okamura T, Hayakawa T, Kadowaki T, Kita Y, Okayama A, et al. Electrocardiogram screening for left high R-wave predicts cardiovascular death in a Japanese community-based population: NIPPON DATA90. Hypertens Res. 2006;29:353–60.
5. Nakamura M, Sato S, Shimamoto T. Improvement in Japanese clinical laboratory measurements of total cholesterol and HDL-cholesterol by the US cholesterol reference method laboratory network. J Atheroscler Thromb. 2003;10:145–53.
6. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972;18:499–502.
7. Ministry of Health and Welfare. The National Nutrition Survey in Japan, 1997. Tokyo, Japan: Daiichi Shuppan; 1997 (in Japanese).
8. Okuda N, Miura K, Yoshita K, Matsumura Y, Okayama A, Nakamura Y, et al. Integration of data from NIPPON DATA80/90 and National Nutrition Survey in Japan: for cohort studies of representative Japanese on nutrition. J Epidemiol. 2010;20 Suppl 3;S506–14.
9. Keys A. Serum cholesterol response to dietary cholesterol. Am J Clin Nutr. 1984;40:351–9.
10. Keys A, Arvanis C, Blackburn H. Seven countries: a multivariate analysis of death and coronary heart disease. Cambridge, MA: Harvard University Press; 1980. 381.
11. Scrimshaw NS, Guzmán MA. Diet and atherosclerosis. Lab Invest. 1968;18:623–8.
12. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Final Report. National Cholesterol Education Program National Heart, Lung, and Blood Institute National Institutes of Health NIH Publication No. 02–5215. September 2002.
13. National Research Council. Diet and health: implications for reducing chronic disease risk. Washington, D.C.: National Academy Press; 1989. 171–201.
14. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Nutrition and your health: dietary guidelines for Americans, 5th edition. Home and Garden Bulletin no. 232. Washington, D.C.: U.S. Department of Agriculture; 2000. 44 pages.
15. Garg A. High-monounsaturated-fat diets for patients with diabetes mellitus: a meta-analysis. Am J Clin Nutr. 1998;67 (3 Suppl):577S–82S.
16. Garg A, Grundy SM, Unger RH. Comparison of effects of high and low carbohydrate diets on plasma lipoproteins and insulin sensitivity in patients with mild NIDDM. Diabetes. 1992;41:1278–85.
17. Katan MB, Grundy SM, Willett WC. Should a low-fat, high-carbohydrate diet be recommended for everyone? Beyond low-fat diets. N Engl J Med. 1997;337:563–6.

日本人集団のカルシウム摂取量とその関連要因：NIPPON DATA80/90 のベースラインデータと国民栄養調査による検討

研究協力者　東口　みづか　（岩手医科大学医学部衛生学公衆衛生学講座）
研究協力者　小野田　敏行　（岩手医科大学医学部衛生学公衆衛生学講座　講師）
研究協力者　Tanvir C. Turin（滋賀医科大学社会医学講座公衆衛生学部門　特別研究員）
分担研究者　坂田　清美　　（岩手医科大学医学部衛生学公衆衛生学講座　教授）

背景：本研究の目的は、日本人集団におけるカルシウム摂取量とそれに関連する食事性要因を明らかにすることである。

方法：1980 年および 1990 年の国民栄養調査に NIPPON DATA80 および 90 のベースラインデータを結合させたデータを用いて解析を行った。解析対象数は、NIPPON DATA80 で 10,422 人（男性 4,585 人、女性 5,837 人）、NIPPON DATA90 で 8,342 人（男性 3,488 人、女性 4,854 人）であった。はじめに、年齢階級別（30-39、40-49、50-59、60-69、70 歳以上）のカルシウム摂取量を算出した。さらに、男女別にカルシウム摂取量を人数が均等になるよう 5 群に分類し、各群の年齢、BMI、血清総コレステロール、収縮期血圧、拡張期血圧、喫煙率、飲酒率、エネルギー摂取量、栄養素等摂取量、食品群別摂取量を算出した。

結果：NIPPON DATA80 および 90 のいずれにおいても、男女ともにカルシウム摂取量は年齢と正の関連を示す傾向にあり、年齢階級間でも有意差が認められた。また、カルシウム摂取量は、たんぱく質、脂質、飽和脂肪酸、ビタミン A、ビタミン C、ナトリウム、カリウム、鉄の摂取量と正の関連を示す傾向が見られた。同様に、種実類、いも類、砂糖類、豆類、果実類、緑黄色野菜、その他の野菜、きのこ類、海草類、魚介類、卵類、乳類の摂取量と正の関連を示す傾向が見られた。

結論：日本人におけるカルシウムの摂取特性を、NIPPON DATA のベースラインデータと国民栄養調査のデータを使用することによって明らかにすることができた。

J Epidemiol 2010;20(Suppl 3):S549-S556
doi:10.2188/jea.JE20090224

Calcium Intake and Associated Factors in a General Japanese Population: Baseline Data of NIPPON DATA80/90 and the National Nutrition Survey

Mizuka Higashiguchi[1], Toshiyuki Onoda[1], Tanvir Chowdhury Turin[2], and Kiyomi Sakata[1], for the NIPPON DATA80/90 Research Group

[1]Department of Hygiene and Preventive Medicine, Iwate Medical University, Morioka, Japan
[2]Department of Health Science, Shiga University of Medical Science, Otsu, Japan

Received December 28, 2009; accepted February 16, 2010; released online March 30, 2010

ABSTRACT

Objective: The purpose of this study was to investigate the dietary calcium intake and associated other dietary factors among representative sample of Japanese general men and women.
Methods: Data was obtained by linking NIPPON DATA80 and 90 with the corresponding National Nutrition Surveys held in 1980 and 1990. We analyzed data for 10 422 subjects (4585 men and 5837 women) in NIPPON DATA80 and 8342 subjects (3488 men and 4854 women) in NIPPON DATA90. Calcium intake was calculated by age groups. Dietary calcium intake was classified into quintiles and physical, life-style, and dietary parameters were examined across the quintiles.
Results: For both men and women, calcium intake tended to be positively associated with age in NIPPON DATA80 and 90, and there were significant differences in estimated calcium intake between age groups. Calcium intake tended to be positively associated with age, protein, fat, saturated fat, vitamins A and C, sodium, potassium, and iron for men and women. Calcium intake also tended to be positively associated with intake of nuts, potatoes, sugar and sweeteners, soybeans and legumes, fruits, green and yellow vegetables, other vegetables, mushrooms, sea algae, fish and shellfish, eggs, and milk and dairy products for men and women.
Conclusions: The characteristics of calcium intake in Japanese people were able to be clarified by using the baseline data of NIPPON DATA and the National Nutrition Survey.

Key words: calcium intake; nutrient and food intakes; age group; NIPPON DATA; the National Nutrition Survey

INTRODUCTION

Calcium, an essential nutrient for human body, plays a crucial role in the regulation of many metabolic processes, in neuromuscular events and in bone health.[1,2] Physiologically, calcium is involved in the maintenance of rhythmic contractions of the heart, in blood coagulation, in nerve conduction, in muscle contraction, in the secretion of hormones, in cellular exocytosis, and in cellular adhesion.[1] Studies have reported the associations of calcium with osteoporosis,[2–4] blood pressure,[5,6] obesity,[7,8] colon cancer,[9,10] and cardiovascular diseases (CVD) and stroke.[11–14]

Insufficient information is available on the dietary calcium intake pattern and its different correlates among Japanese general population. Some more, the entire dietary components needs to be considered when exploring the relationship of chronic diseases conditions and associated risk factors with the dietary patterns of any nutrient in a population, such as dietary intake of calcium that is included in dairy, fish, meat, etc. Calcium intake in Japan is much less than that in Western countries. According to the National Nutrition Survey and the previous studies, the mean calcium intake in Japan was around 450–600 mg/day.[15–17] It is assumed that the leading cause of low calcium intake is low milk and dairy products intake. However, detail of the factor that influences the dietary calcium intake is not clear. Accumulation of reliable data to clarify these problems from a general Japanese population is needed to establish strategies for health promotion and prevention of lifestyle-related diseases that take into account the differences between dietary habits in Japan and Western countries.

The purpose of the present study is to obtain necessary fundamental data in relation between the calcium intake and other dietary nutrient and food group among representative sample of Japanese population using data from NIPPON DATA80 and 90 (National Integrated Project for Prospective Observation of Non-communicable Disease And its Trends in the Aged), and the corresponding National Nutrition Survey.

Address for correspondence. Ms. Mizuka Higashiguchi, Department of Hygiene and Preventive Medicine, Iwate Medical University, 19-1 Uchimaru, Morioka City, Iwate, Morioka 020-8515, Japan (e-mail: mizuka@nau.ac.jp).

Table 1. Calcium intake by age group in NIPPON DATA80 and 90[a]

	Total	Age group (years)					*P*-value[b]
		30–39	40–49	50–59	60–69	≧70	
NIPPON DATA80							
Men							
n	4585	1220	1196	1019	679	471	
Calcium intake (mg/1000 kcal)	229.3 (60.5)	208.7 (51.9)	218.1 (50.9)	236.0 (60.4)	252.6 (65.3)	263.7 (67.3)	<0.001
Women							
n	5837	1583	1469	1319	900	566	
Calcium intake (mg/1000 kcal)	275.9 (70.4)	252.8 (56.5)	264.5 (64.1)	293.2 (76.7)	297.7 (74.2)	295.0 (73.5)	<0.001
NIPPON DATA90							
Men							
n	3488	660	836	793	708	491	
Calcium intake (mg/1000 kcal)	240.8 (73.4)	210.9 (51.3)	219.8 (58.6)	245.1 (75.2)	258.0 (77.6)	284.7 (82.5)	<0.001
Women							
n	4854	1031	1171	1035	915	702	
Calcium intake (mg/1000 kcal)	285.4 (84.9)	252.3 (61.8)	268.4 (73.3)	298.0 (86.9)	314.0 (93.4)	306.3 (94.8)	<0.001

[a]Mean (SD).
[b]Significance of difference was determined by ANOVA.

POPULATIONS AND METHODS

Nutrition survey

In the National Nutrition Survey before 1995, the dietary intake survey was conducted by a three-day weighed dietary record, and nutrient and food intakes of individuals were calculated by dividing the amount of food intake in a household by the number of household members. Since 1995, nutrient and food intakes of individuals have been calculated by a proportional division method in which the amount of food intake is proportionally divided by the consumption rate of each household member. In this study, we used nutrient and food intakes of individuals in the National Nutrition Survey of 1980 and that of 1990, which were adjusted for average intakes by sex and age groups calculated for the National Nutrition Survey in 1995.[18,19] The mean nutrient intake was calculated on the basis of the third revised edition of the Japanese Standard Food Composition Table (which was applied to the National Nutrition Survey in 1980),[20] and the fourth revised edition (which was applied to the National Nutrition Survey in 1990 and that in 1995).[21]

Study population

The study sample in this study were participants in two surveys called NIPPON DATA80 (data from the Third National Survey on Circulatory Disorders, Japan in 1980) and NIPPON DATA90 (data from the Fourth National Survey on Circulatory Disorders, Japan in 1990), which were conducted with the National Nutrition Surveys in 1980 and in 1990. NIPPON DATA80 and 90 were performed for all household members aged 30 years or older in 300 census tracts, which were randomly selected throughout Japan. Such data are considered to be representative of the entire population. These surveys have been described in detail previously.[22–25] The baseline survey was carried out at local public health centers, and all participants had to be capable of reaching the examination center without assistance. Public health nurses obtained demographic and clinical data from the study participants. Data linkage was performed between corresponding National Nutrition Survey and NIPPON DATA with the objective to investigate fundamental data in relation between the dietary nutritional intake and the health.

Statistical analysis

After excluding the participants who had missing data or total energy intake of less than 500 kcal or more than 5000 kcal, we analyzed data for the remaining 10 422 subjects (4585 men and 5837 women) in NIPPON DATA80 and 8342 subjects (3488 men and 4854 women) in NIPPON DATA90. All analyses were performed separately for men and women. Calcium intake was calculated as density intake (mg per 1000 kcal). First, average calcium intake was calculated by age groups (aged 30–39, 40–49, 50–59, 60–69 and ≧70 years old). Dietary calcium intake was classified into quintiles and physical, life-style, and dietary parameters were examined across the quintiles. Data are presented as means and standard deviations. Chi-squared tests were used for the categorical variables. To detect differences in continuous variables in groups, analysis of variance (ANOVA) was used. We used SAS Version9.1 (SAS Inc., Cary, NC, USA) for all analyses. Probability values <0.05 were regarded as statistically significant.

RESULTS

Means of calcium intake by age group are shown in Table 1. From the data obtained from NIPPON DATA80 and 90, the estimated mean values of calcium intake (SD) were

Table 2. Characteristics of participants according to quintiles of calcium intake in NIPPON DATA80[a]

	Quintiles of calcium intake					P-value[b]
	Q1	Q2	Q3	Q4	Q5	
Men						
Calcium intake (mg/1000 kcal)	63.7–179.3	179.4–208.5	208.6–237.4	237.5–273.5	273.6–637.2	
n	916	917	919	916	917	
Age (years)	45.1 (11.9)	46.8 (12.0)	49.3 (13.0)	51.7 (13.1)	56.8 (13.7)	<0.001
Body mass index (kg/m^2)	22.5 (2.8)	22.6 (2.8)	22.5 (2.9)	22.6 (2.9)	22.4 (2.9)	0.42
Total cholesterol (mg/dL)	185.9 (32.7)	187.4 (33.0)	186.4 (32.3)	184.1 (31.9)	187.9 (34.1)	0.12
Systolic blood pressure (mm Hg)	135.8 (20.5)	136.4 (21.1)	137.8 (20.7)	139.5 (21.1)	142.4 (21.3)	<0.001
Diastolic blood pressure (mm Hg)	82.9 (12.6)	83.0 (12.3)	83.8 (12.3)	84.1 (12.3)	83.8 (12.4)	0.15
Current smoker (%)	69.4	65.4	62.8	59.8	58.3	<0.001
Current drinker (%)	77.4	78.1	74.2	73.2	68.9	<0.001
Total energy (kcal)	2461.1 (528.4)	2444.4 (485.3)	2409.3 (481.1)	2415.6 (472.0)	2275.9 (521.3)	<0.001
Carbohydrate (%kcal)	60.6 (6.4)	60.1 (6.1)	59.9 (6.2)	59.3 (6.3)	58.8 (7.1)	<0.001
Protein (%kcal)	13.8 (1.6)	14.5 (1.7)	15.1 (1.8)	15.5 (1.9)	16.5 (2.3)	<0.001
Fat (%kcal)	19.5 (5.6)	19.9 (5.1)	19.8 (4.9)	20.2 (5.2)	20.5 (5.2)	<0.001
Saturated fat (%kcal)	5.3 (1.3)	5.6 (1.4)	5.6 (1.3)	5.8 (1.5)	6.0 (1.7)	0.001
Vitamin A (mg/1000 kcal)	519.7 (198.4)	648.0 (221.5)	721.6 (256.2)	800.5 (301.0)	942.7 (392.9)	<0.001
Vitamin C (mg/1000 kcal)	33.9 (11.6)	41.1 (13.2)	46.0 (14.6)	50.7 (16.2)	59.8 (22.4)	<0.001
Sodium (mg/1000 kcal)	2075.3 (630.0)	2346.9 (653.3)	2478.3 (723.6)	2662.0 (834.3)	2889.0 (1000.0)	<0.001
Potassium (mg/1000 kcal)	1042.7 (147.1)	1170.8 (144.0)	1262.1 (143.2)	1363.7 (171.0)	1532.8 (237.0)	<0.001
Iron (mg/1000 kcal)	5.3 (0.8)	5.9 (0.7)	6.3 (0.8)	6.7 (0.9)	7.4 (1.3)	<0.001
Women						
Calcium intake (mg/1000 kcal)	86.3–217.3	217.4–250.8	250.9–284.9	285.0–328.8	328.9–731.2	
n	1166	1169	1167	1167	1168	
Age (years)	46.1 (12.9)	47.2 (13.1)	49.7 (13.4)	51.9 (13.2)	55.4 (12.8)	<0.001
Body mass index (kg/m^2)	22.8 (3.5)	22.6 (3.3)	22.8 (3.4)	22.9 (3.2)	23.0 (3.3)	0.10
Total cholesterol (mg/dL)	186.0 (32.9)	188.4 (33.9)	190.3 (34.4)	193.1 (33.4)	198.2 (34.1)	<0.001
Systolic blood pressure (mm Hg)	131.3 (21.4)	131.8 (21.1)	133.3 (21.8)	135.4 (21.5)	137.4 (22.3)	<0.001
Diastolic blood pressure (mm Hg)	78.6 (12.2)	78.7 (11.8)	79.6 (12.7)	80.1 (11.2)	80.8 (11.9)	<0.001
Current smoker (%)	12.2	10.9	9.3	8.7	8.1	0.041
Current drinker (%)	21.8	23.5	20.5	18.7	17.3	0.002
Total energy (kcal)	1982.3 (428.7)	1946.9 (377.5)	1935.1 (931.4)	1927.8 (368.5)	1854.9 (431.7)	<0.001
Carbohydrate (%kcal)	63.3 (6.8)	62.3 (6.8)	62.1 (6.7)	61.8 (6.8)	60.9 (6.8)	<0.001
Protein (%kcal)	14.1 (1.6)	14.9 (1.8)	15.4 (1.8)	15.9 (1.9)	17.0 (2.2)	<0.001
Fat (%kcal)	20.9 (6.0)	21.7 (5.8)	21.6 (5.6)	21.9 (5.6)	22.4 (5.7)	<0.001
Saturated fat (%kcal)	5.7 (1.5)	6.1 (1.6)	6.2 (1.6)	6.3 (1.7)	6.6 (1.8)	<0.001
Vitamin A (mg/1000 kcal)	610.0 (242.4)	753.5 (257.8)	843.1 (306.6)	942.7 (352.7)	1134.4 (473.8)	<0.001
Vitamin C (mg/1000 kcal)	45.2 (15.7)	54.3 (17.6)	60.2 (18.8)	67.4 (22.4)	79.3 (28.8)	<0.001
Sodium (mg/1000 kcal)	2246.8 (662.3)	2520.1 (727.6)	2632.2 (723.9)	2810.9 (796.3)	3111.6 (1082.7)	<0.001
Potassium (mg/1000 kcal)	1178.7 (170.7)	1328.8 (170.9)	1423.9 (178.0)	1537.0 (198.1)	1745.2 (273.3)	<0.001
Iron (mg/1000 kcal)	5.9 (0.8)	6.5 (0.9)	6.9 (1.0)	7.5 (1.0)	8.3 (1.4)	<0.001

[a]Mean (SD).
[b]Significance of difference was determined by ANOVA or chi-square test.

229.3 (60.5) mg/1000 kcal and 240.8 (73.4) mg/1000 kcal, respectively, for men and 275.9 (70.4) mg/1000 kcal and 285.4 (84.9) mg/1000 kcal, respectively, for women. For both men and women, calcium intake tended to be positively associated with age in NIPPON DATA80 and 90, and there were significant differences in estimated calcium intake between age groups.

Tables 2 and 3 show the characteristics of the participants according to quintiles of calcium intake in NIPPON DATA80 and 90, respectively. In both NIPPON DATA80 and 90, calcium intake tended to be positively associated with age, protein, fat, saturated fat, vitamins A and C, sodium, potassium, and iron and tended to be inversely associated with current smoking and drinking habits, total energy, and carbohydrate for men. There were no significant differences in BMI between the five groups of dietary calcium intake for men. On the other hand, for women, calcium intake tended to be positively associated with age, dietary protein, fat, saturated fat, vitamins A and C, sodium, potassium, and iron and tended to be inversely associated with current smoking and drinking habits, total energy, and dietary carbohydrate intake. No significant difference in BMI was observed between the five groups of calcium intake.

Tables 4 and 5 show the food group intakes according to quintiles of calcium intake in NIPPON DATA80 and 90, respectively. In both NIPPON DATA80 and 90, calcium intake tended to be positively associated with intake of nuts, potatoes, sugar and sweeteners, sweets and snacks, soybeans and legumes, fruits, green and yellow vegetables, other vegetables, mushrooms, sea algae, fish and shellfish, eggs, and

Table 3. Characteristics of participants according to quintiles of calcium intake in NIPPON DATA90[a]

	Quintiles of calcium intake					P-value[b]
	Q1	Q2	Q3	Q4	Q5	
Men						
Calcium intake (mg/1000 kcal)	76.3–181.6	181.7–214.0	214.1–245.0	245.1–292.2	292.3–728.8	
n	697	698	698	698	697	
Age (years)	48.4 (12.4)	49.4 (12.6)	51.8 (13.3)	56.0 (14.0)	60.8 (12.5)	<0.001
Body mass index (kg/m^2)	22.9 (3.0)	23.1 (3.1)	22.9 (2.8)	22.9 (3.0)	22.8 (3.1)	0.53
Total cholesterol (mg/dL)	196.2 (36.5)	199.0 (35.9)	197.8 (36.6)	199.4 (36.8)	200.7 (38.3)	0.24
Systolic blood pressure (mm Hg)	135.6 (20.3)	135.6 (19.1)	136.6 (20.0)	138.6 (19.5)	142.0 (20.4)	<0.001
Diastolic blood pressure (mm Hg)	83.1 (11.7)	83.2 (11.3)	83.2 (11.9)	84.0 (11.2)	84.2 (12.1)	0.23
Current smoker (%)	64.0	62.7	54.8	49.7	43.8	<0.001
Current drinker (%)	61.4	61.7	58.4	53.8	53.3	<0.001
Total energy (kcal)	2362.4 (493.7)	2355.5 (451.6)	2315.5 (430.7)	2289.6 (456.3)	2256.5 (465.1)	<0.001
Carbohydrate (%kcal)	57.6 (6.2)	56.8 (5.4)	56.8 (5.6)	56.4 (6.1)	56.0 (5.5)	<0.001
Protein (%kcal)	14.6 (1.9)	15.0 (1.6)	15.5 (1.7)	16.1 (1.9)	16.7 (1.9)	<0.001
Fat (%kcal)	21.5 (4.8)	22.3 (4.3)	22.3 (4.4)	22.7 (4.4)	22.9 (4.4)	<0.001
Saturated fat (%kcal)	5.4 (1.3)	5.7 (1.2)	5.9 (1.3)	6.1 (1.4)	6.4 (1.4)	<0.001
Vitamin A (mg/1000 kcal)	981.0 (1029.8)	1119.1 (1041.0)	1236.4 (1116.0)	1393.3 (1273.2)	1543.0 (1465.3)	<0.001
Vitamin C (mg/1000 kcal)	41.0 (19.8)	51.0 (30.5)	54.7 (23.9)	60.1 (21.6)	69.4 (25.4)	<0.001
Sodium (mg/1000 kcal)	2292.7 (601.2)	2463.1 (641.7)	2582.3 (758.3)	2551.8 (693.2)	2641.7 (718.4)	<0.001
Potassium (mg/1000 kcal)	1092.1 (171.0)	1214.5 (179.0)	1304.8 (186.1)	1402.1 (222.8)	1568.8 (264.4)	<0.001
Iron (mg/1000 kcal)	4.7 (0.7)	5.2 (0.8)	5.5 (0.8)	5.8 (0.9)	6.5 (1.4)	<0.001
Women						
Calcium intake (mg/1000 kcal)	90.9–217.6	217.7–254.3	254.4–291.1	291.2–345.9	346.0–888.4	
n	970	970	971	971	971	
Age (years)	48.8 (13.7)	50.1 (13.9)	51.6 (14.3)	54.9 (13.8)	58.6 (12.6)	<0.001
Body mass index (kg/m^2)	22.8 (3.4)	22.9 (3.4)	22.9 (3.3)	22.7 (3.2)	22.8 (3.3)	0.85
Total cholesterol (mg/dL)	201.6 (37.2)	201.2 (38.8)	204.2 (37.1)	211.5 (38.4)	216.4 (40.5)	<0.001
Systolic blood pressure (mm Hg)	132.2 (21.6)	131.4 (20.7)	132.0 (19.9)	135.3 (21.2)	137.5 (20.0)	<0.001
Diastolic blood pressure (mm Hg)	79.2 (12.1)	78.7 (11.9)	78.7 (11.6)	80.0 (11.4)	81.1 (11.6)	<0.001
Current smoker (%)	14.8	9.9	9.4	7.2	6.3	<0.001
Current drinker (%)	7.4	8.3	6.6	5.9	4.4	0.016
Total energy (kcal)	1877.8 (382.9)	1871.9 (367.6)	1853.2 (338.6)	1866.0 (358.9)	1824.9 (382.0)	0.013
Carbohydrate (%kcal)	59.7 (6.6)	59.3 (6.2)	58.8 (6.1)	58.4 (5.8)	58.3 (5.8)	<0.001
Protein (%kcal)	14.9 (1.9)	15.5 (1.7)	15.8 (1.7)	16.4 (1.9)	17.2 (2.0)	<0.001
Fat (%kcal)	23.7 (5.4)	24.1 (5.1)	24.6 (5.0)	24.7 (4.7)	24.9 (4.8)	<0.001
Saturated fat (%kcal)	5.9 (1.4)	6.2 (1.4)	6.5 (1.5)	6.7 (1.5)	7.0 (1.6)	<0.001
Vitamin A (mg/1000 kcal)	1123.5 (1068.8)	1288.6 (1167.8)	1424.5 (1700.6)	1599.7 (1471.7)	1737.3 (1265.6)	<0.001
Vitamin C (mg/1000 kcal)	54.3 (23.4)	65.0 (26.1)	71.4 (38.4)	77.2 (29.1)	88.4 (32.2)	<0.001
Sodium (mg/1000 kcal)	2530.8 (682.5)	2652.4 (668.4)	2746.7 (778.6)	2763.4 (787.0)	2925.0 (884.6)	<0.001
Potassium (mg/1000 kcal)	1233.7 (198.2)	1376.1 (208.5)	1464.2 (220.1)	1571.2 (242.4)	1784.6 (310.0)	<0.001
Iron (mg/1000 kcal)	5.2 (0.8)	5.7 (0.8)	5.9 (0.9)	6.3 (1.0)	7.1 (1.6)	<0.001

[a]Mean (SD).
[b]Significance of difference was determined by ANOVA or chi-square test.

milk and dairy products and tended to be inversely associated with intake of cereals, rice, fats and oils, and meats for men. There were no significant differences in condiments and beverages in NIPPON DATA80 and flour products in NIPPON DATA90 between the five groups of calcium intake. On the other hand, calcium intake tended to be positively associated with intake of nuts, potatoes, sugar and sweeteners, soybeans and legumes, fruits, green and yellow vegetables, other vegetables, mushrooms, sea algae, fish and shellfish, eggs, and milk and dairy products and tended to be inversely associated with intake of cereals, rice, flour products, fats and oils, and meats for women. There were no significant differences in condiments and beverages in NIPPON DATA80 and sweets and snacks in NIPPON DATA90 between the five groups of calcium intake.

DISCUSSION

In this cross-sectional study in representative Japanese men and women, we investigated calcium intake and other associated dietary factors. For men and women, higher calcium intake was associated with more advanced age. Calcium intake tended to be inversely associated with intake of meats and it seemed to be related to more advanced age. Nevertheless, calcium intake tended to be positively associated with intake of protein, fat, and saturated fat, and these results seem to be related to higher intake of soybeans and legumes, fish and shellfish, eggs, and milk and dairy products. Calcium intake tended to be positively associated with intake of vitamins A and C, and potassium and iron, and it seemed to be related to higher intake of fruits, green and

Table 4. Food intakes according to quintiles of calcium intake in NIPPON DATA80[a]

	Quintiles of calcium intake					*P*-value[b]
	Q1	Q2	Q3	Q4	Q5	
Men						
Calcium intake (mg/1000 kcal)	63.7–179.3	179.4–208.5	208.6–237.4	237.5–273.5	273.6–637.2	
n	916	917	919	916	917	
Cereals (g/1000 kcal)	177.1 (29.8)	166.9 (27.4)	160.5 (27.1)	152.0 (26.8)	144.5 (30.9)	<0.001
Rice (g/1000 kcal)	142.0 (34.8)	131.3 (32.4)	125.5 (32.0)	120.7 (32.2)	122.4 (34.5)	<0.001
Flour product (g/1000 kcal)	38.8 (27.6)	38.8 (24.5)	37.4 (24.1)	33.7 (23.7)	33.5 (25.2)	<0.001
Nuts (g/1000 kcal)	0.3 (1.2)	0.5 (1.6)	0.5 (1.6)	0.6 (2.1)	0.8 (2.0)	<0.001
Potatoes (g/1000 kcal)	22.2 (16.8)	25.5 (17.3)	27.8 (18.2)	30.5 (20.3)	32.4 (21.7)	<0.001
Sugar and sweeteners (g/1000 kcal)	5.2 (4.0)	5.6 (4.0)	5.8 (4.2)	5.9 (4.1)	6.0 (4.1)	<0.001
Sweets and snacks (g/1000 kcal)	5.1 (6.0)	5.9 (5.9)	6.7 (7.3)	6.5 (7.1)	7.5 (9.0)	<0.001
Fats and oils (g/1000 kcal)	7.8 (4.8)	7.6 (4.4)	6.9 (4.1)	6.9 (4.3)	6.3 (4.0)	<0.001
Soybeans and legumes (g/1000 kcal)	21.1 (13.3)	29.1 (14.6)	34.0 (16.7)	39.8 (19.4)	49.4 (27.0)	<0.001
Fruits (g/1000 kcal)	39.9 (30.1)	52.9 (34.1)	58.6 (35.6)	65.7 (38.3)	78.9 (47.6)	<0.001
Green and yellow vegetables (g/1000 kcal)	15.8 (10.4)	20.5 (12.7)	23.9 (13.9)	26.4 (17.0)	32.4 (21.5)	<0.001
Other vegetables (g/1000 kcal)	78.0 (28.6)	87.9 (29.8)	95.2 (34.1)	104.4 (38.5)	117.8 (49.4)	<0.001
Mushrooms (g/1000 kcal)	3.7 (5.2)	3.7 (5.0)	4.1 (5.3)	4.2 (5.2)	5.0 (6.3)	<0.001
Sea algae (g/1000 kcal)	1.3 (1.3)	1.8 (1.9)	2.3 (2.3)	3.0 (2.8)	5.1 (5.7)	<0.001
Condiments and beverages (g/1000 kcal)	81.8 (86.6)	82.3 (72.1)	82.3 (71.5)	86.9 (74.2)	78.1 (71.0)	0.17
Fish and shellfish (g/1000 kcal)	46.4 (22.5)	48.5 (22.9)	52.4 (23.8)	54.4 (25.9)	59.8 (29.7)	<0.001
Meats (g/1000 kcal)	32.9 (17.0)	31.7 (17.2)	29.3 (15.3)	28.1 (15.6)	25.5 (16.3)	<0.001
Eggs (g/1000 kcal)	15.3 (9.3)	17.1 (8.5)	17.1 (9.2)	17.9 (9.2)	18.6 (11.3)	<0.001
Milk and dairy products (g/1000 kcal)	14.9 (11.4)	22.0 (14.2)	28.4 (17.0)	35.3 (21.9)	51.1 (35.6)	<0.001
Women						
Calcium intake (mg/1000 kcal)	86.3–217.3	217.4–250.8	250.9–284.9	285.0–328.8	328.9–731.2	
n	1166	1169	1167	1167	1168	
Cereals (g/1000 kcal)	170.7 (27.9)	160.0 (28.2)	155.1 (26.2)	148.0 (26.7)	138.6 (29.5)	<0.001
Rice (g/1000 kcal)	123.2 (32.1)	111.2 (32.2)	108.0 (31.2)	105.6 (31.7)	97.8 (31.8)	<0.001
Flour product (g/1000 kcal)	45.0 (28.5)	47.6 (30.1)	45.6 (29.2)	41.2 (27.4)	39.7 (28.9)	<0.001
Nuts (g/1000 kcal)	0.5 (2.0)	0.8 (2.6)	0.9 (2.8)	0.9 (2.3)	1.2 (2.8)	<0.001
Potatoes (g/1000 kcal)	27.6 (20.7)	31.6 (21.0)	33.3 (21.6)	35.7 (24.1)	39.4 (27.7)	<0.001
Sugar and sweeteners (g/1000 kcal)	6.5 (5.0)	7.2 (5.1)	6.8 (4.7)	6.7 (4.6)	6.7 (4.5)	<0.001
Sweets and snacks (g/1000 kcal)	11.7 (13.1)	13.5 (13.6)	14.2 (13.6)	13.9 (13.9)	13.4 (14.1)	<0.001
Fats and oils (g/1000 kcal)	8.3 (4.9)	8.6 (4.9)	8.0 (4.6)	7.7 (4.6)	7.3 (4.7)	<0.001
Soybeans and legumes (g/1000 kcal)	24.1 (14.3)	29.8 (15.4)	36.4 (17.9)	43.8 (21.8)	52.6 (28.5)	<0.001
Fruits (g/1000 kcal)	68.6 (48.7)	86.3 (51.3)	95.3 (51.8)	105.9 (59.7)	124.2 (72.3)	<0.001
Green and yellow vegetables (g/1000 kcal)	20.2 (13.8)	25.8 (15.5)	30.1 (18.0)	34.3 (20.6)	43.2 (28.5)	<0.001
Other vegetables (g/1000 kcal)	88.3 (33.2)	100.7 (35.9)	107.4 (39.0)	118.3 (43.0)	132.9 (54.2)	<0.001
Mushrooms (g/1000 kcal)	4.0 (5.6)	4.4 (5.8)	4.4 (5.5)	4.9 (6.1)	5.7 (7.2)	<0.001
Sea algae (g/1000 kcal)	1.5 (1.6)	2.1 (2.1)	2.6 (2.8)	3.6 (3.5)	6.2 (6.9)	<0.001
Condiments and beverages (g/1000 kcal)	34.7 (47.5)	35.6 (35.9)	34.7 (31.7)	36.0 (32.3)	34.8 (50.8)	0.91
Fish and shellfish (g/1000 kcal)	44.1 (21.9)	47.3 (23.1)	50.3 (23.7)	51.8 (23.7)	58.2 (27.8)	<0.001
Meats (g/1000 kcal)	30.1 (16.6)	30.0 (16.7)	27.8 (15.3)	27.0 (14.9)	24.8 (15.4)	<0.001
Eggs (g/1000 kcal)	16.6 (9.7)	18.2 (10.3)	18.5 (9.6)	18.7 (9.8)	19.8 (11.7)	<0.001
Milk and dairy products (g/1000 kcal)	24.0 (18.1)	37.7 (23.4)	45.7 (28.6)	53.8 (32.7)	75.9 (50.2)	<0.001

[a]Mean (SD).
[b]Significance of difference was determined by ANOVA.

yellow vegetables, other vegetables, mushrooms, and sea algae. We observed that the participants with higher intake of dietary calcium tended to be from older age categories. These findings are comparable to the National Nutrition Survey in 2003 findings,[15] which demonstrated that calcium intake of people aged 50 and over was higher than younger people. The National Nutrition Survey in 2003 was based on the individual nutrition intake data. The INTERMAP study that based on 24-hour dietary recall and involved people of 40–59 years of age from four centres in Japan reported lower intake of calcium among younger age group people.[16] The Japan Collaborative Cohort Study (JACC Study) that was based on food frequency questionnaire and involved people of 40–79 years of age from 45 communities across Japan also reported similar findings.[17] Direct comparison is not possible because of differences in the method and period of the dietary survey in the present study and the previous studies. Dietary record is considered to be the gold standard to assess nutrition survey because it has high validity and reliability. Even if it is taken into consideration that calcium intake was adjusted for average intakes by sex and age groups calculated for the National Nutrition Survey in 1995, the results of this study that was calculated by three-day weighing record method in the National Nutrition Survey are not likely to compare unfavorably with the findings in the previous studies in validity and reliability.

Table 5. Food intakes according to quintiles of calcium intake in NIPPON DATA90[a]

	Quintiles of calcium intake					P-value[b]
	Q1	Q2	Q3	Q4	Q5	
Men						
Calcium intake (mg/1000 kcal)	76.3–181.6	181.7–214.0	214.1–245.0	245.1–292.2	292.3–728.8	
n	697	698	698	698	697	
Cereals (g/1000 kcal)	161.2 (28.2)	151.3 (26.8)	146.6 (24.5)	141.9 (26.9)	132.9 (27.2)	<0.001
Rice (g/1000 kcal)	127.5 (31.6)	116.5 (29.5)	113.6 (29.1)	106.1 (27.6)	96.6 (27.8)	<0.001
Flour product (g/1000 kcal)	36.0 (26.7)	36.6 (23.9)	34.7 (23.7)	36.3 (23.5)	35.9 (26.2)	0.67
Nuts (g/1000 kcal)	0.4 (1.3)	0.5 (1.4)	0.6 (1.9)	0.8 (1.8)	1.1 (2.2)	<0.001
Potatoes (g/1000 kcal)	25.6 (16.2)	27.8 (17.3)	29.4 (17.6)	31.2 (19.9)	34.0 (20.5)	<0.001
Sugar and sweeteners (g/1000 kcal)	4.8 (3.7)	5.2 (3.6)	5.4 (3.4)	5.3 (3.9)	5.6 (4.2)	0.001
Sweets and snacks (g/1000 kcal)	4.8 (6.6)	5.7 (6.7)	5.6 (7.2)	6.4 (8.4)	6.3 (8.4)	<0.001
Fats and oils (g/1000 kcal)	7.9 (4.4)	8.1 (4.0)	7.6 (3.8)	7.2 (3.7)	6.6 (3.7)	<0.001
Soybeans and legumes (g/1000 kcal)	26.8 (15.6)	32.9 (17.7)	38.1 (19.2)	41.6 (21.4)	48.6 (27.0)	<0.001
Fruits (g/1000 kcal)	35.0 (33.1)	44.7 (33.6)	51.8 (37.4)	60.8 (40.0)	72.6 (47.1)	<0.001
Green and yellow vegetables (g/1000 kcal)	26.5 (16.4)	31.8 (17.1)	36.5 (18.2)	41.7 (21.6)	52.8 (31.3)	<0.001
Other vegetables (g/1000 kcal)	70.0 (28.0)	78.4 (31.1)	84.5 (32.7)	90.6 (36.0)	91.9 (38.1)	<0.001
Mushrooms (g/1000 kcal)	4.3 (5.5)	4.9 (5.5)	5.1 (5.8)	6.0 (7.0)	6.7 (7.6)	<0.001
Sea algae (g/1000 kcal)	2.2 (2.8)	2.7 (2.8)	3.2 (3.5)	3.8 (5.1)	4.8 (5.6)	<0.001
Condiments and beverages (g/1000 kcal)	108.4 (97.1)	123.9 (111.8)	107.6 (86.9)	93.6 (78.5)	89.9 (80.5)	<0.001
Fish and shellfish (g/1000 kcal)	49.9 (24.9)	52.1 (22.1)	55.8 (24.7)	57.5 (26.5)	59.6 (23.9)	<0.001
Meats (g/1000 kcal)	34.1 (17.5)	32.4 (15.5)	30.9 (15.7)	29.4 (16.1)	25.3 (14.3)	<0.001
Eggs (g/1000 kcal)	18.3 (9.8)	19.5 (9.5)	19.4 (9.6)	20.6 (9.7)	20.8 (9.8)	<0.001
Milk and dairy products (g/1000 kcal)	14.9 (12.9)	25.3 (16.4)	36.1 (20.0)	49.4 (25.7)	73.8 (47.9)	<0.001
Women						
Calcium intake (mg/1000 kcal)	90.9–217.6	217.7–254.3	254.4–291.1	291.2–345.9	346.0–888.4	
n	970	970	971	971	971	
Cereals (g/1000 kcal)	154.4 (26.9)	147.4 (26.2)	141.3 (24.9)	136.2 (24.3)	128.4 (32.4)	<0.001
Rice (g/1000 kcal)	110.3 (30.3)	101.9 (28.1)	97.0 (28.3)	93.3 (26.1)	87.4 (30.7)	<0.001
Flour product (g/1000 kcal)	41.5 (27.8)	43.7 (26.8)	43.0 (26.7)	41.6 (26.4)	39.4 (27.5)	0.006
Nuts (g/1000 kcal)	0.6 (2.0)	0.6 (1.6)	0.8 (2.1)	1.0 (2.5)	1.3 (2.6)	<0.001
Potatoes (g/1000 kcal)	30.9 (20.7)	33.9 (21.6)	35.4 (21.5)	37.3 (22.6)	40.8 (24.9)	<0.001
Sugar and sweeteners (g/1000 kcal)	5.9 (4.3)	6.3 (4.6)	6.5 (4.3)	6.2 (4.6)	6.5 (4.7)	0.011
Sweets and snacks (g/1000 kcal)	11.0 (13.7)	12.0 (13.3)	11.8 (13.5)	12.1 (13.2)	11.5 (13.9)	0.39
Fats and oils (g/1000 kcal)	9.1 (4.9)	8.9 (4.6)	8.8 (4.6)	8.1 (4.0)	7.5 (4.2)	<0.001
Soybeans and legumes (g/1000 kcal)	28.9 (16.9)	35.4 (19.6)	39.0 (20.2)	43.4 (22.8)	51.4 (27.8)	<0.001
Fruits (g/1000 kcal)	57.5 (46.4)	74.5 (53.6)	83.0 (55.8)	91.1 (57.2)	106.2 (60.9)	<0.001
Green and yellow vegetables (g/1000 kcal)	33.7 (21.2)	40.1 (21.8)	44.1 (22.9)	52.5 (27.0)	66.0 (36.1)	<0.001
Other vegetables (g/1000 kcal)	80.5 (33.3)	90.7 (35.8)	95.7 (37.1)	99.7 (39.5)	104.2 (43.6)	<0.001
Mushrooms (g/1000 kcal)	5.1 (7.4)	5.5 (6.1)	5.9 (6.2)	6.6 (7.2)	7.7 (8.8)	<0.001
Sea algae (g/1000 kcal)	2.6 (3.4)	3.2 (3.2)	3.7 (3.9)	4.4 (5.9)	5.8 (6.8)	<0.001
Condiments and beverages (g/1000 kcal)	46.7 (48.2)	46.4 (40.5)	47.3 (41.7)	43.2 (37.2)	40.1 (32.4)	<0.001
Fish and shellfish (g/1000 kcal)	48.1 (22.7)	51.3 (21.7)	52.5 (22.7)	55.4 (24.8)	57.3 (23.3)	<0.001
Meats (g/1000 kcal)	32.7 (17.3)	30.5 (14.9)	29.8 (15.3)	28.4 (15.6)	25.1 (14.3)	<0.001
Eggs (g/1000 kcal)	19.8 (10.7)	21.0 (10.7)	20.9 (9.9)	21.7 (10.2)	22.0 (10.7)	<0.001
Milk and dairy products (g/1000 kcal)	23.2 (19.5)	41.3 (26.1)	55.7 (32.3)	74.4 (36.7)	102.6 (57.6)	<0.001

[a]Mean (SD).
[b]Significance of difference was determined by ANOVA.

Calcium intake in Japan is less than that in Western countries. According to the INTERMAP study, levels of calcium intake per day for people of 40–59 years of age were 1013.3 mg for men and 843.1 mg for women in the United Kingdom and 882.2 mg for men and 699.5 mg for women in the United States, whereas the levels were only 605.4 mg for men and 606.9 mg for women in Japan.[16] Although direct comparison is not possible in the present study and the INTERMAP study, we also found that calcium intake in Japan is lower than that in Western countries. A guideline for dietary intake of calcium was set by the Ministry of Health, Labour and Welfare, the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of Education, Culture, Sports, Science and Technology in 2000.[26] Milk and dairy products, legumes, green and yellow vegetables intakes are recommended to increase the calcium intake by this guideline. In National Health Promotion in the 21st Century (Health Japan 21) that started in 2000, daily levels of food intake for sufficient calcium supply, such as more than 130 g for milk and dairy products, more than 100 g for legumes and more than 120 g for green and yellow vegetables,[27] have been set, but current intake levels of 125.1 g, 59.3 g and 94.4 g, respectively,[28] are below these levels. In the past couple of decades, there has been almost no change in calcium intake, as