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Original Article

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Association between Dietary Patterns and Serum Low Density Lipoprotein Cholesterol in Japanese Women and Men: The Japan Multi-Institutional Collaborative Cohort (J-MICC) Study

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Aims: The association between dietary patterns and serum low density lipoprotein (LDL) cholesterol would be changing in recent dietary habits in Japan. We investigated the relationship between dietary patterns and serum LDL cholesterol in a large general population.

Methods: From the baseline survey of Japan Multi-Institutional Collaborative Cohort Study between 2005 and 2013, 27,237 participants (13,994 were women) aged 35–69 years were cross-sectionally analyzed. Using a semi-quantitative food frequency questionnaire, five major sex-specific dietary patterns were identified using factor analysis. We assessed serum LDL cholesterol by quintiles of dietary pattern factor score.

Results: We identified dietary patterns; "vegetable rich pattern" , "meat and fried food rich pattern" and "high bread and low rice pattern" in women and men; "fish and shellfish rich pattern" and "high confectioneries and low alcohol pattern" in men; "healthy Japanese diet pattern" and "high alcohol and low rice pattern" in women. Serum LDL cholesterol in men was associated with "high bread and low rice pattern" score (Q5 was 4.2 mg/dL

higher than Q1, p for trend <0.001) and "high confectioneries and low alcohol pattern" scores (Q5 was 9.5 mg/dL higher than Q1, p for trend <0.001). In women, serum LDL cholesterol was associated with "high bread and low rice pattern" score (Q5 was 7.1 mg/dL higher than Q1, p for trend <0.001).

Conclusion: Some recent dietary patterns in Japan were associated with serum LDL cholesterol. Serum LDL cholesterol was associated with high bread and low rice pattern in both sex, and high confectioneries and low alcohol pattern in men.

Key words: Dietary patterns, Low density lipoprotein cholesterol, Food frequency questionnaire, Factor analysis

Introduction

Japan is one of the most successful countries in the world on account of excellent health outcomes[1], but cardiovascular diseases (CVD) continue to be among the main causes of morbidity and mortality. Also, dyslipidemia, especially hypercholesterolemia, is an important risk factor of atherosclerotic CVD in Japan. Dietary patterns have been increasingly highlighted in the management of non-communicable diseases, including dyslipidemia, instead of single food items or nutrients. Indices measuring adherence to the Healthy Eating Index[2], the Alternative Healthy Eating Index[3], the Dietary Approaches to Stop Hypertension (DASH) dietary pattern[4, 5], and the Mediterranean dietary pattern[6] have been associated with lower risk of CVD. Also, some cross-sectional studies have addressed the association of some dietary patterns with hypercholesterolemia or serum LDL cholesterol[7, 8]. Given the variety of dietary habits and dietary cultures across the world, the identified dietary patterns could differ by population, especially between Eastern and Western countries. Previous studies in Asia reported that meat and fast-food pattern in Korea and Western dietary pattern in Japan were associated with serum LDL cholesterol[9, 10]. However, because dietary habits, commercial food supplies and dietary patterns are changing rapidly throughout the world[11], the effect of dietary patterns on serum LDL cholesterol could have changed in recent Japanese population.

Aim

The aim of this study is to analyze the relationship between dietary patterns and fasting serum LDL cholesterol among a large general Japanese population from the Japan Multi-Institutional Collaborative Cohort (J-MICC) Study.

Methods

The J-MICC Study launched in 2005, details of the J-MICC Study have been described in previous reports[12, 13]. The candidates are those aged 35–69 years at enrollment from 13 cohorts in Japan, whose resident records are at the local government offices of the target areas. Physical data, blood samples, and self-reported health questionnaires were collected. Other inclusion or exclusion criteria can be made in each Cohort Study Executing Group. All participants in the J-MICC Study provided written informed consent prior to participating. The study was approved by the ethics committees of Nagoya University Graduate School of Medicine, Japan (2010-0939-9), and Shiga University of Medicine, Japan (G2005-103), and performed in accordance with the relevant guidelines and regulations.

The present study comprised a total 92,530 individuals from 13 cohorts, who were eligible in the baseline surveys. The baseline surveys were conducted from 2005 to 2013. We used the data ver. 20201218. We excluded participants based on the following criteria: missing data on total cholesterol; high density lipoprotein (HDL) cholesterol; and triglycerides (TG) (n=25,485); TG ≥ 400 mg/dL (n=1,310); and nonfasting participants at the time of blood collection (n=53,321). Also we excluded treatment of dyslipidemia or missing data on treatment of dyslipidemia (n=9,392), missing data on treatment of

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diabetes and hypertension (n=79), incomplete dietary survey (n=1,752), extreme self-reported energy intake (<500 kcal/day, or ≥ 5,000 kcal/day) (n=223), missing data on body mass index (BMI) (n=19,628), missing data on physical activity (n=546), missing data on smoking habits (n=499). Consequently, data in 27,237 participants from 10 cohorts were included in this analysis **(Supplemental Table 1)**.

Self-Administered Questionnaire

Participants completed a questionnaire about lifestyle and medical information and gave a blood sample at the time of the baseline survey. Physical activity was evaluated using a self-administered questionnaire similar to a short format of the International Physical Activity Questionnaire[14]. This measure assesses the types of intensity of physical activity and sitting time that people do as part of their daily lives are considered to estimate total physical activity in MET-hours/week and time spent sitting. Physical activity with 3 METs or more intensity was summed and divided into quartile as MET-hours/week in this study. Smoking status was classified as never, past smoker, current smoker consuming <20 cigarettes per day, or current smoker consuming ≥ 20 cigarettes per day.

We used a semi-quantitative food frequency questionnaire (FFQ) to estimate food intake that has been reported previously[15-18]. Participants were asked how often they had consumed 47 foods and beverages over the past year. Consumption of rice, bread, and noodles at breakfast, lunch, and dinner were divided into six categories from rarely to every day. For the other 44 foods and beverages, the intake frequency was categorized into eight categories from rarely to ≥ 3 times per day. Each food and beverage were classified as the frequency per week in this study.

Anthropometric and Biochemical Measurements

At health screening, height (cm) and weight (kg) were measured, and BMI was calculated as weight (kg) divided by the square of height (m). We used overnight fasting blood samples only for analysis. Concentrations of fasting serum total cholesterol, HDL cholesterol, TG, blood sugar, and HbA1c were measured. LDL cholesterol was calculated using the Friedewald formula[19], where we excluded participants whose TG were 400 mg/dL or more.

Statistical Analysis

Data were expressed as mean and standard deviation (SD) or median (25 percentile, 75 percentile) for continuous variables, and percentages for categorical variables respectively. The sex differences were tested using t-test or χ^2 test. To derive dietary patterns, factor analysis was conducted using the data for daily consumption of 47 items from the FFQ and alcohol consumption per week. In determining the number of factors to retain, we considered eigenvalue (1.0 or more), and factor interpretability. To achieve a simpler structure with greater interpretability, we rotated by orthogonal transformation (varimax rotation function). Consequently, five major sex-specific dietary patterns were identified, and we calculated a factor score by summing the consumption of each food item weighted by its factor loading in each pattern. Multivariable linear regression analysis was performed using each of the dietary pattern score as an independent variable and serum LDL cholesterol, HDL cholesterol, and non HDL cholesterol as dependent variables. The standardized regression coefficients were adjusted for the values of age, region, BMI, smoking habits, physical activity, energy intake, drug treatment of hypertension and diabetes mellitus, and all other dietary factor scores. According to the quintiles of each dietary pattern score using analysis of covariance, adjusted mean values of serum LDL cholesterol were calculated; adjusted for age, region, other possible confounders, and all other dietary factor scores. The linear effect of serum LDL cholesterol and the quintiles of each dietary pattern score was tested via the contrast using the corresponding option of PROC GLM in SAS. These data were expressed as means and 95% confidence intervals. All analysis were performed using SAS, Version 9.4 (SAS Institute, Cary, NC, USA). A p-value of <0.05 was considered to be significant.

Results

The baseline characteristics of the participants by sex are shown in **Table 1**. Mean age (SD) was 54.8 (9.6) years in men and 53.2 (9.5) years in women. Mean values of serum total cholesterol, HDL cholesterol, and LDL cholesterol were significantly lower in men than those in women.

Table 2 shows the factor-loading matrix for major dietary patterns identified by factor analysis. We identified five major sex-specific dietary pattern factors; described as "vegetable rich pattern" (factor 1), "meat and fried food rich pattern" (factor 3) and "high bread and low rice pattern" (factor 4) in both women and men; "fish and shellfish rich pattern" (factor 2) and "high confectioneries and low alcohol pattern" (factor 5) in men; "healthy Japanese diet pattern" (factor 2) and "high alcohol and low rice pattern" (factor 5) in women. Dietary pattern factors 1–5 in

Table 1. Baseline characteristics of the participants by sex: J-MICC study

	Men		Women		*P* value
	n		*n*		
Age (years)§	13,243	54.8 (9.6)	13,994	53.2 (9.5)	<0.001
Height (cm)§	13,243	167.7 (6.3)	13,994	155.3 (5.8)	<0.001
Weight (kg)§	13,243	66.3 (9.9)	13,994	53.1 (8.3)	<0.001
BMI (kg/m²)§	13,243	23.5 (3.0)	13,994	22.1 (3.3)	<0.001
SBP (mmHg)§	13,242	126.7 (17.4)	13,988	120.3 (18.6)	<0.001
DBP (mmHg)§	13,242	79.3 (11.1)	13,988	73.4 (11.3)	<0.001
Total cholesterol (mg/dL)§	13,243	204.4 (32.4)	13,994	213.4 (34.6)	<0.001
HDL cholesterol (mg/dL)§	13,243	59.2 (15.6)	13,994	69.5 (16.0)	<0.001
Non HDL cholesterol (mg/dL)§	13,243	145.2 (33.3)	13,994	143.9 (35.3)	0.002
LDL cholesterol (mg/dL)§	13,243	121.5 (29.9)	13,994	126.7 (31.8)	<0.001
TG (mg/dL)§	13,243	102 (73, 146)	13,994	75 (56, 104)	<0.001
Blood glucose (mg/dL)§	11,012	101.4 (19.8)	9,966	93.3 (13.6)	<0.001
HbA1c (%)§	10,154	5.3 (0.7)	8,738	5.1 (0.5)	<0.001
Quartile of physical activity (METs-hour/week) (no., %)‡					<0.001
Q1 (Men: 0-26.3, Women: 0-26.3)		3,832 (28.9)		2,789 (19.9)	
Q2 (Men: 42.0-57.8, Women: 42.0-73.5)		3,285 (24.8)		4,106 (29.3)	
Q3 (Men: 63.0-141.8, Women: 84.0-136.5)		2,885 (21.8)		3,591 (25.7)	
Q4 (Men: 147.0-577.5, Women: 141.8-577.5)		3,241 (24.5)		3,505 (25.0)	
Alcohol drinking (no., %)‡					<0.001
Never		2,778 (21.0)		8,255 (59.0)	
Past		291 (2.2)		208 (1.5)	
Current		10,162 (76.7)		5,519 (39.4)	
Missing		11 (0.1)		9 (0.1)	
Smoking (no., %)‡					<0.001
Never		4,124 (31.1)		12,088 (86.4)	
Past		5,393 (40.7)		981 (7.0)	
Current <20 per day		1,268 (9.6)		625 (4.5)	
Current >=20 par day		2,458 (18.6)		300 (2.1)	
Drug treatment (no., %)‡					
Hypertension		2,320 (17.5)		1,382 (9.9)	<0.001
Diabetes		566 (4.3)		172 (1.2)	<0.001

§Values are expressed means (Standard deviations) or median (25 percentile, 75 percentile) and *P* values between group comparisons were analyzed by unpaired *t*-test

‡Values are expressed numbers (percentages) and *P* values between group comparisons were analyzed by χ^2 test

SD, standard deviation; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high density lipoprotein; LDL, low density lipoprotein; TG, triglycerides.

men accounted for 17.6%, 7.2%, 7.8%, 8.8%, and 4.1% of variance and together explained 45.4% of the variability. Dietary pattern factors 1–5 in women accounted for 13.5%, 10.3%, 6.7%, 11.5%, and 3.3% of variance and together explained 45.2% of the variability. Detailed information about nutrition intake according to each of dietary pattern factor are shown in the **Supplemental Tables 2, 3, 4, 5, 6**.

Table 3 shows the association between serum cholesterol and five dietary pattern factors using multivariable linear regression analysis. After multivariable adjustment, "fish and shellfish rich pattern" (factor 2) in men was inversely associated with serum LDL cholesterol ($p<0.001$), and positively associated with serum HDL cholesterol ($p<0.001$). "High bread and low rice pattern" (factor 4) in both sexes was positively associated with serum LDL cholesterol ($p<0.001$) and with serum HDL cholesterol ($p<0.001$). "High confectioneries and low alcohol pattern" (factor 5) in men was positively associated with serum LDL cholesterol ($p<0.001$), and inversely associated with serum HDL cholesterol ($p<0.001$).

Table 4 shows adjusted mean values of serum LDL cholesterol according to the quintiles of each dietary pattern factor in women and men, respectively.

Table 2. Factor-loading matrix for major dietary patterns identified by factor analysis

	Men					Women				
	Factor1	Factor2	Factor3	Factor4	Factor5	Factor1	Factor2	Factor3	Factor4	Factor5
Green leaves vegetables (e.g. Spinach, Komatsuna, Shungiku, etc.)	0.676					0.698				
Other green-yellow vegetables (e.g. Green pepper, String beans, etc.)	0.658					0.684				
Other vegetables (e.g. Cucumber, Lettuce, Bean sprouts, Onion, Chinese cabbage etc.)	0.643					0.677				
Carrot	0.612					0.552				
Daikon (Japanese radish)	0.610					0.456	0.371			
Mushrooms (e.g. Shiitake, Shimeji, Enoki, etc.)	0.606					0.562				
Cabbage	0.584					0.485				
Seaweeds (e.g. Brown algae, Kelp, etc.)	0.529					0.477	0.318			
Potatoes (e.g. Potato, Sweet-potato, Taro, Yam)	0.510					0.369	0.366			
Broccoli	0.477					0.327	0.314			
Other fruits	0.429					0.342	0.329			
Pumpkin/squash	0.426						0.427			
Burdock, Bamboo shoot	0.415						0.429			
Citrus fruits (e.g. Orange, Tangerine, Mandarin orange, etc.)	0.357						0.347			
Natto (Fermented soybean), Soybean	0.320						0.337			
Tofu (Soybean curd) for Hiyayakko, Yu-dofu							0.305			
Shellfish (e.g. Short-necked clam, Corbicula, Oyster)		0.610					0.547			
Cuttlefish, Squid, Octopus, Shrimp, Crab		0.591					0.483			
Fish egg (e.g. Cod fish egg, Salted salmon egg, etc.)		0.483					0.319			
Fish paste products (e.g. Kamaboko, Chikuwa)		0.362					0.325			
Fish	0.330	0.337					0.418			
Bone-edible small fish (e.g. Boiled and semidried whitebait, Smelt)	0.322	0.333					0.468			
Liver		0.321					0.304			
Ganmodoki (Fried tofu paste), Nama-age (Fried tofu)		0.316					0.372			
Canned tuna		0.314						0.326		
Kiriboshi-daikon (Dry strips of Japanese radish)							0.439			
Light fried food			0.653					0.449		
Deep fried food			0.642					0.527		
Beef, Pork			0.489					0.484		
Mayonnaise (including Salad dressed with mayonnaise [e.g. Potato-salad, etc.])			0.475					0.477		
Chicken			0.428					0.455		
Ham, Sausage, Bacon, Salami-sausage			0.370					0.465		
Egg			0.300					0.404		
Bread (including White Bread, Bun etc.)				0.776					0.871	
Margarine				0.505					0.501	
Noodles (Udon, Soba, Chinese noodle)										0.341
Miso soup				-0.433					-0.341	
Rice				-0.726					-0.663	-0.408
Japanese style confectioneries (Manju, etc.)					0.538					
Western style confectioneries (e.g. Short cake, Cream puff, etc.)					0.503					
Yogurt										
Milk										
Alcohol					-0.408					0.394
Peanut, Almond										
Coffee										
Butter										
Green tea										

Absolute values $>=0.300$ were not listed for simplicity

Table 3. The association between serum cholesterol and 5 dietary pattern factors using multivariable linear regression analysis by sex

	Men (n=13,243)						Women (n=13,994)					
	LDL-C		HDL-C		non HDL-C		LDL-C		HDL-C		non HDL-C	
	SRC	*P* value	SRC	*P* value	SRC	*P* value	SRC	*P* value	SRC	*P* value	SRC	*P* value
Factor 1	-0.008	0.349	0.007	0.411	-0.019	0.030	-0.006	0.425	0.032	<0.001	-0.012	0.118
Factor 2	-0.033	<0.001	0.037	<0.001	-0.025	0.003	0.001	0.890	-0.001	0.110	-0.007	0.407
Factor 3	0.027	0.003	0.019	0.030	0.023	0.011	-0.011	0.221	0.016	0.077	-0.015	0.089
Factor 4	0.049	<0.001	0.054	<0.001	0.044	<0.001	0.068	<0.001	0.053	<0.001	0.054	<0.001
Factor 5	0.093	<0.001	-0.169	<0.001	0.059	<0.001	-0.022	0.015	0.070	<0.001	-0.013	0.142
Adjusted R^2	0.057		0.162		0.086		0.186		0.167		0.221	

Dietary pattern factors;
Factor 1: Men and Women; Vegetable rich pattern
Factor 2: Men; Fish and shellfish rich pattern, Women; Healthy Japanese diet pattern
Factor 3: Men and Women; Meat and fried food rich pattern
Factor 4: Men and Women; High bread and low rice pattern
Factor 5: Men; High confectioneries and low alcohol pattern, Women: High alcohol and low rice pattern
Multivariate linear regression analysis was performed using serum fasting lipids (LDL cholesterol [LDL-C], HDL cholesterol [HDL- C], or non HDL cholesterol [non HDL-C] as independent variables. The standardized regression coefficients (SRC) were adjusted for sex, age, region, smoking habits, physical activity, BMI, energy intake, drug treatment of hypertension and diabetes mellitus, and all other dietary factor scores.

Table 4. Adjusted mean values of serum LDL cholesterol (mg/dL) according to the quintiles of each dietary pattern factor by sex

	Quintile of each dietary pattern Score					*P* for trend
	Q1	Q2	Q3	Q4	Q5	
Men (n=13,243)						
Factor 1	118.7 (117.0, 120.5)	119.1 (117.4, 120.9)	118.2 (116.4, 119.9)	118.2 (116.4, 119.9)	118.3 (116.5, 120.0)	0.384
Factor 2	120.1 (118.3, 121.6)	119.8 (118.0, 121.6)	117.5 (115.7, 119.2)	117.7 (116.0, 119.5)	117.4 (115.6, 119.2)	<0.001
Factor 3	118.7 (116.9, 120.5)	116.8 (115.1, 118.6)	118.6 (116.8, 120.3)	118.6 (116.9, 120.4)	119.7 (118.0, 121.5)	0.079
Factor 4	115.5 (113.7, 117.3)	117.9 (116.1, 119.6)	118.6 (116.9, 120.3)	120.6 (118.9, 122.4)	119.7 (117.9, 121.5)	<0.001
Factor 5	112.6 (110.9, 114.4)	118.7 (117.0, 120.5)	119.9 (118.1, 121.7)	120.2 (118.4, 121.9)	122.1 (120.3, 123.9)	<0.001
Women (n=13,994)						
Factor 1	122.1 (119.6, 124.6)	122.5 (120.0, 125.0)	122.6 (120.0, 125.1)	122.2 (119.7, 124.7)	122.7 (120.3, 125.2)	0.479
Factor 2	121.9 (119.4, 124.4)	122.5 (119.9, 124.8)	122.5 (120.0, 125.0)	122.6 (120.1, 125.1)	122.7 (120.2, 125.3)	0.299
Factor 3	123.5 (121.0, 126.0)	122.0 (119.5, 124.5)	123.2 (120.7, 125.7)	121.5 (119.0, 124.0)	121.9 (119.4, 124.4)	0.055
Factor 4	118.1 (115.6, 120.6)	121.9 (119.4, 124.4)	124.2 (121.7, 126.7)	122.8 (120.3, 125.2)	125.2 (122.7, 127.8)	<0.001
Factor 5	121.6 (119.1, 124.1)	123.6 (121.1, 126.0)	123.0 (120.5, 125.5)	122.7 (120.2, 125.2)	121.1 (118.5, 123.6)	0.385

Dietary pattern factors;
Factor 1: Men and Women; Vegetable rich pattern
Factor 2: Men; Fish and shellfish rich pattern, Women; Healthy Japanese diet pattern
Factor 3: Men and Women; Meat and fried food rich pattern
Factor 4: Men and Women; High bread and low rice pattern
Factor 5: Men; High confectioneries and low alcohol pattern, Women: High alcohol and low rice pattern
The linear effect of serum LDL cholesterol by the quintiles of dietary patterns score was tested by multivariable linear regression. Adjusted mean values of serum LDL cholesterol by the quintiles of each dietary pattern were calculated by analysis of covariance, adjusted for sex, age, region, smoking habits, physical activity, BMI, energy intake, drug treatment of hypertension and diabetes mellitus, and all other dietary factor scores.

After multivariable adjustment, serum LDL cholesterol in men was significantly associated with the quintiles of "high bread and low rice pattern" (factor 4) (Q5 was 4.2 mg/dL higher than Q1, p for trend <0.001), of "high confectioneries and low alcohol pattern" (factor 5) (Q5 was 9.5 mg/dL higher than Q1, p for trend <0.001), and of "fish and shellfish rich pattern" (factor 2) (Q5 was 2.7 mg/dL lower than Q1, p for trend <0.001). In women, serum LDL cholesterol levels was significantly associated with the quintiles of "high bread and low rice pattern" (factor 4) (Q5 was 7.1 mg/dL higher than Q1, p for trend <0.001).

Discussion

In this cross-sectional analysis on the associations between serum LDL cholesterol and dietary patterns in a large Japanese population, we identified five major sex-specific dietary pattern factors by factor analysis. Serum LDL cholesterol calculated using Friedewald formula was positively associated with "high bread and low rice pattern" (factor 4) in both women and men. In men, serum LDL cholesterol was also positively associated with "high confectioneries and low alcohol pattern" (factor 5) and inversely associated with "fish and shellfish rich pattern" (factor 2).

In this study, intake of total fat and saturated fatty acids (SFA) was positively associated with the quintiles of "high bread and low rice pattern" (factor 4) **(Supplemental Table 5)**, which may influence the relationship between serum LDL cholesterol and "high bread and low rice pattern"[20, 21]. Breads in Japan include not only white breads but also sweet pastries and delicatessen breads, which are rich in SFA, including butter and margarine[22]. Serum HDL cholesterol was also positively associated with this factor (factor 4), probably because both serum LDL cholesterol and HDL cholesterol tend to increase with higher total fat intake. "High confectioneries and low alcohol pattern" in men would be also related to higher serum LDL cholesterol through higher intake of SFA and trans fatty acids (TFA) affected by higher intake of some kinds of confectionaries[23]. While it is possible that there are a certain number of Japanese who consume excessive amounts of SFA and TFA because of their high intake of confectioneries, sweet pastries and delicatessen breads, a previous study reported the snack dietary pattern was newly emerged in China which was associated with a higher risk of hypercholesterolemia[24].

In men, "high confectioneries and low alcohol pattern" (factor 5) was positively associated with serum LDL cholesterol. Also, "fish and shellfish rich pattern" (factor 2) in men was inversely associated with serum LDL cholesterol **(Supplemental Table 3 and 6)**, and, in women, "high alcohol and low rice pattern" (factor 5) was inversely associated with serum LDL cholesterol. Alcohol intake itself would have LDL cholesterol lowering effect; this has been supported by previous studies[25-27]. Also, among Japanese, it has been reported that alcohol intake has a causal role in not only increasing HDL cholesterol but also decreasing LDL cholesterol and particle numbers[28]. On the other hand, nutrients consumed with alcohol intake may affect serum LDL cholesterol. Previous studies reported that alcohol related dietary patterns differed among different studies, where they were related to intakes of red meat[29, 30], noodles[31, 32], or snacks[33, 34]. Therefore, dietary patterns related to alcohol intake in each study from various countries may have different effects on serum cholesterol.

"Meat and fried food rich pattern" (factor 3) in men was positively (but not linearly) associated with fasting serum LDL cholesterol, and this pattern was not associated with LDL cholesterol in women. A previous study in Korea reported that the meat and fast-food pattern score was associated with higher LDL cholesterol levels[9]. In present study, the "meat and fried food rich pattern" (factor 3) included higher intake of red meat, chicken, processed meat (e.g. hum, sausage and bacon) and egg. Also, this pattern included higher intake of fried foods, where many Japanese dishes include stir-fried vegetables and deep-fried vegetables like "tempura" using plant-based oils. This may be related to the reason why this pattern was not related to LDL cholesterol, although SFA and dietary cholesterol intakes were positively associated with this pattern in both women and men.

"Fish and shellfish rich pattern" (factor 2) in men was inversely associated with serum LDL cholesterol; however, "healthy Japanese diet pattern" (factor 2) in women was not related to LDL cholesterol. Similar to previous studies[35-37], this pattern (factor 2) in women in the present study was characterized by a high intake of vegetables, fruits, soy products and fish/shellfish. High intake of these food items was associated with a high intake of dietary fiber and n-3 polyunsaturated fatty acids[22]. The Japan Diet is recommended by the Japan Atherosclerosis Society based on the traditional Japanese diet for the prevention of atherosclerotic CVD[38]. The ideal "healthy Japanese dietary pattern" should be established for the prevention of non-communicable diseases and longer longevity.

A strength of our study is that the study was based on a large-scale survey data from various areas of Japan, which was highly standardized in obtaining

socio-demographic, dietary, and lifestyle characteristics as well as biological cardiovascular risk factors. However, the present study has some limitations. First, as the association was derived from the cross-sectional study, the causal relationship between dietary patterns and serum LDL cholesterol could not be determined due to possible reverse causality. The awareness of previously diagnosed dyslipidemia can alter their dietary patterns. However, we excluded participants who were on treatment of dyslipidemia to minimize reverse causality. Second, exploratory patterns are specific to the population investigated, so the contribution of single study findings to evidence-based recommendations is limited. Also, the five major dietary patterns could explain 45% of the total variation in dietary patterns for both men and women. The remaining 55% of the total variation could be attributed to minor dietary patterns. Third, this study may have participants selection bias since we limited the analyses in participants who had fasting blood samples. However, the dietary pattern factors were almost similar in participants including nonfasting participants (data not shown). Fourth, we did not measure serum LDL cholesterol directly, so we had to evaluate serum LDL cholesterol by Friedewald formula using fasting serum values of total cholesterol, HDL cholesterol and TG and in participants with TG less than 400 mg/dL. Our results on serum LDL cholesterol may be partly due to the changes of fasting TG and HDL cholesterol by dietary patterns.

Conclusion

We identified five major sex-specific dietary pattern factors in this large-scale Japanese population. Serum LDL cholesterol was associated with high bread and low rice pattern in both sex, and high confectioneries and low alcohol pattern in men. The risk of high LDL cholesterol may be reduced by the improvement of these dietary patterns in modern Japanese population.

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Disclosures

All authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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Supplemental Table 1. Number of participants each of the regions in this study

	Men	Women	Total (n)	Total (%)
Okazaki (Aichi)	2,975	2,576	5,551	20.4
Shizuoka and Daiko (Aichi)	3,903	4,308	8,211	30.1
Takashima (Shiga)	501	1,037	1,538	5.6
Kyoto	289	327	616	2.3
Fukuoka	197	208	405	1.5
Saga	353	521	874	3.2
Kagoshima	2,068	2,758	4,826	17.7
Tokushima	524	526	1,050	3.9
Sakuragaoka (Shizuoka)	2,144	1,349	3,493	12.8
Iga (Mie)	289	384	673	2.5
Total	13,243	13,994	27,237	100.0

Supplemental Table 2. Nutrients intake according to the quintile of factor 1 (Men and Women; vegetable rich pattern)

	Factor 1 (Men)					
	Q1 (n=2648)	Q2 (n=2649)	Q3 (n=2649)	Q4 (n=2649)	Q5 (n=2648)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1853.2 ± 379.8	1883.3 ± 357.9	1922.3 ± 356.0	1954.7 ± 338.3	2001.7 ± 354.9	<0.001
Protein (%energy)	11.0 ± 1.7	11.3 ± 1.5	11.6 ± 1.5	11.9 ± 1.7	12.5 ± 2.0	<0.001
Fat (% energy)	19.3 ± 5.5	19.7 ± 4.9	20.2 ± 5.2	20.7 ± 5.4	21.9 ± 5.8	<0.001
Carbohydrate (% energy)	57.1 ± 7.0	57.1 ± 6.6	57.3 ± 6.5	57.4 ± 6.1	57.4 ± 6.2	0.065
Alcohol (g/day)	18.1 ± 22.2	17.1 ± 20.2	16.3 ± 19.9	16.0 ± 19.9	15.1 ± 18.8	<0.001
Alcohol (% energy)	6.7 ± 7.8	6.3 ± 7.2	5.9 ± 6.8	5.6 ± 6.5	5.2 ± 6.1	<0.001
Saturated fatty acids (% energy)	5.02 ± 1.32	5.11 ± 1.23	5.18 ± 1.30	5.23 ± 1.29	5.34 ± 1.37	<0.001
Monounsaturated fatty acids (% energy)	7.53 ± 2.16	7.53 ± 1.90	7.61 ± 2.01	7.79 ± 2.09	8.18 ± 2.29	<0.001
Polyunsaturated fatty acids (% energy)	5.74 ± 1.64	5.97 ± 1.49	6.15 ± 1.61	6.38 ± 1.67	6.87 ± 1.90	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.01 ± 0.29	1.03 ± 0.27	1.06 ± 0.28	1.10 ± 0.30	1.20 ± 0.33	<0.001
n-6 Polyunsaturated fatty acids (% energy)	4.86 ± 1.48	5.04 ± 1.33	5.18 ± 1.43	5.35 ± 1.47	5.68 ± 1.64	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.29 ± 0.13	0.31 ± 0.13	0.33 ± 0.14	0.36 ± 0.15	0.43 ± 0.20	<0.001
Cholesterol (mg/ 1000 kcal)	121.2 ± 38.9	123.6 ± 36.9	123.8 ± 37.4	127.0 ± 38.5	133.1 ± 41.5	<0.001
Na (mg/1000 kcal)	853.7 ± 266.6	915.9 ± 260.3	949.1 ± 272.6	982.3 ± 271.0	1045.1 ± 285.1	<0.001
K (mg/1000 kcal)	950.4 ± 183.1	1005.5 ± 174.7	1052.4 ± 180.5	1120.7 ± 186.8	1292.3 ± 250.5	<0.001
Ca (mg/1000 kcal)	223.8 ± 64.3	242.8 ± 70.1	255.6 ± 73.2	266.5 ± 75.6	294.3 ± 86.6	<0.001
Fe (mg/1000 kcal)	3.0 ± 0.8	3.4 ± 0.8	3.6 ± 0.8	3.9 ± 0.9	4.6 ± 1.1	<0.001
Carotene (μg/1000 kcal)	1007.7 ± 250.2	1181.4 ± 288.9	1343.2 ± 351.2	1591.9 ± 429.9	2177.8 ± 785.5	<0.001
Vitamin A (μgRAE/ 1000 kcal)	394.4 ± 222.1	432.1 ± 209.0	457.9 ± 203.1	511.2 ± 218.7	613.1 ± 251.4	<0.001
Vitamin D (μg/ 1000 kcal)	3.08 ± 1.39	3.37 ± 1.37	3.65 ± 1.46	4.05 ± 1.67	4.90 ± 2.26	<0.001
Vitamin E (mg/ 1000 kcal)	3.74 ± 1.01	3.90 ± 0.95	4.04 ± 1.00	4.28 ± 1.05	4.86 ± 1.29	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.35 ± 0.08	0.35 ± 0.07	0.34 ± 0.07	0.34 ± 0.07	0.35 ± 0.07	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.50 ± 0.14	0.53 ± 0.13	0.56 ± 0.14	0.57 ± 0.15	0.62 ± 0.16	<0.001
Folate (μg/ 1000 kcal)	131.9 ± 37.5	147.9 ± 37.0	160.9 ± 39.0	178.4 ± 42.3	220.6 ± 60.3	<0.001
Vitamin C (mg/ 1000 kcal)	34.7 ± 10.6	40.5 ± 11.4	44.5 ± 12.0	49.5 ± 13.4	62.3 ± 19.7	<0.001
Soluble dietary fiber (g/ 1000 kcal)	0.74 ± 0.21	0.84 ± 0.21	0.92 ± 0.22	1.02 ± 0.24	1.26 ± 0.35	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	2.98 ± 0.67	3.33 ± 0.69	3.60 ± 0.72	3.97 ± 0.81	4.90 ± 1.26	<0.001
Total dietary fiber (g/ 1000 kcal)	4.10 ± 0.97	4.62 ± 0.97	5.01 ± 1.03	5.54 ± 1.14	6.85 ± 1.74	<0.001

(Contl Supplemental Table 2)

	Factor 1 (Women)					
	Q1 (n=2798)	Q2 (n=2799)	Q3 (n=2799)	Q4 (n=2799)	Q5 (n=2799)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1493.0 ± 264.2	1509.8 ± 246.1	1525.2 ± 236.0	1544.8 ± 238.6	1589.0 ± 256.0	<0.001
Protein (%energy)	12.5 ± 1.7	13.0 ± 1.7	13.2 ± 1.8	13.6 ± 1.9	13.9 ± 2.0	<0.001
Fat (% energy)	24.8 ± 5.5	26.1 ± 5.6	26.7 ± 5.8	27.6 ± 5.9	28.5 ± 6.6	<0.001
Carbohydrate (% energy)	55.1 ± 5.8	54.6 ± 5.7	54.6 ± 5.8	54.6 ± 5.6	54.8 ± 5.7	0.047
Alcohol (g/day)	3.5 ± 8.6	3.3 ± 7.9	3.4 ± 9.3	2.8 ± 7.4	2.6 ± 7.4	<0.001
Alcohol (% energy)	1.7 ± 4.2	1.6 ± 3.7	1.6 ± 4.0	1.3 ± 3.3	1.2 ± 3.2	<0.001
Saturated fatty acids (% energy)	6.66 ± 1.55	6.89 ± 1.59	6.94 ± 1.56	7.07 ± 1.59	7.11 ± 1.60	<0.001
Monounsaturated fatty acids (% energy)	9.26 ± 2.17	9.65 ± 2.17	9.87 ± 2.37	10.19 ± 2.39	10.55 ± 2.75	<0.001
Polyunsaturated fatty acids (% energy)	7.28 ± 1.81	7.63 ± 1.83	7.88 ± 1.94	8.23 ± 2.02	8.68 ± 2.34	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.24 ± 0.30	1.29 ± 0.30	1.33 ± 0.31	1.39 ± 0.33	1.46 ± 0.38	<0.001
n-6 Polyunsaturated fatty acids (% energy)	6.20 ± 1.62	6.51 ± 1.62	6.69 ± 1.70	6.94 ± 1.77	7.26 ± 2.03	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.36 ± 0.15	0.38 ± 0.15	0.40 ± 0.16	0.43 ± 0.18	0.46 ± 0.20	<0.001
Cholesterol (mg/ 1000 kcal)	156.1 ± 42.6	159.0 ± 42.3	161.4 ± 48.0	164.2 ± 45.3	165.2 ± 46.3	<0.001
Na (mg/1000 kcal)	1048.3 ± 293.8	1101.7 ± 283.3	1138.0 ± 299.8	1165.9 ± 303.3	1209.4 ± 329.9	<0.001
K (mg/1000 kcal)	1177.1 ± 209.1	1277.2 ± 215.8	1362.6 ± 228.2	1471.3 ± 249.0	1708.1 ± 340.8	<0.001
Ca (mg/1000 kcal)	318.7 ± 93.8	338.5 ± 95.4	351.1 ± 96.6	367.9 ± 102.1	391.6 ± 108.1	<0.001
Fe (mg/1000 kcal)	4.0 ± 1.0	4.3 ± 1.0	4.7 ± 1.1	5.1 ± 1.2	5.9 ± 1.5	<0.001
Carotene (μg/1000 kcal)	1495.8 ± 385.1	1805.8 ± 472.9	2132.2 ± 571.2	2492.5 ± 675.7	3363.9 ± 1218.4	<0.001
Vitamin A (μgRAE/ 1000 kcal)	524.9 ± 317.9	571.3 ± 270.5	624.3 ± 275.9	692.9 ± 282.2	842.4 ± 326.6	<0.001
Vitamin D (μg/ 1000 kcal)	3.88 ± 1.63	4.18 ± 1.61	4.49 ± 1.76	4.91 ± 1.98	5.46 ± 2.29	<0.001
Vitamin E (mg/ 1000 kcal)	4.91 ± 1.11	5.19 ± 1.12	5.46 ± 1.23	5.82 ± 1.31	6.50 ± 1.60	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.43 ± 0.08	0.43 ± 0.08	0.44 ± 0.08	0.44 ± 0.08	0.44 ± 0.08	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.68 ± 0.17	0.71 ± 0.17	0.73 ± 0.17	0.76 ± 0.18	0.79 ± 0.18	<0.001
Folate (μg/ 1000 kcal)	181.3 ± 48.6	201.7 ± 49.3	222.7 ± 55.5	248.0 ± 59.8	309.1 ± 86.2	<0.001
Vitamin C (mg/ 1000 kcal)	52.9 ± 15.9	60.4 ± 18.1	67.0 ± 19.9	75.3 ± 23.2	88.9 ± 29.2	<0.001
Soluble dietary fiber (g/ 1000 kcal)	1.04 ± 0.25	1.18 ± 0.26	1.30 ± 0.28	1.44 ± 0.32	1.73 ± 0.45	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	4.30 ± 0.83	4.82 ± 0.90	5.29 ± 1.00	5.86 ± 1.16	7.02 ± 1.69	<0.001
Total dietary fiber (g/ 1000 kcal)	5.77 ± 1.16	6.53 ± 1.25	7.19 ± 1.36	8.00 ± 1.59	9.61 ± 2.31	<0.001

Supplemental Table 3. Nutrition intake according to the quintile of factor 2 (Men; fish and shellfish rich pattern, Women; healthy Japanese diet pattern)

	Factor 2 (Men)					
	Q1 (n=2648)	Q2 (n=2649)	Q3 (n=2649)	Q4 (n=2649)	Q5 (n=2648)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1885.8 ± 342.3	1879.9 ± 344.5	1902.7 ± 358.6	1939.6 ± 360.2	2007.3 ± 384.5	<0.001
Protein (%energy)	11.0 ± 1.4	11.2 ± 1.4	11.4 ± 1.6	11.9 ± 1.7	12.7 ± 2.0	<0.001
Fat (% energy)	20.3 ± 5.6	19.7 ± 5.1	19.8 ± 5.3	20.3 ± 5.4	21.6 ± 5.5	<0.001
Carbohydrate (% energy)	59.0 ± 5.6	58.2 ± 5.9	57.1 ± 6.5	56.5 ± 6.8	55.4 ± 7.0	<0.001
Alcohol (g/day)	10.5 ± 15.1	13.6 ± 17.3	17.2 ± 19.7	19.2 ± 21.7	22.2 ± 24.1	<0.001
Alcohol (% energy)	3.8 ± 5.4	5.0 ± 6.1	6.3 ± 7.0	6.9 ± 7.4	7.7 ± 7.8	<0.001
Saturated fatty acids (% energy)	5.10 ± 1.30	5.10 ± 1.29	5.15 ± 1.30	5.19 ± 1.31	5.33 ± 1.34	<0.001
Monounsaturated fatty acids (% energy)	7.67 ± 2.25	7.49 ± 1.95	7.55 ± 2.02	7.73 ± 2.07	8.20 ± 2.14	<0.001
Polyunsaturated fatty acids (% energy)	6.10 ± 1.80	5.96 ± 1.55	6.05 ± 1.63	6.24 ± 1.67	6.75 ± 1.77	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.03 ± 0.29	1.02 ± 0.27	1.05 ± 0.29	1.10 ± 0.30	1.19 ± 0.33	<0.001
n-6 Polyunsaturated fatty acids (% energy)	5.26 ± 1.63	5.05 ± 1.38	5.05 ± 1.44	5.18 ± 1.45	5.56 ± 1.54	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.27 ± 0.12	0.30 ± 0.12	0.34 ± 0.15	0.37 ± 0.16	0.44 ± 0.19	<0.001
Cholesterol (mg/ 1000 kcal)	118.1 ± 37.8	120.9 ± 36.3	123.9 ± 37.2	128.1 ± 38.6	137.7 ± 41.3	<0.001
Na (mg/1000 kcal)	910.5 ± 285.5	919.9 ± 269.1	941.9 ± 271.9	965.5 ± 277.8	1008.2 ± 277.8	<0.001
K (mg/1000 kcal)	1115.9 ± 258.8	1062.4 ± 208.5	1060.2 ± 218.7	1071.9 ± 216.4	1110.7 ± 236.6	0.760
Ca (mg/1000 kcal)	249.1 ± 77.8	248.1 ± 74.4	253.5 ± 77.2	259.0 ± 75.7	273.3 ± 81.9	<0.001
Fe (mg/1000 kcal)	3.6 ± 1.1	3.5 ± 0.9	3.6 ± 1.0	3.8 ± 1.0	4.0 ± 1.1	<0.001
Carotene (μg/1000 kcal)	1536.1 ± 764.0	1388.3 ± 533.1	1368.5 ± 518.5	1430.8 ± 542.2	1578.3 ± 659.6	0.001
Vitamin A (μgRAE/ 1000 kcal)	416.7 ± 192.0	427.7 ± 174.3	461.5 ± 188.1	508.6 ± 215.9	594.3 ± 322.3	<0.001
Vitamin D (μg/ 1000 kcal)	2.97 ± 1.30	3.31 ± 1.31	3.69 ± 1.56	4.15 ± 1.75	4.93 ± 2.14	<0.001
Vitamin E (mg/ 1000 kcal)	4.14 ± 1.20	3.98 ± 1.01	4.01 ± 1.06	4.14 ± 1.10	4.55 ± 1.21	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.33 ± 0.07	0.34 ± 0.07	0.35 ± 0.07	0.35 ± 0.08	0.36 ± 0.08	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.52 ± 0.14	0.53 ± 0.14	0.55 ± 0.14	0.57 ± 0.15	0.60 ± 0.16	<0.001
Folate (μg/ 1000 kcal)	168.1 ± 61.9	159.5 ± 47.1	162.3 ± 47.9	168.8 ± 50.9	180.9 ± 55.9	<0.001
Vitamin C (mg/ 1000 kcal)	45.3 ± 17.6	44.1 ± 15.0	45.2 ± 15.9	46.9 ± 16.3	50.1 ± 17.8	<0.001
Soluble dietary fiber (g/ 1000 kcal)	0.95 ± 0.33	0.91 ± 0.27	0.92 ± 0.28	0.96 ± 0.30	1.04 ± 0.34	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	3.79 ± 1.19	3.59 ± 0.93	3.61 ± 0.97	3.75 ± 1.05	4.03 ± 1.19	<0.001
Total dietary fiber (g/ 1000 kcal)	5.18 ± 1.68	4.96 ± 1.32	5.04 ± 1.36	5.26 ± 1.47	5.68 ± 1.67	<0.001

(Cont. Supplemental Table 3)

	Factor 2 (Women)					
	Q1 (n=2798)	Q2 (n=2799)	Q3 (n=2799)	Q4 (n=2799)	Q5 (n=2799)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1479.1 ± 253.9	1496.7 ± 245.0	1516.1 ± 224.5	1550.1 ± 235.8	1619.8 ± 266.7	<0.001
Protein (%energy)	12.6 ± 1.6	12.8 ± 1.6	13.0 ± 1.6	13.4 ± 1.8	14.4 ± 2.2	<0.001
Fat (% energy)	27.9 ± 6.5	26.4 ± 5.5	26.1 ± 5.7	26.3 ± 5.8	27.0 ± 6.5	<0.001
Carbohydrate (% energy)	53.4 ± 6.3	54.5 ± 5.5	54.9 ± 5.5	55.4 ± 5.4	55.5 ± 5.7	<0.001
Alcohol (g/day)	4.2 ± 10.8	3.3 ± 7.8	2.8 ± 7.1	2.6 ± 7.1	2.5 ± 7.1	<0.001
Alcohol (% energy)	2.0 ± 4.9	1.6 ± 3.7	1.4 ± 3.4	1.2 ± 3.1	1.1 ± 3.1	<0.001
Saturated fatty acids (% energy)	7.05 ± 1.66	6.92 ± 1.54	6.90 ± 1.53	6.86 ± 1.53	6.94 ± 1.65	0.004
Monounsaturated fatty acids (% energy)	10.43 ± 2.69	9.74 ± 2.18	9.66 ± 2.27	9.73 ± 2.28	9.97 ± 2.55	<0.001
Polyunsaturated fatty acids (% energy)	7.87 ± 2.16	7.59 ± 1.81	7.72 ± 1.93	7.99 ± 1.96	8.52 ± 2.26	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.33 ± 0.34	1.29 ± 0.30	1.31 ± 0.31	1.35 ± 0.32	1.44 ± 0.37	<0.001
n-6 Polyunsaturated fatty acids (% energy)	6.91 ± 1.97	6.52 ± 1.62	6.54 ± 1.68	6.68 ± 1.72	6.95 ± 1.91	0.064
n-3 Highly unsaturated fatty acids (% energy)	0.31 ± 0.11	0.35 ± 0.13	0.39 ± 0.14	0.44 ± 0.16	0.53 ± 0.21	<0.001
Cholesterol (mg/ 1000 kcal)	159.6 ± 47.4	158.2 ± 43.3	157.9 ± 43.2	161.3 ± 42.8	169.0 ± 47.5	<0.001
Na (mg/1000 kcal)	1026.5 ± 267.8	1075.3 ± 269.2	1131.7 ± 299.3	1180.9 ± 314.4	1248.8 ± 330.8	<0.001
K (mg/1000 kcal)	1341.0 ± 313.3	1334.9 ± 273.9	1370.6 ± 292.9	1418.0 ± 290.1	1531.8 ± 342.5	<0.001
Ca (mg/1000 kcal)	320.3 ± 94.8	335.8 ± 89.9	352.3 ± 96.8	363.9 ± 100.0	395.5 ± 112.8	<0.001
Fe (mg/1000 kcal)	4.2 ± 1.2	4.4 ± 1.1	4.7 ± 1.2	5.0 ± 1.2	5.6 ± 1.4	<0.001
Carotene (μg/1000 kcal)	2054.7 ± 940.2	2061.7 ± 837.3	2151.0 ± 853.0	2317.1 ± 889.7	2705.9 ± 1148.8	<0.001
Vitamin A (μgRAE/ 1000 kcal)	550.2 ± 246.0	592.2 ± 242.8	628.0 ± 249.5	677.9 ± 282.4	807.6 ± 444.0	<0.001
Vitamin D (μg/ 1000 kcal)	3.44 ± 1.21	3.93 ± 1.39	4.41 ± 1.55	4.96 ± 1.74	6.17 ± 2.42	<0.001
Vitamin E (mg/ 1000 kcal)	5.52 ± 1.40	5.32 ± 1.21	5.39 ± 1.30	5.57 ± 1.33	6.08 ± 1.62	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.45 ± 0.08	0.44 ± 0.08	0.43 ± 0.08	0.43 ± 0.08	0.43 ± 0.08	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.66 ± 0.16	0.70 ± 0.16	0.74 ± 0.17	0.76 ± 0.17	0.81 ± 0.20	<0.001
Folate (μg/ 1000 kcal)	207.7 ± 73.0	215.1 ± 65.5	227.9 ± 65.9	242.2 ± 70.3	269.9 ± 85.5	<0.001
Vitamin C (mg/ 1000 kcal)	55.5 ± 18.6	61.1 ± 19.6	67.7 ± 20.7	74.4 ± 23.9	85.9 ± 29.3	<0.001
Soluble dietary fiber (g/ 1000 kcal)	1.17 ± 0.32	1.22 ± 0.32	1.30 ± 0.35	1.40 ± 0.36	1.61 ± 0.47	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	4.90 ± 1.24	5.04 ± 1.21	5.31 ± 1.31	5.64 ± 1.36	6.40 ± 1.74	<0.001
Total dietary fiber (g/ 1000 kcal)	6.52 ± 1.72	6.79 ± 1.66	7.23 ± 1.79	7.74 ± 1.88	8.82 ± 2.37	<0.001

Supplemental Table 4. Nutrition intake according to the quintile of factor 3 (Men and Women; meat and fried food rich pattern)

	Factor 3 (Men)					
	Q1 (n=2648)	Q2 (n=2649)	Q3 (n=2649)	Q4 (n=2649)	Q5 (n=2648)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1848.9 ± 345.1	1869.6 ± 335.9	1910.1 ± 350.6	1947.4 ± 360.7	2039.2 ± 381.4	<0.001
Protein (%energy)	11.3 ± 1.8	11.3 ± 1.6	11.5 ± 1.6	11.8 ± 1.7	12.4 ± 1.9	<0.001
Fat (% energy)	17.1 ± 4.2	18.2 ± 4.2	19.6 ± 4.3	21.6 ± 4.5	25.3 ± 5.7	<0.001
Carbohydrate (% energy)	58.5 ± 6.6	57.8 ± 6.3	57.5 ± 6.3	56.7 ± 6.6	55.7 ± 6.4	<0.001
Alcohol (g/day)	15.0 ± 19.1	16.5 ± 19.7	16.2 ± 18.2	17.5 ± 22.7	17.5 ± 21.2	<0.001
Alcohol (% energy)	5.6 ± 7.0	6.1 ± 6.9	6.0 ± 6.6	6.2 ± 7.4	5.9 ± 6.8	0.059
Saturated fatty acids (% energy)	5.03 ± 1.35	5.06 ± 1.28	5.11 ± 1.27	5.22 ± 1.28	5.46 ± 1.31	<0.001
Monounsaturated fatty acids (% energy)	6.26 ± 1.37	6.82 ± 1.37	7.39 ± 1.51	8.28 ± 1.68	9.90 ± 2.28	<0.001
Polyunsaturated fatty acids (% energy)	5.25 ± 1.25	5.59 ± 1.23	5.97 ± 1.36	6.58 ± 1.47	7.72 ± 1.94	<0.001
n-3 Polyunsaturated fatty acids (% energy)	0.95 ± 0.27	0.98 ± 0.23	1.03 ± 0.25	1.13 ± 0.27	1.31 ± 0.33	<0.001
n-6 Polyunsaturated fatty acids (% energy)	4.27 ± 0.99	4.62 ± 1.00	4.98 ± 1.13	5.58 ± 1.24	6.66 ± 1.72	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.36 ± 0.20	0.33 ± 0.15	0.33 ± 0.15	0.34 ± 0.15	0.35 ± 0.16	0.004
Cholesterol (mg/ 1000 kcal)	113.6 ± 36.7	120.3 ± 37.7	125.3 ± 36.5	129.3 ± 37.1	140.1 ± 41.0	<0.001
Na (mg/1000 kcal)	984.5 ± 301.3	953.0 ± 276.1	946.6 ± 279.1	935.4 ± 262.1	926.6 ± 269.7	<0.001
K (mg/1000 kcal)	1081.5 ± 246.3	1061.5 ± 217.4	1080.8 ± 220.6	1084.1 ± 225.4	1113.2 ± 235.2	<0.001
Ca (mg/1000 kcal)	276.6 ± 89.0	258.8 ± 76.7	253.8 ± 74.7	249.1 ± 72.5	244.7 ± 71.9	<0.001
Fe (mg/1000 kcal)	3.8 ± 1.1	3.6 ± 1.0	3.7 ± 1.0	3.7 ± 1.0	3.7 ± 1.0	0.851
Carotene (μg/1000 kcal)	1424.9 ± 657.7	1385.3 ± 540.9	1448.8 ± 603.9	1459.1 ± 594.7	1583.9 ± 658.8	<0.001
Vitamin A (μgRAE/ 1000 kcal)	455.4 ± 238.1	469.1 ± 209.4	487.4 ± 243.8	481.9 ± 229.3	515.0 ± 244.0	<0.001
Vitamin D (μg/ 1000 kcal)	4.06 ± 2.18	3.70 ± 1.61	3.70 ± 1.62	3.72 ± 1.67	3.86 ± 1.71	<0.001
Vitamin E (mg/ 1000 kcal)	3.58 ± 0.92	3.78 ± 0.89	4.02 ± 0.92	4.37 ± 1.01	5.07 ± 1.25	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.33 ± 0.07	0.34 ± 0.07	0.35 ± 0.07	0.35 ± 0.07	0.36 ± 0.07	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.57 ± 0.16	0.56 ± 0.15	0.55 ± 0.15	0.55 ± 0.14	0.55 ± 0.14	<0.001
Folate (μg/ 1000 kcal)	168.0 ± 55.6	164.5 ± 49.8	166.6 ± 52.1	167.4 ± 53.2	173.1 ± 56.4	<0.001
Vitamin C (mg/ 1000 kcal)	48.4 ± 19.2	45.3 ± 15.8	45.6 ± 16.0	45.7 ± 15.6	46.5 ± 16.3	<0.001
Soluble dietary fiber (g/ 1000 kcal)	0.99 ± 0.36	0.93 ± 0.30	0.95 ± 0.30	0.94 ± 0.28	0.96 ± 0.29	0.009
Insoluble dietary fiber (g/ 1000 kcal)	3.84 ± 1.24	3.65 ± 1.03	3.72 ± 1.04	3.72 ± 1.02	3.84 ± 1.06	0.418
Total dietary fiber (g/ 1000 kcal)	5.36 ± 1.75	5.09 ± 1.47	5.17 ± 1.48	5.17 ± 1.42	5.33 ± 1.47	0.821

(Cont. Supplemental Table 4)

	Factor 3 (Women)					
	Q1 (n=2798)	Q2 (n=2799)	Q3 (n=2799)	Q4 (n=2799)	Q5 (n=2799)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1410.9 ± 252.7	1472.0 ± 218.7	1531.8 ± 231.0	1570.4 ± 212.5	1676.7 ± 251.1	<0.001
Protein (%energy)	12.7 ± 1.9	12.8 ± 1.7	13.1 ± 1.7	13.4 ± 1.7	14.1 ± 2.0	<0.001
Fat (% energy)	23.4 ± 5.3	24.7 ± 5.1	26.0 ± 5.1	28.0 ± 5.0	31.6 ± 6.0	<0.001
Carbohydrate (% energy)	55.8 ± 6.3	55.6 ± 5.6	55.1 ± 5.5	54.3 ± 5.4	53.0 ± 5.3	<0.001
Alcohol (g/day)	3.0 ± 8.8	2.9 ± 7.5	3.0 ± 8.3	3.2 ± 8.0	3.3 ± 8.1	0.088
Alcohol (% energy)	1.6 ± 4.3	1.4 ± 3.6	1.4 ± 3.6	1.5 ± 3.6	1.4 ± 3.4	0.124
Saturated fatty acids (% energy)	6.70 ± 1.66	6.76 ± 1.58	6.87 ± 1.57	7.04 ± 1.51	7.29 ± 1.53	<0.001
Monounsaturated fatty acids (% energy)	8.63 ± 2.06	9.12 ± 1.99	9.57 ± 1.95	10.34 ± 2.05	11.86 ± 2.58	<0.001
Polyunsaturated fatty acids (% energy)	7.03 ± 1.77	7.42 ± 1.74	7.71 ± 1.76	8.21 ± 1.85	9.33 ± 2.29	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.25 ± 0.32	1.26 ± 0.30	1.30 ± 0.30	1.36 ± 0.30	1.53 ± 0.36	<0.001
n-6 Polyunsaturated fatty acids (% energy)	5.75 ± 1.39	6.21 ± 1.42	6.54 ± 1.49	7.01 ± 1.60	8.08 ± 2.04	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.44 ± 0.20	0.40 ± 0.17	0.40 ± 0.16	0.39 ± 0.15	0.40 ± 0.17	<0.001
Cholesterol (mg/ 1000 kcal)	146.4 ± 42.3	153.5 ± 42.3	158.2 ± 42.2	168.0 ± 44.9	179.9 ± 45.9	<0.001
Na (mg/1000 kcal)	1180.9 ± 323.1	1148.4 ± 315.8	1133.9 ± 303.9	1108.0 ± 290.2	1092.1 ± 294.8	<0.001
K (mg/1000 kcal)	1451.7 ± 352.4	1397.3 ± 312.0	1378.5 ± 292.1	1374.8 ± 295.5	1394.1 ± 297.9	<0.001
Ca (mg/1000 kcal)	381.7 ± 115.6	360.3 ± 102.4	348.0 ± 97.3	342.9 ± 95.7	334.9 ± 92.9	<0.001
Fe (mg/1000 kcal)	5.0 ± 1.5	4.8 ± 1.3	4.7 ± 1.3	4.7 ± 1.2	4.7 ± 1.3	<0.001
Carotene (μg/1000 kcal)	2394.6 ± 1126.2	2200.7 ± 957.8	2180.6 ± 886.7	2189.2 ± 895.4	2325.5 ± 953.2	0.008
Vitamin A (μgRAE/ 1000 kcal)	656.1 ± 295.0	631.1 ± 287.5	626.1 ± 261.0	642.8 ± 297.1	699.9 ± 410.4	<0.001
Vitamin D (μg/ 1000 kcal)	5.03 ± 2.32	4.53 ± 1.93	4.46 ± 1.83	4.36 ± 1.71	4.52 ± 1.85	<0.001
Vitamin E (mg/ 1000 kcal)	5.19 ± 1.37	5.26 ± 1.27	5.38 ± 1.23	5.67 ± 1.28	6.38 ± 1.50	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.44 ± 0.09	0.43 ± 0.08	0.43 ± 0.08	0.44 ± 0.07	0.44 ± 0.07	0.004
Vitamin B2 (mg/ 1000 kcal)	0.76 ± 0.20	0.74 ± 0.18	0.72 ± 0.17	0.72 ± 0.17	0.73 ± 0.17	<0.001
Folate (μg/ 1000 kcal)	250.9 ± 84.6	231.4 ± 73.9	225.6 ± 69.9	224.0 ± 70.8	231.0 ± 75.5	<0.001
Vitamin C (mg/ 1000 kcal)	77.8 ± 30.2	68.8 ± 24.5	66.4 ± 23.2	65.4 ± 22.1	66.1 ± 22.3	<0.001
Soluble dietary fiber (g/ 1000 kcal)	1.46 ± 0.47	1.33 ± 0.39	1.31 ± 0.38	1.29 ± 0.36	1.31 ± 0.37	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	5.95 ± 1.77	5.43 ± 1.44	5.33 ± 1.42	5.25 ± 1.31	5.33 ± 1.34	<0.001
Total dietary fiber (g/ 1000 kcal)	8.07 ± 2.45	7.38 ± 2.01	7.25 ± 1.97	7.15 ± 1.82	7.25 ± 1.87	<0.001

Supplemental Table 5. Nutrition intake according to the quintile of factor 4 (Men and Women; high bread and low rice pattern)

	Factor 4 (Men)					
	Q1 (n=2648)	Q2 (n=2649)	Q3 (n=2649)	Q4 (n=2649)	Q5 (n=2648)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	2106.3 ± 346.6	1979.0 ± 344.2	1867.7 ± 342.0	1828.3 ± 361.6	1834.0 ± 331.8	<0.001
Protein (%energy)	11.0 ± 1.6	11.3 ± 1.7	11.6 ± 1.7	12.0 ± 1.8	12.3 ± 1.7	<0.001
Fat (% energy)	16.9 ± 4.4	18.5 ± 4.7	20.3 ± 4.9	22.3 ± 5.2	23.8 ± 5.0	<0.001
Carbohydrate (% energy)	61.0 ± 4.9	58.8 ± 5.8	56.6 ± 6.3	55.2 ± 6.8	54.6 ± 6.2	<0.001
Alcohol (g/day)	16.2 ± 18.2	18.0 ± 20.6	19.0 ± 22.0	16.3 ± 21.5	13.2 ± 18.2	<0.001
Alcohol (% energy)	5.2 ± 5.6	6.2 ± 6.7	7.1 ± 7.6	6.3 ± 7.8	5.0 ± 6.5	0.432
Saturated fatty acids (% energy)	4.44 ± 0.99	4.84 ± 1.09	5.21 ± 1.12	5.56 ± 1.40	5.82 ± 1.41	<0.001
Monounsaturated fatty acids (% energy)	6.92 ± 1.81	7.43 ± 1.96	7.98 ± 2.09	8.21 ± 2.30	8.11 ± 2.05	<0.001
Polyunsaturated fatty acids (% energy)	6.02 ± 1.65	6.06 ± 1.67	6.22 ± 1.71	6.35 ± 1.80	6.44 ± 1.68	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.00 ± 0.27	1.05 ± 0.29	1.11 ± 0.30	1.13 ± 0.34	1.09 ± 0.29	<0.001
n-6 Polyunsaturated fatty acids (% energy)	4.90 ± 1.47	4.95 ± 1.47	5.15 ± 1.50	5.44 ± 1.51	5.68 ± 1.41	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.34 ± 0.16	0.35 ± 0.16	0.35 ± 0.16	0.35 ± 0.18	0.33 ± 0.15	0.726
Cholesterol (mg/ 1000 kcal)	114.3 ± 36.2	122.4 ± 36.3	129.4 ± 37.4	130.6 ± 41.6	131.9 ± 39.8	<0.001
Na (mg/1000 kcal)	943.6 ± 328.1	897.2 ± 287.2	902.5 ± 261.9	973.6 ± 247.7	1029.3 ± 237.3	<0.001
K (mg/1000 kcal)	1038.0 ± 203.1	1073.8 ± 219.6	1098.5 ± 228.1	1101.9 ± 250.7	1108.9 ± 237.3	<0.001
Ca (mg/1000 kcal)	228.5 ± 65.6	241.3 ± 68.4	255.8 ± 71.2	270.0 ± 84.4	287.4 ± 84.0	<0.001
Fe (mg/1000 kcal)	3.9 ± 1.0	3.8 ± 1.1	3.7 ± 1.0	3.6 ± 1.1	3.5 ± 1.0	<0.001
Carotene (μg/1000 kcal)	1357.9 ± 579.7	1436.6 ± 590.9	1478.1 ± 632.4	1497.8 ± 623.2	1531.5 ± 639.2	<0.001
Vitamin A (μgRAE/ 1000 kcal)	435.3 ± 198.7	471.2 ± 223.4	497.2 ± 230.5	502.9 ± 245.2	502.0 ± 260.9	<0.001
Vitamin D (μg/ 1000 kcal)	3.80 ± 1.81	3.84 ± 1.77	3.86 ± 1.74	3.89 ± 1.94	3.66 ± 1.61	0.016
Vitamin E (mg/ 1000 kcal)	3.67 ± 0.96	3.96 ± 1.02	4.22 ± 1.10	4.39 ± 1.22	4.58 ± 1.12	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.30 ± 0.05	0.33 ± 0.06	0.36 ± 0.06	0.37 ± 0.09	0.37 ± 0.07	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.51 ± 0.13	0.54 ± 0.14	0.56 ± 0.14	0.58 ± 0.16	0.59 ± 0.16	<0.001
Folate (μg/ 1000 kcal)	162.0 ± 46.2	167.0 ± 51.7	169.7 ± 54.8	170.9 ± 56.9	170.0 ± 56.9	<0.001
Vitamin C (mg/ 1000 kcal)	45.4 ± 14.7	45.8 ± 15.9	46.1 ± 16.8	47.0 ± 17.9	47.2 ± 17.8	<0.001
Soluble dietary fiber (g/ 1000 kcal)	0.85 ± 0.30	0.88 ± 0.30	0.92 ± 0.29	1.02 ± 0.29	1.11 ± 0.29	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	3.36 ± 0.99	3.54 ± 1.03	3.70 ± 1.05	3.99 ± 1.09	4.19 ± 1.04	<0.001
Total dietary fiber (g/ 1000 kcal)	4.82 ± 1.47	4.95 ± 1.49	5.12 ± 1.51	5.49 ± 1.51	5.75 ± 1.46	<0.001

(Cont. Supplemental Table 5)

	Factor 4 (Women)					
	Q1 (n=2798)	Q2 (n=2799)	Q3 (n=2799)	Q4 (n=2799)	Q5 (n=2799)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1594.1 ± 207.6	1518.7 ± 263.1	1488.1 ± 268.8	1526.4 ± 235.3	1534.5 ± 260.9	<0.001
Protein (%energy)	12.8 ± 2.0	13.2 ± 2.0	13.4 ± 1.9	13.3 ± 1.7	13.5 ± 1.7	<0.001
Fat (% energy)	23.4 ± 5.8	25.9 ± 6.0	27.5 ± 6.0	27.7 ± 5.2	29.3 ± 5.4	<0.001
Carbohydrate (% energy)	58.4 ± 5.0	55.7 ± 5.9	53.9 ± 5.8	53.8 ± 4.7	52.0 ± 5.0	<0.001
Alcohol (g/day)	3.1 ± 10.1	3.6 ± 8.9	3.4 ± 8.3	2.7 ± 6.8	2.6 ± 5.9	0.002
Alcohol (% energy)	1.3 ± 4.1	1.8 ± 4.4	1.7 ± 4.0	1.3 ± 3.0	1.2 ± 2.8	0.016
Saturated fatty acids (% energy)	6.21 ± 1.35	6.83 ± 1.51	7.17 ± 1.65	7.02 ± 1.46	7.43 ± 1.65	<0.001
Monounsaturated fatty acids (% energy)	9.36 ± 2.38	10.07 ± 2.54	10.24 ± 2.56	9.85 ± 2.21	10.00 ± 2.28	<0.001
Polyunsaturated fatty acids (% energy)	7.87 ± 2.18	8.02 ± 2.15	8.02 ± 2.12	7.78 ± 1.84	8.00 ± 1.94	0.382
n-3 Polyunsaturated fatty acids (% energy)	1.31 ± 0.34	1.38 ± 0.36	1.38 ± 0.35	1.32 ± 0.30	1.31 ± 0.31	0.036
n-6 Polyunsaturated fatty acids (% energy)	6.46 ± 1.94	6.63 ± 1.88	6.77 ± 1.85	6.75 ± 1.60	6.98 ± 1.63	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.42 ± 0.19	0.42 ± 0.18	0.41 ± 0.17	0.39 ± 0.16	0.38 ± 0.16	<0.001
Cholesterol (mg/ 1000 kcal)	153.0 ± 45.2	163.6 ± 45.7	167.2 ± 46.3	159.7 ± 42.7	162.5 ± 44.1	<0.001
Na (mg/1000 kcal)	1127.5 ± 395.1	1100.7 ± 325.1	1126.1 ± 285.2	1132.9 ± 255.3	1176.0 ± 247.3	<0.001
K (mg/1000 kcal)	1357.5 ± 303.3	1439.8 ± 334.7	1427.0 ± 332.3	1359.2 ± 273.7	1412.8 ± 302.4	0.001
Ca (mg/1000 kcal)	322.8 ± 91.7	351.5 ± 103.7	362.3 ± 109.0	351.4 ± 95.9	379.8 ± 102.4	<0.001
Fe (mg/1000 kcal)	5.1 ± 1.4	5.0 ± 1.4	4.8 ± 1.3	4.5 ± 1.1	4.4 ± 1.2	<0.001
Carotene (μg/1000 kcal)	2205.4 ± 968.4	2368.5 ± 1054.5	2302.1 ± 1025.9	2153.6 ± 851.6	2260.7 ± 929.6	0.550
Vitamin A (μgRAE/ 1000 kcal)	634.5 ± 299.0	680.7 ± 320.8	678.5 ± 356.8	622.1 ± 269.6	640.1 ± 320.8	0.115
Vitamin D (μg/ 1000 kcal)	4.80 ± 2.15	4.83 ± 2.06	4.65 ± 1.93	4.35 ± 1.74	4.29 ± 1.79	<0.001
Vitamin E (mg/ 1000 kcal)	5.13 ± 1.32	5.61 ± 1.46	5.70 ± 1.48	5.53 ± 1.24	5.90 ± 1.38	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.40 ± 0.07	0.44 ± 0.08	0.45 ± 0.09	0.43 ± 0.07	0.44 ± 0.07	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.69 ± 0.17	0.74 ± 0.18	0.76 ± 0.19	0.72 ± 0.17	0.76 ± 0.18	<0.001
Folate (μg/ 1000 kcal)	230.7 ± 72.9	242.8 ± 80.0	237.9 ± 79.9	222.6 ± 66.5	228.9 ± 76.7	<0.001
Vitamin C (mg/ 1000 kcal)	66.3 ± 22.1	70.9 ± 25.8	70.1 ± 26.5	66.2 ± 23.1	71.1 ± 27.0	<0.001
Soluble dietary fiber (g/ 1000 kcal)	1.22 ± 0.41	1.32 ± 0.43	1.36 ± 0.41	1.34 ± 0.34	1.45 ± 0.36	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	5.00 ± 1.44	5.48 ± 1.61	5.59 ± 1.57	5.43 ± 1.28	5.79 ± 1.41	<0.001
Total dietary fiber (g/ 1000 kcal)	6.94 ± 2.10	7.48 ± 2.25	7.57 ± 2.14	7.31 ± 1.79	7.80 ± 1.91	<0.001

Supplemental Table 6. Nutrition intake according to the quintile of factor 5 (Men: high confectioneries and low alcohol pattern, Women: high alcohol and low rice pattern)

	Factor 5 (Men)					
	Q1 (n=2648)	Q2 (n=2649)	Q3 (n=2649)	Q4 (n=2649)	Q5 (n=2648)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1862.9 ± 416.2	1887.4 ± 363.8	1908.1 ± 341.2	1925.5 ± 312.5	2031.4 ± 341.4	<0.001
Protein (%energy)	11.7 ± 2.3	11.6 ± 1.8	11.6 ± 1.6	11.6 ± 1.5	11.7 ± 1.5	0.407
Fat (% energy)	20.5 ± 6.3	19.7 ± 5.3	19.8 ± 5.1	20.4 ± 5.1	21.4 ± 5.2	<0.001
Carbohydrate (% energy)	51.7 ± 7.6	57.2 ± 5.8	59.1 ± 5.4	59.3 ± 5.1	59.0 ± 4.9	<0.001
Alcohol (g/day)	37.4 ± 27.2	19.1 ± 16.6	11.6 ± 13.1	8.2 ± 11.0	6.3 ± 9.9	<0.001
Alcohol (% energy)	13.8 ± 8.6	6.9 ± 5.6	4.1 ± 4.5	2.9 ± 3.7	2.1 ± 3.2	<0.001
Saturated fatty acids (% energy)	5.09 ± 1.36	5.04 ± 1.26	5.07 ± 1.23	5.26 ± 1.32	5.43 ± 1.33	<0.001
Monounsaturated fatty acids (% energy)	8.22 ± 2.58	7.68 ± 2.03	7.54 ± 1.92	7.49 ± 1.86	7.72 ± 1.98	<0.001
Polyunsaturated fatty acids (% energy)	6.38 ± 2.01	6.12 ± 1.64	6.08 ± 1.60	6.13 ± 1.55	6.40 ± 1.67	0.658
n-3 Polyunsaturated fatty acids (% energy)	1.19 ± 0.38	1.09 ± 0.29	1.05 ± 0.27	1.03 ± 0.25	1.05 ± 0.27	<0.001
n-6 Polyunsaturated fatty acids (% energy)	5.25 ± 1.76	5.10 ± 1.45	5.12 ± 1.43	5.21 ± 1.36	5.43 ± 1.45	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.40 ± 0.20	0.35 ± 0.16	0.32 ± 0.14	0.31 ± 0.13	0.32 ± 0.14	<0.001
Cholesterol (mg/ 1000 kcal)	133.3 ± 45.4	125.3 ± 38.0	122.6 ± 36.2	121.5 ± 36.1	125.9 ± 36.8	<0.001
Na (mg/1000 kcal)	933.8 ± 291.4	940.9 ± 285.3	942.9 ± 273.2	960.5 ± 274.3	967.9 ± 267.2	<0.001
K (mg/1000 kcal)	1076.3 ± 267.3	1082.0 ± 233.2	1076.4 ± 212.0	1086.3 ± 211.4	1100.1 ± 219.6	<0.001
Ca (mg/1000 kcal)	242.7 ± 74.6	247.7 ± 74.5	250.0 ± 74.4	266.8 ± 78.1	275.9 ± 82.8	<0.001
Fe (mg/1000 kcal)	3.8 ± 1.2	3.7 ± 1.0	3.7 ± 1.0	3.7 ± 1.0	3.7 ± 1.0	<0.001
Carotene (μg/1000 kcal)	1498.7 ± 724.7	1441.1 ± 591.7	1428.3 ± 555.8	1428.4 ± 552.4	1505.5 ± 636.2	0.885
Vitamin A (μgRAE/ 1000 kcal)	516.2 ± 251.5	485.4 ± 236.2	466.6 ± 219.1	461.3 ± 211.6	479.3 ± 245.8	<0.001
Vitamin D (μg/ 1000 kcal)	4.44 ± 2.23	3.91 ± 1.81	3.60 ± 1.53	3.51 ± 1.47	3.60 ± 1.58	<0.001
Vitamin E (mg/ 1000 kcal)	4.29 ± 1.34	4.09 ± 1.10	4.06 ± 1.06	4.10 ± 1.02	4.29 ± 1.11	0.964
Vitamin B1 (mg/ 1000 kcal)	0.38 ± 0.09	0.35 ± 0.07	0.34 ± 0.06	0.33 ± 0.06	0.32 ± 0.06	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.54 ± 0.16	0.54 ± 0.15	0.54 ± 0.14	0.57 ± 0.14	0.58 ± 0.14	<0.001
Folate (μg/ 1000 kcal)	171.7 ± 62.2	165.9 ± 54.0	165.3 ± 50.4	166.4 ± 49.2	170.2 ± 50.7	0.376
Vitamin C (mg/ 1000 kcal)	42.7 ± 16.4	44.0 ± 16.0	45.1 ± 15.2	47.7 ± 15.8	52.0 ± 18.2	<0.001
Soluble dietary fiber (g/ 1000 kcal)	0.92 ± 0.33	0.92 ± 0.30	0.94 ± 0.28	0.97 ± 0.29	1.03 ± 0.32	<0.001
Insoluble dietary fiber (g/ 1000 kcal)	3.63 ± 1.22	3.62 ± 1.08	3.66 ± 0.97	3.78 ± 0.96	4.09 ± 1.09	<0.001
Total dietary fiber (g/ 1000 kcal)	5.09 ± 1.69	5.06 ± 1.55	5.09 ± 1.38	5.24 ± 1.38	5.65 ± 1.54	<0.001

(Cont. Supplemental Table 6)

	Factor 5 (Women)					
	Q1 (n=2798)	Q2 (n=2799)	Q3 (n=2799)	Q4 (n=2799)	Q5 (n=2799)	P for trend
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
Energy intake (kcal/day)	1654.4 ± 221.3	1594.2 ± 216.8	1538.4 ± 219.6	1474.4 ± 224.0	1400.5 ± 283.0	<0.001
Protein (%energy)	13.0 ± 1.9	12.9 ± 1.7	13.1 ± 1.7	13.3 ± 1.7	13.8 ± 2.2	<0.001
Fat (% energy)	25.6 ± 5.9	25.7 ± 5.6	26.5 ± 5.6	27.3 ± 5.8	28.6 ± 6.7	<0.001
Carbohydrate (% energy)	56.9 ± 4.9	56.4 ± 4.7	55.4 ± 4.7	54.3 ± 4.9	50.8 ± 7.0	<0.001
Alcohol (g/day)	0.6 ± 1.8	1.0 ± 2.5	1.6 ± 3.4	2.8 ± 5.1	9.5 ± 15.1	<0.001
Alcohol (% energy)	0.2 ± 0.7	0.4 ± 1.1	0.7 ± 1.5	1.3 ± 2.3	4.6 ± 6.8	<0.001
Saturated fatty acids (% energy)	6.71 ± 1.57	6.68 ± 1.48	6.88 ± 1.48	7.08 ± 1.51	7.32 ± 1.78	<0.001
Monounsaturated fatty acids (% energy)	9.30 ± 2.28	9.42 ± 2.17	9.76 ± 2.20	10.12 ± 2.35	10.93 ± 2.70	<0.001
Polyunsaturated fatty acids (% energy)	8.09 ± 2.15	7.68 ± 1.90	7.74 ± 1.94	7.88 ± 1.99	8.31 ± 2.20	<0.001
n-3 Polyunsaturated fatty acids (% energy)	1.27 ± 0.31	1.27 ± 0.30	1.32 ± 0.31	1.36 ± 0.32	1.49 ± 0.37	<0.001
n-6 Polyunsaturated fatty acids (% energy)	6.80 ± 1.89	6.52 ± 1.66	6.60 ± 1.73	6.70 ± 1.76	6.99 ± 1.88	<0.001
n-3 Highly unsaturated fatty acids (% energy)	0.39 ± 0.16	0.38 ± 0.16	0.39 ± 0.17	0.41 ± 0.16	0.46 ± 0.19	<0.001
Cholesterol (mg/ 1000 kcal)	152.3 ± 44.9	153.2 ± 40.1	158.4 ± 39.8	164.4 ± 44.4	177.8 ± 50.4	<0.001
Na (mg/1000 kcal)	1183.2 ± 375.4	1095.6 ± 288.4	1104.2 ± 290.5	1122.2 ± 278.1	1158.1 ± 284.8	0.060
K (mg/1000 kcal)	1400.6 ± 302.2	1355.9 ± 283.6	1379.9 ± 298.5	1402.0 ± 301.1	1458.1 ± 359.8	<0.001
Ca (mg/1000 kcal)	367.9 ± 108.1	343.0 ± 98.0	345.5 ± 95.7	351.0 ± 97.6	360.4 ± 109.7	0.095
Fe (mg/1000 kcal)	5.0 ± 1.4	4.6 ± 1.2	4.6 ± 1.3	4.7 ± 1.3	4.9 ± 1.4	<0.001
Carotene (μg/1000 kcal)	2329.9 ± 1041.7	2170.1 ± 887.3	2205.7 ± 925.9	2245.2 ± 932.6	2339.6 ± 1047.6	0.203
Vitamin A (μgRAE/ 1000 kcal)	627.8 ± 293.2	607.8 ± 265.1	632.8 ± 288.6	660.7 ± 311.7	726.9 ± 390.8	<0.001
Vitamin D (μg/ 1000 kcal)	4.49 ± 1.91	4.32 ± 1.84	4.42 ± 1.91	4.59 ± 1.85	5.09 ± 2.14	<0.001
Vitamin E (mg/ 1000 kcal)	5.33 ± 1.39	5.29 ± 1.26	5.46 ± 1.28	5.66 ± 1.34	6.13 ± 1.55	<0.001
Vitamin B1 (mg/ 1000 kcal)	0.39 ± 0.06	0.41 ± 0.06	0.43 ± 0.06	0.45 ± 0.06	0.50 ± 0.09	<0.001
Vitamin B2 (mg/ 1000 kcal)	0.74 ± 0.18	0.71 ± 0.17	0.72 ± 0.17	0.74 ± 0.17	0.76 ± 0.20	<0.001
Folate (μg/ 1000 kcal)	228.1 ± 69.6	222.7 ± 67.6	228.1 ± 71.8	234.6 ± 75.3	249.4 ± 89.5	<0.001
Vitamin C (mg/ 1000 kcal)	73.5 ± 26.1	67.6 ± 24.0	67.3 ± 23.7	67.3 ± 24.3	68.9 ± 26.7	<0.001
Soluble dietary fiber (g/ 1000 kcal)	1.40 ± 0.45	1.29 ± 0.37	1.31 ± 0.38	1.32 ± 0.37	1.37 ± 0.41	0.285
Insoluble dietary fiber (g/ 1000 kcal)	5.53 ± 1.56	5.25 ± 1.35	5.35 ± 1.40	5.46 ± 1.40	5.71 ± 1.67	<0.001
Total dietary fiber (g/ 1000 kcal)	7.63 ± 2.21	7.12 ± 1.90	7.24 ± 1.97	7.38 ± 1.94	7.73 ± 2.22	0.002