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The Japanese food score and risk of all-cause, CVD and cancer mortality: the Japan Collaborative Cohort Study

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Abstract

Few studies have reported the association between the Japanese diet as food score and mortality. This study aimed to investigate adherence to the Japanese food score associated with all-cause, CVD and cancer mortality. A total of 58 767 (23 162 men and 34 232 women) Japanese participants aged 40–79 years, who enrolled in the Japan Collaborative Cohort Study between 1988 and 1990, were included. The Japanese food score was derived from the components of seven food groups (beans and bean products, fresh fishes, vegetables, Japanese pickles, fungi, seaweeds and fruits) based on the FFQ. The total score ranged from 0 to 7, and participants were divided into five categories based on scores (0–2, 3, 4, 5 and 6–7). Hazard ratios (HR) and 95 % CI for all-cause, CVD and cancer mortality based on sex were estimated using Cox proportional models. During the follow-up period until 2009, 11 692 participants with all-cause, 3408 with CVD and 4247 with cancer died. The multivariable HR in the 6–7 and 0–2 Japanese food score groups were 0·93 (95 % CI 0·86, 1·01) in men and 0·82 (95 % CI 0·75, 0·90) in women for all-cause mortality and 0·89 (95 % CI 0·76, 1·04) in men and 0·66 (95 % CI 0·56, 0·77) in women for CVD mortality. Our findings suggest that adherence to the Japanese food score consisting of food combinations characterised by a Japanese diet may help in preventing all-cause and CVD mortality, especially in women.

Key words: **Diets: Scores: Japanese: Mortality: Cohort studies**

Recently, the associations between dietary patterns and overall diet and health outcomes are widely reported[1–6]. Dietary patterns are identified from *a priori* (via theoretical score or index) or *a posteriori* (via principal component analysis or factor analysis using food/nutritional data)[7]. However, *a posteriori*-defined dietary patterns can potentially differ for each study due to different population; dietary assessment methods, such as FFQ, dietary record and 24-h dietary recall; and analysis approach, such as consolidation of food items into food groups, number of factors to extract and labelling of factor components. The Mediterranean diet score, Healthy Eating Index (HEI), Alternate Healthy Eating Index (AHEI) and Dietary Approaches to Stop Hypertension (DASH) score are known as typical *a priori* dietary patterns worldwide. Higher adherence to the Mediterranean diet score, HEI, AHEI and DASH score was associated with lower rate of all-cause, CVD and cancer mortality[8,9].

The Japanese diet consists of a wide variety of foods[10] and is different from diets in Western countries. Previous studies showed that intake of individual food groups such as fruits, vegetables, beans and fishes were inversely associated with all-cause and/or CVD mortality in Japan[11–13]. The score assessing the interactions between different dietary beneficial components of the Japanese diet is necessary to determine dietary patterns. Some studies reported that scores consisting of Japanese diet intake, that is *a priori*-defined Japanese diet score, decreased the risk of non-communicable diseases[14] and functional disabilities[15] among Japanese individuals. However, only a few *a priori* score or index evaluated the Japanese diet, and their effects on health are scarcely evident.

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In this study, the Japanese food score consisting of combined foods characterised by the Japanese diet was identified based on the previous studies using the data from the Japan Collaborative Cohort (JACC) Study. We investigated whether adherence to the Japanese food score is associated with the risk reduction of all-cause, CVD and cancer mortality among Japanese populations.

Methods

Study population

Between 1988 and 1990, participants were enrolled to participate in the JACC Study and were evaluated for cancer risk by assessing the impact of lifestyle factors on their health. Details of the study design have been described elsewhere[16]. In brief 110 585 (46 395 men and 64 190 women) participants aged 40–79 years from forty-five regions throughout Japan were enrolled. Most participants were recruited during a health check-up by completing a self-administered questionnaire. Among the 110 585 participants, those with a history of cancer (*n* 1461), stroke (*n* 1440) or myocardial infarction (*n* = 2774) at baseline were excluded. In addition, participants who lived in eleven study regions where the self-administered FFQ survey was not conducted at baseline (*n* 23 187) and those who did not complete the dietary survey (*n* 22 941) were also excluded. Moreover, those with missing information on four or more items in the following thirteen food items constituting seven food group items in the FFQ (*n* 10) were also excluded: beans and beans products (boiled beans and tofu), fresh fishes, vegetables (spinach or garland chrysanthemum, carrots or pumpkin, tomatoes, cabbage or head lettuce and Chinese cabbage), Japanese pickles, fungi, seaweeds and fruits (citrus fruit and others). A total of 58 767 participants were included in the analysis for this study. The study design was approved by the Ethical Review Board of Nagoya University School of Medicine.

Dietary assessment and the Japanese food score

Information on the intake of thirty-nine food items was assessed from a previously validated self-administered questionnaire, including an FFQ at baseline[17]. Most food items were assessed based on five frequency categories: never or seldom, 1–2 times/month, 1–2 times/week, 3–4 times/week and almost daily. Rice and miso soup intakes were assessed using the number of bowls consumed daily. Beverages were assessed based on five frequency categories: almost never, 1–2 cups/month, 1–2 cups/week, 3–4 cups/week and almost daily for green tea, tea, oolong tea and coffee. The frequency of alcohol consumption was assessed using the following categories: never, former, and current drinker (<1 time/week, 1–2 times/week, 3–4 times/week and almost daily). The consumption of each food was calculated by multiplying the frequency of consumption of each food with the portion size[18], estimated from the validation study conducted[17]. The average daily intake of nutrients was calculated by multiplying the frequency of consumption of each item by its nutrient content per serving and totalling the nutrient intake for all food items. Total energy and nutrient intakes were estimated based on the fifth edition of the *Japan Food Table*[19], and nutrient intakes from food groups were adjusted based on the total energy intake using density methods.

The Japanese food score in this study was proposed based on several previous studies reporting dietary patterns as the Japanese diet using the principal components/factor analysis[20–23]. The Japanese food score consisted of seven food groups, namely, beans and beans products (boiled beans and tofu), fresh fish, vegetables (spinach or garland chrysanthemum, carrots or pumpkin, tomatoes, cabbage or head lettuce and Chinese cabbage), Japanese pickles, fungi, seaweeds and fruits (citrus fruit and others). Japanese individuals traditionally eat rice as staple foods and miso soup as soup stock with main and side dishes. We focused on the main and side dishes other than staple foods and soup stocks and assessed their Japanese food scores because 71·9 % of the participants ate ≥3 cups of rice, and 72·2 % took miso soup every day in this study. For participants who left some questions with blanks/no answer on three or less items in the thirteen food items constituting the seven food group items, missing data were replaced with the median values based on their sex and geographical region. Because the most common frequency of food intake for many items is 1–2 times/week or 3–4 times/week in the present study, ≥3–4 times/week was considered as the cut-off point (1 point is given) in participants who ate any food item from the seven food groups. Thus, the total Japanese food scores ranged from 0 to 7, with higher scores indicating more Japanese food intake. Participants were divided into five categories based on the Japanese food scores for the analysis (0–2, 3, 4, 5 or 6–7).

Covariables

Other information on demographic and lifestyle factors were collected using a self-administered questionnaire at baseline: educational levels, occupation, marital status, number of children, medical history (such as cancer, stroke, myocardial infarction, diabetes and hypertension), family history, health check-up status, smoking status, environmental tobacco smoke, alcohol drinking status, sports habits, sleep duration, height, weight, weight at 20 years old, blood pressure, number of pregnancy and parity (for women) and menarche and menopausal age (for women). BMI was calculated as weight (kg) divided by height (m^2).

Follow-up

Mortality data were centralised at the Ministry of Health and Welfare, and the underlying causes of deaths were coded using National Vital Statistics codes in accordance with the 10th revision of the International Classification of Disease-10. Follow-up was completed at the end of 2009 in most regions but was terminated at the end of 1999 in four regions, 2003 in another four regions and 2008 in two regions. The censoring was determined when follow-period was completed from study enrolment. Participants who moved from their regions during the study period were treated as censored at the time of their move. Cause-specific mortality was individually coded for cancer (C02–97) and CVD (I05–99).

Statistical analysis

Sex-specific age-adjusted and multivariate hazard ratios (HR) and 95 % CI for the mortality risk related to all-cause, cancer and CVD were evaluated based on the Japanese food scores of 3 to 6–7 and compared with those of 0–2 using the Cox proportional hazard model. The linear relationship was assessed using the Japanese food scores as continuous variables, and P_{trend} values were obtained. The following variables were included in the multivariate models as potential confounders: age (continuous variable), geographical region, BMI (<18·5, 18·5–24·9, 25·0–29·9, ≥30·0 kg/m^2 or unknown), educational levels (<13, ≥13 years or unknown), smoking status (never, former, current smoker or unknown), alcohol drinking status (never, former, current drinker or unknown), sports habits (rarely, 1–2, 3–4, ≥5 h/week or unknown), sleep duration (<6·0, 6·0–6·9, 7·0–7·9, 8·0–8·9, ≥9 h or unknown), history of hypertension and diabetes (yes, no, or unknown), and total daily energy intake (<5895, 5896–7242, 7243–8745 or ≥8746 kJ/d (<1409, 1410–1731, 1732–2090 or ≥2091 kcal/d) in men and <4971, 4972–5858, 5869–6853 or 6854 kJ/d (<1188, 1189–1400, 1401–1638 or ≥1639 kcal/d) in women). In addition, we analysed the data of women using a different category (0–3, 4, 5, 6 and 7) because the number of women with high Japanese food scores was higher than of men with high Japanese food scores in the present study. The SAS statistical package for Windows (version 9.4; SAS Institute Inc.) was used to perform all statistical analyses. Differences were considered statistically significant at $P < 0·05$.

Results

Tables 1 (men) and 2 (women) show the demographic and nutritional baseline characteristics of the participants according to the adherence to Japanese food scores based on sex. Male participants with higher Japanese food scores were older, more educated, had longer duration of sleep and sports hours, and were not current smokers, whereas female participants with higher Japanese food scores were older, had higher educational levels, had longer sports hours, and were not current smokers, compared with participants with lower Japanese food scores. Those with higher adherence to the Japanese food score had a higher mean intake of almost all nutrients but had lower carbohydrate (% of energy) and the Na:K ratio (in both men and women).

During the 373 232 person-years and a median follow-up period of 18·9 years, 6309, 1674 and 2490 deaths were attributed to all-cause, CVD and cancer mortality in men, respectively. In women, during the 594 634 person-years and a median follow-up period of 19·4 years, 5383, 1734, 1757 deaths were attributed to all-cause, CVD and cancer mortality, respectively. Tables 3 (men) and 4 (women) show the Cox proportional hazard model results between the adherence to the Japanese food score and all-cause, CVD, and cancer mortality based on sex. In men, higher Japanese food score was associated with a marginally decreased risk of all-cause mortality, with multivariate HR of 0·96 (95 % CI 0·88, 1·04), 0·92 (95 % CI 0·84, 1·00), 0·95 (95 % CI 0·88, 1·03) and 0·93 (95 % CI 0·86, 1·01) for scores 3, 4, 5 and 6–7, respectively; P_{trend} was 0·067. In women, higher Japanese food score was associated with decreased risk of all-cause mortality, with multivariate HR of 0·92 (95 % CI 0·82, 1·03), 0·99 (95 % CI 0·89, 1·09), 0·85 (95 % CI 0·77, 0·94) and 0·82 (95 % CI 0·75, 0·90) for scores 3, 4, 5 and 6–7, respectively; P_{trend} was <0·001. CVD mortality decreased when the Japanese food score was higher, with multivariate HR of 0·80 (95 % CI 0·67, 0·97), 0·87 (95 % CI 0·74, 1·03), 0·76 (95 % CI 0·64, 0·89) and 0·66 (95 % CI 0·56, 0·77) for scores 3, 4, 5 and 6–7, respectively (P_{trend} <0·001). However, regarding cancer mortality, no significant associations were observed with the Japanese food score in both men and women. Using separate cut-off points for the Japanese food score in men (0–2, 3, 4, 5 and 6–7) and women (0–3, 4, 5, 6 and 7) yielded similar results (data not shown).

Discussion

The Japanese food score comprising of food groups characterised in the Japanese diet was identified and evaluated based on the data from Japanese individuals who participated in a large prospective cohort study. It was determined by adding the food intakes based on the Japanese diet, which is diverse[10] and commonly taken foods in a normal dietary habit. The score from the food intake frequency also provided an easily accessible public health information to the general population. In addition, adherence to the Japanese food score may help in preventing all-cause and CVD mortality, especially in women, but not in cancer mortality.

A previous Japanese study has reported the following reduced-salt Japanese food score: egg intake of ≤2 eggs/week, ≥1 fish intake in 2 d, meat intake of ≤2 times/week, ≥1 Japanese pickle intake/d, infrequent intake of soup with noodles, use of low-salt soya sauce and occasional drinking[14]. Higher reduced-salt Japanese food score was associated with lower rate of all-cause and CVD mortality, but not on cancer mortality[14]. Another Japanese study reported the Japanese diet index score based on the consumption of a good (rice, miso soup, seaweeds, pickles, green and yellow vegetables, fish and green tea) and bad foods (beef, pork and coffee)[15]. The Japanese diet index score was associated with decreased risk of functional disability incidence among elderly people[15]. The components of the Japanese food score measured using the intake frequency of beans and bean products, fresh fishes, vegetables, Japanese pickles, fungi, seaweeds, and fruits in this study were different from those in previous studies[14,15]. However, our results were consistent with those of previous studies revealing the beneficial effects of the score in evaluating Japanese diet on all-cause mortality and health-related outcomes, but not on cancer mortality.

Some individual food groups (Japanese pickles, fruits, vegetables and fishes) were inversely associated with all-cause and/or CVD mortality in previous studies[14,24,25]. Many Japanese pickles composing part of the Japanese food score are traditionally made using salt, and Japanese people mainly consume salt from foods (such as Japanese pickles) and seasonings (such as soya sauce and miso). In general, high salt intake is likely to increase the risk of stroke and total CVD[26] through

Table 1. Demographic and nutrient baseline characteristics of participants according to the Japanese food scores (men)
(Mean values and standard deviations; percentages)

	Score 0–2 (*n* 4694)		Score 3 (*n* 3502)		Score 4 (*n* 4238)		Score 5 (*n* 4752)		Score 6–7 (*n* 5976)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	54·2	10·1	55·3	10·1	55·8	9·9	56·7	9·7	57·2	9·6
Educational level (years) (%)*										
<13	76·2		76·2		75·1		74·5		72·7	
≥13	16·3		17·0		16·9		16·6		17·8	
BMI (kg/m^2) (%)*										
<18·5	5·4		4·6		4·3		4·8		4·6	
18·5–24·9	71·1		73·6		75·4		74·9		73·8	
25·0–29·9	18·2		17·3		16·3		16·3		17·4	
≥30·0	1·0		1·0		1·2		0·9		1·0	
Smoking status (%)*										
Current smoker	57·5		54·1		53·0		51·0		49·2	
Former smoker	21·4		24·5		25·1		24·9		25·4	
Never smoker	19·0		19·5		19·3		21·4		22·0	
Alcohol drinking status (%)*										
Current drinker	73·6		76·1		75·6		74·2		75·8	
Former drinker	5·9		6·0		5·3		5·8		5·6	
Never drinker	20·5		17·9		19·1		20·1		18·6	
Sport habits (h/week) (%)*										
Rarely	70·3		68·1		68·2		66·2		63·7	
1–2	16·1		15·9		16·0		16·3		18·4	
3–4	5·9		7·5		6·6		7·3		7·5	
≥5	5·5		6·0		6·7		7·5		7·9	
Sleep duration (h/d) (%)*										
<6	3·5		2·9		2·9		2·9		2·6	
6–<7	15·1		15·0		13·9		13·6		12·5	
7–<8	33·9		35·2		33·5		33·8		32·4	
8–<9	35·4		34·8		37·2		37·0		40·3	
≥9	9·5		9·7		10·3		10·1		10·3	
Hypertension (%)*										
Diabetes (%)*	16·4		17·8		17·9		19·6		18·5	
Dietary intake	4·9		5·2		6·1		6·1		6·3	
Energy intake (kJ)	6406	2000	6945	1908	7326	1962	7669	1992	8226	2100
Energy intake (kcal)	1531	478	1660	456	1751	469	1833	476	1966	502
Protein (% energy)	11·2	2·4	12·0	2·3	12·5	2·4	13·1	2·3	13·8	2·3
Fat (% energy)	14·9	5·1	16·1	4·8	16·6	4·7	17·5	4·6	18·4	4·5
Carbohydrate (% energy)	59·1	11·5	58·0	10·5	57·4	10·4	57·1	9·5	56·1	8·8
Na (mg/4184 kJ (mg/1000 kcal))	1066	581	1156	525	1205	499	1265	473	1331	429
K (mg/4184 kJ (mg/1000 kcal))	1018	302	1145	307	1208	306	1291	312	1390	313
Na:K ratio (mg/mg)	1·03	0·43	1·00	0·35	1·00	0·32	0·98	0·28	0·96	0·24
Ca (mg/4184 kJ (mg/1000 kcal))	231	97	255	93	265	90	281	88	294	82
Mg (mg/4184 kJ (mg/1000 kcal))	150	28	157	26	161	25	167	25	172	24
Fe (mg/4184 kJ (mg/1000 kcal))	3·75	1·28	4·09	1·23	4·29	1·17	4·54	1·17	4·80	1·12
β-Carotene equivalents (μg/4184 kJ (μg/1000 kcal))*	114	68	142	81	158	86	180	91	205	88
Retinol equivalents (μg/4184 kJ (μg/1000 kcal))*	362	424	394	410	424	436	453	433	497	432
Vitamin D (μg/4184 kJ (μg/1000 kcal))	2·72	1·44	3·34	1·65	3·71	1·75	4·14	1·72	4·83	1·68
Vitamin K (μg/4184 kJ (μg/1000 kcal))	69·1	34·3	89·3	39·8	97·3	38·8	107·1	39·1	116·5	37·2
Vitamin B_1 (mg/4184 kJ (mg/1000 kcal))	0·52	0·09	0·55	0·09	0·57	0·09	0·59	0·08	0·61	0·08
Vitamin B_2 (mg/4184 kJ (mg/1000 kcal))	0·51	0·20	0·55	0·19	0·57	0·19	0·60	0·19	0·64	0·18
Niacin (mg/4184 kJ (mg/1000 kcal))	10·3	1·8	10·6	1·7	10·8	1·7	11·1	1·6	11·5	1·6
Vitamin B_6 (mg/4184 kJ (mg/1000 kcal))	0·59	0·12	0·65	0·12	0·68	0·12	0·71	0·12	0·76	0·12
Vitamin B_{12} (mg/4184 kJ (mg/1000 kcal))	3·36	1·96	3·73	1·92	4·01	1·98	4·33	1·97	4·76	1·90
Folate (μg/4184 kJ (μg/1000 kcal))	149	61	170	63	181	63	194	64	209	63
Vitamin C (mg/4184 kJ (mg/1000 kcal))	41·1	18·9	51·2	21·2	55·7	21·3	60·9	21·5	67·4	21·1
SFA (% energy)	5·26	2·28	5·56	2·10	5·63	1·98	5·85	1·90	6·05	1·78
MUFA (% energy)	5·23	1·95	5·67	1·8·9	5·85	1·84	6·15	1·80	6·50	1·78
PUFA (% energy)	3·92	1·30	4·25	1·27	4·47	1·24	4·72	1·22	4·99	1·15
n-3 PUFA (% energy)	0·68	0·27	0·79	0·29	0·86	0·30	0·94	0·30	1·04	0·28
n-6 PUFA (% energy)	3·23	1·09	3·44	1·06	3·59	1·02	3·76	1·00	3·93	0·93
Cholesterol (mg/4184 kJ (mg/1000 kcal))	114	54	127	52	133	51	142	49	148	45
Dietary fibre (g/4184 kJ (g/1000 kcal))	6·18	1·59	6·75	1·56	7·10	1·55	7·50	1·55	8·02	1·55

* Unknown percentage was not shown.

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Table 2. Demographic and nutrient baseline characteristics of participants according to the Japanese food scores (women)
(Mean values and standard deviations; percentages)

	Score 0–2 (*n* 3766)		Score 3 (*n* 4096)		Score 4 (*n* 6291)		Score 5 (*n* 8242)		Score 6–7 (*n* 13 210)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	56·3	10·6	55·9	10·2	55·9	10·0	56·1	9·8	56·7	9·5
Educational level (years) (%)*										
<13	84·2		83·9		82·8		81·6		79·6	
≥13	7·6		8·5		9·3		9·7		11·0	
BMI (kg/m^2) (%)*										
<18·5	6·8		5·6		5·9		5·6		5·3	
18·5–24·9	65·1		68·9		67·8		69·3		69·7	
25·0–29·9	19·8		19·0		20·4		20·0		19·6	
≥30·0	2·8		2·4		2·0		1·8		1·8	
Smoking status (%)*										
Current smoker	7·4		6·0		5·0		3·9		3·3	
Former smoker	1·6		1·6		1·2		1·3		1·1	
Never smoker	83·1		85·0		86·2		87·0		87·3	
Alcohol drinking status (%)*										
Current drinker	22·7		22·7		23·2		22·0		21·9	
Former drinker	1·8		2·2		1·5		1·3		1·3	
Never drinker	69·7		70·9		71·0		72·7		72·2	
Sports habits (h/week) (%)*										
Rarely	78·7		76·6		75·2		74·4		71·1	
1–2	9·9		11·5		12·1		12·8		14·9	
3–4	4·2		4·2		5·3		4·7		5·7	
≥5	3·3		4·5		3·9		4·3		4·5	
Sleep duration (h/d) (%)*										
<6	7·2		6·5		5·8		4·9		5·0	
6–<7	22·4		23·3		21·9		22·7		21·9	
7–<8	33·9		36·7		37·9		38·2		38·3	
8–<9	26·4		24·6		25·3		26·2		26·4	
≥9	6·9		5·5		5·7		5·5		5·4	
Hypertension (%)*										
Diabetes (%)*	18·6		19·9		20·5		19·7		19·1	
Dietary intake	3·6		3·4		3·3		2·9		3·2	
Energy intake (kJ)	4983	1502	5452	1439	5757	1456	6025	1414	6489	1481
Energy intake (kcal)	1191	359	1303	344	1376	348	1440	338	1551	354
Protein (% energy)	13·0	2·3	13·7	2·2	14·3	2·2	14·9	2·2	15·8	2·1
Fat (% energy)	17·8	5·4	19·1	5·0	19·9	4·8	20·7	4·5	21·8	4·3
Carbohydrate (% energy)	66·4	8·2	65·0	7·3	63·7	7·0	62·7	6·5	60·9	6·1
Na (mg/4184 kJ (mg/1000 kcal))	1188	641	1259	580	1329	532	1400	495	1467	444
K (mg/4184 kJ (mg/1000 kcal))	1236	320	1376	312	1466	311	1554	309	1662	300
Na:K ratio (mg/mg)	0·95	0·42	0·91	0·34	0·90	0·31	0·90	0·27	0·88	0·23
Ca (mg/4184 kJ (mg/1000 kcal))	275	104	302	97	321	96	338	91	356	85
Mg (mg/4184 kJ (mg/1000 kcal))	171	24	177	23	182	22	188	22	193	21
Fe (mg/4184 kJ (mg/1000 kcal))	4·33	1·39	4·62	1·29	4·88	1·23	5·16	1·20	5·45	1·12
β-Carotene equivalents (μg/4184 kJ (μg/1000 kcal))*	154	92	190	105	211	107	238	110	262	101
Retinol equivalents (μg/4184 kJ (μg/1000 kcal))*	425	536	465	533	489	504	514	497	563	497
Vitamin D (μg/4184 kJ (μg/1000 kcal))	3·21	1·59	3·80	1·86	4·25	1·96	4·78	1·98	5·73	1·88
Vitamin K (μg/4184 kJ (μg/1000 kcal))	86·9	41·7	107·1	44·1	118·3	45·8	129·3	44·2	139·2	40·0
Vitamin B_1 (mg/4184 kJ (mg/1000 kcal))	0·61	0·07	0·64	0·07	0·65	0·07	0·67	0·07	0·69	0·07
Vitamin B_2 (mg/4184 kJ (mg/1000 kcal))	0·61	0·23	0·65	0·21	0·68	0·21	0·71	0·20	0·76	0·19
Niacin (mg/4184 kJ (mg/1000 kcal))	11·6	1·5	11·8	1·6	12·0	1·6	12·3	1·5	12·8	1·4
Vitamin B_6 (mg/4184 kJ (mg/1000 kcal))	0·70	0·12	0·75	0·12	0·79	0·12	0·83	0·12	0·88	0·12
Vitamin B_{12} (mg/4184 kJ (mg/1000 kcal))	3·73	2·27	4·05	2·30	4·37	2·22	4·72	2·18	5·30	2·10
Folate (μg/4184 kJ (μg/1000 kcal))	181	72	202	72	216	71	229	70	245	67
Vitamin C (mg/4184 kJ (mg/1000 kcal))	55·3	23·9	67·5	24·8	73·0	24·4	78·3	23·9	84·1	22·0
SFA (% energy)	6·32	2·43	6·70	2·21	6·93	2·15	7·07	1·99	7·37	1·86
MUFA (% energy)	6·32	2·16	6·81	2·02	7·11	1·95	7·36	1·85	7·78	1·76
PUFA (% energy)	4·53	1·42	4·83	1·34	5·11	1·29	5·39	1·21	5·69	1·13
n-3 PUFA (% energy)	0·79	0·30	0·89	0·32	0·97	0·32	1·07	0·32	1·20	0·31
n-6 PUFA (% energy)	3·73	1·18	3·93	1·12	4·12	1·08	4·31	1·00	4·47	0·91
Cholesterol (mg/4184 kJ (mg/1000 kcal))	132	61	146	58	155	56	163	53	174	49
Dietary fibre (g/4184 kJ (g/1000 kcal))	7·34	1·61	7·93	1·57	8·34	1·58	8·78	1·58	9·26	1·52

* Unknown percentage was not shown.

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Table 3. Japanese food scores and all-cause, CVD and cancer mortality (men)
(Hazard ratios (HR) and 95 % confidence intervals)

	Score 0–2 (*n* 4694)		Score 3 (*n* 3502)		Score 4 (*n* 4238)		Score 5 (*n* 4752)		Score 6–7 (*n* 5976)		
	HR	95 % CI	HR	95 % CI	HR	95 % CI	HR	95 % CI	HR	95 % CI	P_{trend}
Person-years	74 938		56 082		68 176		76 767		97 269		
All-cause mortality											
No. of deaths	1186		925		1090		1370		1738		
Age adjusted	1·00	Ref.	0·94	0·86, 1·02	0·89	0·82, 0·96	0·90	0·84, 0·98	0·86	0·80, 0·93	<0·001
Multivariate*	1·00	Ref.	0·96	0·88, 1·04	0·92	0·84, 1·00	0·95	0·88, 1·03	0·93	0·86, 1·01	0·067
CVD mortality											
No. of deaths	321		242		275		365		471		
Age adjusted	1·00	Ref.	0·89	0·76, 1·05	0·82	0·69, 0·96	0·87	0·75, 1·01	0·84	0·73, 0·96	0·011
Multivariate*	1·00	Ref.	0·92	0·77, 1·08	0·86	0·73, 1·01	0·90	0·77, 1·05	0·89	0·76, 1·04	0·108
Cancer mortality											
No. of deaths	452		370		423		558		687		
Age adjusted	1·00	Ref.	1·00	0·87, 1·15	0·92	0·81, 1·05	1·00	0·88, 1·13	0·94	0·83, 1·06	0·272
Multivariate*	1·00	Ref.	1·02	0·89, 1·17	0·94	0·82, 1·07	1·05	0·93, 1·20	1·01	0·89, 1·14	0·843

Ref., referent values.
* Adjusted for age, geographical region, BMI, education duration, smoking status, alcohol drinking status, sports habits, sleeping duration, history of hypertension and diabetes and total energy intake.

Table 4. Japanese food scores and all-cause, CVD and cancer mortality (women)
(Hazard ratios (HR) and 95 % confidence intervals)

	Score 0–2 (*n* 3766)		Score 3 (*n* 4096)		Score 4 (*n* 6291)		Score 5 (*n* 8242)		Score 6–7 (*n* 13 210)		
	HR	95 % CI	HR	95 % CI	HR	95 % CI	HR	95 % CI	HR	95 % CI	P_{trend}
Person-years	61 377		66 943		103 740		138 157		224 416		
All-cause mortality											
No. of deaths	677		627		999		1173		1907		
Age adjusted	1·00	Ref.	0·89	0·80, 1·00	0·95	0·86, 1·05	0·80	0·73, 0·88	0·76	0·70, 0·83	<0·001
Multivariate*	1·00	Ref.	0·92	0·82, 1·03	0·99	0·89, 1·09	0·85	0·77, 0·94	0·82	0·75, 0·90	<0·001
CVD mortality											
No. of deaths	250		201		327		387		569		
Age adjusted	1·00	Ref.	0·79	0·66, 0·95	0·88	0·74, 1·03	0·74	0·63, 0·87	0·64	0·55, 0·74	<0·001
Multivariate*	1·00	Ref.	0·80	0·67, 0·97	0·87	0·74, 1·03	0·76	0·64, 0·89	0·66	0·56, 0·77	<0·001
Cancer mortality											
No. of deaths	168		195		337		385		672		
Age adjusted	1·00	Ref.	1·09	0·89, 1·34	1·23	1·02, 1·48	1·02	0·85, 1·23	1·06	0·89, 1·25	0·790
Multivariate*	1·00	Ref.	1·12	0·91, 1·38	1·29	1·07, 1·56	1·09	0·90, 1·31	1·14	0·95, 1·36	0·502

Ref., referent values.
* Adjusted for age, geographical region, BMI, education duration, smoking status, alcohol drinking status, sports habits, sleeping duration, history of hypertension and diabetes and total energy intake.

hypertension[27]. However, previous studies and our study observed that the score including Japanese pickles intake prevented CVD mortality. Na intake is positively associated with blood pressure, whereas K intake is inversely associated[27]. Moreover, higher Na:K ratio or high-Na-and-low-K intake was associated with increasing all-cause and/or CVD mortality[28–31]. Because vegetables and fruits are renowned for their high K content, the Na:K ratio reasonably decreases when the Japanese food score increases (Tables 1 and 2). Therefore, a higher Japanese food score representing a larger amount of vegetable and fruit intake may reduce the risk of all-cause and/or CVD mortality.

Participants with higher Japanese food scores had higher mean intakes of almost all nutrients and lower carbohydrate intake in this study. Low carbohydrate and higher protein and fat diets were inversely associated with CVD and all-cause mortality among Japanese women[32]. Reviews on the associations between the dietary lifestyle and CVD showed that lower saturated fat and higher *n*-3 polyunsaturated fat intakes might contribute to the lower prevalence and risk of hypercholesterolaemia and CHD among Japanese people, respectively[33]. Increased intake of almost all nutrients and decreased intake of carbohydrates due to higher Japanese food score can lead to reduced risk of all-cause and CVD mortality.

This study has several strengths. The present population-based study relates to its prospective observation design by recruiting a large number of study participants nationwide, which was suitable in calculating the Japanese food scores. As a long-term follow-up study, the outcomes are sufficient to investigate the impact of the Japanese food scores. Furthermore, associated interests were examined by adjusting for potential confounders. However, the following are some limitations of this study. First, the dietary habits of participants were assessed only at the baseline and might have changed during the follow-up period; however, this type of data collection methodology is commonly used for epidemiological studies. Second, a large number of participants who had missing data regarding their dietary habits were excluded from the analyses. However, most baseline characteristics (such as BMI, smoking status and alcohol drinking) were similar between the participants and those excluded from the study, except for age (56·0 and 56·3 years for study participants *v.* 59·2 and 59·9 years for those excluded from the study and in men and women, respectively) and educational levels of ≥13 years (17·0 *v.* 8·4 % in men and 9·8 *v.* 4·3 % in women, respectively). Therefore, we consider that bias was unlikely in this study, despite the slight differences in baseline characteristics.

In conclusion, adherence to the Japanese food score was associated with decreased risk of all-cause and CVD mortality in a large-scale cohort study, especially in women. Our findings can provide evidence that food combinations characterised by the Japanese diet may help prevent mortality in the general population.

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E. O. analysed the data and wrote the manuscript. A. T., H. I. and K. W. designed and implemented the study. C. D. analysed the FFQ data. K. N., S. U. and all other authors critically revised the manuscript.

The authors declare that there are no conflicts of interest.

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Appendix: Members of the Japan Collaborative Cohort Study Group

The present members of the JACC Study Group who co-authored this paper include Dr Akiko Tamakoshi (present chairperson of the study group), Hokkaido University Graduate School of Medicine; Dr Mitsuru Mori and Fumio Sakauchi, Sapporo Medical University School of Medicine; Dr Yutaka Motohashi, Akita University School of Medicine; Dr Ichiro Tsuji, Tohoku University Graduate School of Medicine; Dr Yosikazu Nakamura, Jichi Medical School; Dr Hiroyasu Iso, Osaka University School of Medicine; Dr Haruo Mikami, Chiba Cancer Center; Dr Michiko Kurosawa, Juntendo University School of Medicine; Dr Yoshiharu Hoshiyama, Yokohama Soei University; Dr Naohito Tanabe, University of Niigata Prefecture; Dr Koji Tamakoshi, Nagoya University Graduate School of Health Science; Dr Kenji Wakai, Nagoya University Graduate School of Medicine; Dr Shinkan Tokudome, National Institute of Health and Nutrition; Dr Koji Suzuki, Fujita Health University School of Health Sciences; Dr Shuji Hashimoto, Fujita Health University School of Medicine; Dr Shogo Kikuchi, Aichi Medical University School of Medicine; Dr Yasuhiko Wada, Faculty of Nutrition, University of Kochi; Dr Takashi Kawamura, Kyoto University Center for Student Health; Dr Yoshiyuki Watanabe, Kyoto Prefectural University of Medicine Graduate School of Medical Science; Dr Kotaro Ozasa, Radiation Effects Research Foundation; Dr Tsuneharu Miki, Kyoto Prefectural University of Medicine Graduate School of Medical Science; Dr Chigusa Date, School of Human Science and Environment, University of Hyogo; Dr Kiyomi Sakata, Iwate Medical University; Dr Yoichi Kurozawa, Tottori University Faculty of Medicine; Dr Takesumi Yoshimura and Yoshihisa Fujino, University of Occupational and Environmental Health; Dr Akira Shibata, Kurume University; Dr Naoyuki Okamoto, Kanagawa Cancer Center; and Dr Hideo Shio, Moriyama Municipal Hospital.

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