with those of other prospective studies that showed that the metabolic syndrome based on NCEP-ATP III criteria was associated with risks of mortality and incidence of cardiovascular disease (*1, 2, 4–7, 13, 16–18, 27, 28*), and that the metabolic syndrome based on IDF criteria was less predictive of cardiovascular disease risk (*29–31*). The metabolic syndrome based on NCEP-ATP III, but not IDF criteria, was associated with cardiovascular disease among male diabetic patients (*14, 15*).

Based on the Japanese criteria, the excess risk of ischemic cardiovascular disease was similar in non-abdominal obese persons with at least two metabolic risk factors and abdominal obese persons with at least two risk factors. The lack of significant associations of ischemic heart disease and ischemic cardiovascular disease based on the Japanese criteria was due to the inclusion of a high-risk group of persons without abdominal obesity as a reference group. In other words, excess risk of ischemic cardiovascular disease was similar for persons with at least two metabolic risk factors, irrespective of the presence of abdominal obesity. It is controversial whether the abdominal obesity defined by waist circumference should be required for diagnosis of the metabolic syndrome (*27, 30*). Waist circumference is a valuable component of metabolic syndrome, but the requirement of an increased waist circumference may lead to reduced predictive power for cardiovascular disease (*27, 29–33*).

The strengths of the present study include the use of standardized measurements of waist circumference, serum lipids, and blood pressure levels. The stroke surveillance was almost complete, and a high percentages of the events were confirmed using imaging studies (92%).

The limitations of the present study were, first, the small number of incident cases, particularly for ischemic heart disease. However, we found a statistically significant association between the metabolic syndrome and risks of ischemic heart disease and ischemic stroke. Second, we collected non-fasting blood samples from 94% of the participants during the 1990–1993 examinations. We used non-fasting data at the baseline examination, in particular, non-fasting serum triglycerides ≥1.69 mmol/L (≥150 mg/dL) as a component of metabolic syndrome. Although the justification of the use for the same cutoff point as fasting status is under debate, the data of non-fasting triglycerides can be used because of their significant predictive power for ischemic heart disease (*34*). We used non-fasting glucose ≥7.77 mmol/L as a component of metabolic syndrome, and we may have misclassified participants with high blood glucose. However, we found no significant difference in the percentage of participants with high blood glucose in non-fasting and fasting blood samples probably because we used the different cutoff points: ≥110 mg/dL for fasting and ≥140 mg/dL for non-fasting. In men, the percentage of high blood glucose was 26% for non-fasting blood samples and 30% for fasting blood samples. In women, the respective percentages were 17% and 14%.

In summary, the metabolic syndrome based on NCEP-ATPIII criteria predicted risks of ischemic heart disease, ischemic stroke and total cardiovascular disease, whereas that based on the other three criteria predicted them to a lesser extent.

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Trends in dietary intakes of vitamins A, C and E among Japanese men and women from 1974 to 2001

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Abstract

Objective: To investigate long-term trends in dietary intakes of vitamins A, C and E in Japanese adults.

Design: Time series by community-based nutrition survey.

Setting: Two rural communities (Ikawa and Kyowa) between 1974 and 2001 in Japan.

Subjects: A total of 3713 men and 3726 women aged 40–69 years.

Methods: Dietary intake data were collected by the 24 h dietary recall.

Results: In Ikawa, mean intake of vitamin A (β-carotene and retinol) increased by 13–40 %; vitamins C and E increased by approximately 23–33 % among men and women from 1974–1977 to 1998–2000. In Kyowa, mean intake of vitamin A, primarily retinol, increased by 13–21 % among men and women; vitamin C from fruits decreased by 16 % among men; and vitamin E increased by 29 % among women from 1982–1986 to 1998–2001. Mean intake of vitamin E in the latest survey period was lower than the Adequate Intake among men and women in both communities. Generally, there were increased intakes of β-carotene and vitamin C from green/yellow and other vegetables; increased retinol intake from fish/shellfish, eggs, milk/dairy products and fats/oils; and increased vitamin E intake from green/yellow and other vegetables, fish/shellfish, eggs, milk/dairy products and fats/oils.

Conclusions: Mean intakes of the antioxidant vitamins A, C and E increased among middle-aged Japanese men and women between the 1970s and the 1990s except for decreased vitamin C among Kyowa men. The lower mean intake of vitamin E than the Adequate Intake should be considered a potential public health issue for the prevention of CVD.

Keywords
Vitamin C
Vitamin E
Vitamin A
Foods
Trends

Vitamins with antioxidant properties may be protective against CVD and cancer[1–3]. Antioxidants can reduce the oxidative modification of LDL to affect blood cholesterol levels[1] and to prevent oxidative damage to cells, thereby reducing the risk of cancer[4–8].

Higher serum levels of carotenoids such as α- and β-carotene have been associated with lower mortality from lung[9,10] and colorectal cancers[11] among Japanese men. Vitamin C was reported to lower blood pressure levels[12] and was inversely associated with the incidence[13] of and mortality[14] from stroke.

Intake of another major antioxidant vitamin, vitamin E, has been associated with reduced risks of CHD and stroke when used in high doses[15–18], although vitamin E supplementation had no effect on mortality from CVD and all causes in clinical trials[19,20]. A clinical trial of approximately 30 000 Chinese adults demonstrated that a diet

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supplemented with β-carotene, vitamin E and Se reduced the risk of cancer by 13%[21]. These findings suggest potential benefits of antioxidant vitamins for the prevention of CVD and cancer.

In 2000, the Ministry of Science and Education revised the Japanese standard food composition table for the first time in 18 years, to reflect the increasing diversification of Japanese dietary habits. Vitamins A, C and E were included in the new table, so that trends for the intake of these vitamins could be evaluated using the existing database of dietary surveys.

In the present study, we investigated long-term trends in dietary intakes of vitamins A, C and E, according to population-based surveys in two Japanese communities between 1974 and 2001.

Methods

The subjects in the present study comprised men and women aged from 40 to 69 years, living in Ikawa town, Akita Prefecture, and Kyowa town (presently a district of Chikusei city), Ibaraki Prefecture. Ikawa is located near the Sea of Japan in the north, where nearly half of the town is forest and rice-crop agriculture is the main industry. Kyowa is on a plain area in the mid-eastern region of Japan; this area is predominantly horticultural with a mix of rice-crop agriculture and light industry.

The nutrition surveys were conducted by 24 h dietary recall in approximately 10% of the participants in the annual cardiovascular risk surveys. Subjects aged over 70 years were excluded from the nutrition survey because the accuracy of recall-based data may decline with ageing. The participants in the cardiovascular risk surveys were recruited for the nutrition surveys, but were not pre-informed of the recruitment.

The surveys were conducted from 1974 to 2000 for Ikawa and from 1982 to 2001 for Kyowa. The survey data were collected during autumn in Kyowa and during spring in Ikawa. The nutrition survey term was stratified into seven time periods for Ikawa: 1974–1977, 1978–1981, 1982–1985, 1986–1989, 1990–1993, 1994–1997 and 1998–2000; and into four periods for Kyowa: 1982–1986, 1990–1993, 1994–1997 and 1998–2001. If a participant undertook the nutrition survey more than once during one survey period, we used the data from the earliest year in each survey period. The numbers of subjects by sex and time period in Ikawa and Kyowa are presented in Table 1.

The 24 h dietary recall method involves trained dietitians interviewing the study subjects on what they had eaten during the 24 h prior to examination. The same dietitians were used over the survey periods where possible to avoid fluctuations in interviewing technique over time. New dietitians were carefully trained before interviewing for the survey. In the interviews, actualized food models, pictures of food materials and dishes, and/or real foods and dishes were shown to the participants to enable easy recall of their food intake. The same basic food models and interview forms were used throughout the surveys. Intake of green tea was included in the surveys from 1994. Rice and *miso* soup quantities were estimated by asking the subjects to put the usual amount of their intake into a bowl and this was then measured. We also investigated the intake frequencies of sixteen major foods and food groups per week to confirm that the foods included in the 24 h dietary recall were representative of the subject's usual diet. Survey periods encompassing special events such as a festival or celebration were excluded from the surveys. The interview took approximately 30 min per subject. We did not ask about the use of vitamin supplements because supplement use has been uncommon during the survey periods.

Nutrient intakes were estimated based on fifth revised edition of the *Standard Tables of Food Composition in Japan*[22]. The data were originally coded based on the fourth edition of the food composition tables between 1974 and 1999, and on the fifth edition between 2000 and 2001. Foods appearing for the first time in the fifth and fifth revised editions were rarely eaten by our study participants. The data on vitamins were total vitamin A (μg retinol equivalents (RE)/d), β-carotene (μg/d), vitamin C (mg/d) and α-tocopherol (μg/d) as vitamin E. It is possible that the amounts of vitamins A, C and E contained in the same foods may have changed from the 1970s to the present, but we have no data to support this possibility. Therefore, we used the data in the fifth edition throughout the surveys.

The food composition tables provide nutritional data after cooking only for selected foods. Thus, we evaluated all data in the pre-cooked state to investigate long-term trends, although this may have introduced a systematic overestimation of nutrient intakes.

For primary trend analyses, we did not include dietary intake of green tea because this intake was not surveyed prior to 1994. However, for the secondary analyses, we included vitamins A, C and E from green tea in the latest survey period, to estimate the true proportions of these nutrients in the total intakes. Persons who reported upper and lower 1% of these vitamins were excluded from the analyses (n 528).

Sex-specific age-adjusted mean values and standard errors of vitamin A, C and E intakes were calculated by analysis of covariance for each survey period as described above. We also evaluated intakes of these vitamins by major food group. Differences in mean values from the earliest survey period were determined using Dunnett's multiple comparison method. The SAS statistical software package version 9·13 (SAS Institute Inc., Cary, NC, USA) was used for statistical analysis. P values less than 0·05 were regarded as statistically significant throughout the surveys.

Results

The number of survey participants in each survey period was between 176 and 370 for men and between 132 and 325 for women in Ikawa, while the respective number in Kyowa was between 355 and 627 and between 433 and 572 (Table 1).

Age-adjusted mean (SE) BMI (kg/m^2) in the latest survey period (1998–2000 in Ikawa, 1998–2001 in Kyowa) was 23·9 (0·2) among men and 24·3 (0·2) among women in Ikawa, and 23·7 (0·1) among men and 23·5 (0·2) among women in Kyowa. The proportion of subjects who drank more than one alcoholic drink per week was 86% among men and 9% among women in Ikawa, and 74% among men and 11% among women in Kyowa.

Table 1 shows trends for sex-specific age-adjusted mean dietary intakes of vitamins A, C and E in the two communities. Mean intake of total vitamin A increased by 13% among men and 40% among women; β-carotene increased by 2% among men and 31% among women; and retinol increased by 56% among men and 105% among women from 1974–1977 to 1998–2000 in Ikawa. Among men and women in Kyowa, mean intake of total vitamin A increased by 13% for men and 21% for women; retinol increased by 16% for men and 29% for women, but β-carotene did not change between 1982–1986 and 1998–2001.

Mean intake of vitamin C increased by 23% among men and 29% among women from 1974–1977 to 1978–1981, and plateaued thereafter in Ikawa. In Kyowa, it decreased by 16% among men, but did not change among women from 1982–1986 to 1990–1993.

Mean intake of vitamin E increased by 34% among men and 33% among women from 1974–1977 to 1982–1985, and plateaued thereafter in Ikawa. In Kyowa, mean intake of vitamin E did not change among men, but increased by 8% among women from 1982–1986 to 1998–2001.

Table 2 shows trends for sex-specific age-adjusted mean dietary intakes of vitamins A, C and E by food group in the two communities. Mean intake of β-carotene from green/yellow vegetables, a primary food source, increased among men from 1974–1977 to 1982–1985, and plateaued thereafter in Ikawa, whereas that from fruits and algae decreased among men and women from 1974–1977 to 1998–2000 in Ikawa. In Kyowa, mean intake of β-carotene from fruits decreased among men, but did not change substantially among women from 1982–1986 to 1990–1993.

Mean intake of retinol from fish/shellfish increased among men and women from 1974–1977 to 1998–2000 in

Table 1 Trends for sex-specific age-adjusted mean dietary intakes of vitamins A, C and E in men and women aged 40–69 years in Ikawa and Kyowa, Japan

Sex/community	Survey years	No. of subjects	Total vitamin A (μg RE/d)		β-Carotene (μg/d)		Retinol (μg/d)		Vitamin C (mg/d)		Vitamin E (mg/d)	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Men												
Ikawa												
	1974–1977	306	506	22·2	4470	198·3	129	14·3	81	3·4	5·9	0·17
	1978–1981	176	515	29·1	4427	259·9	138	18·7	100**	4·5	6·1	0·22
	1982–1985	370	615**	20·0	5503***	179·3	150	12·9	110***	3·1	7·9***	0·15
	1986–1989	308	563	22·0	5375**	197·1	170	14·2	108***	3·4	7·4***	0·16
	1990–1993	262	606*	23·9	5252*	213·7	202**	15·4	98**	3·7	7·3***	0·18
	1994–1997	281	599*	23·2	5591***	207·9	165	15·0	106***	3·6	7·3***	0·17
	1998–2000	224	571	25·8	4559	230·5	201**	16·6	97*	3·9	7·0***	0·19
Kyowa												
	1982–1986	627	436	13·1	3752	119·5	119	7·4	137	3·7	6·4	0·12
	1990–1993	355	426	17·4	3148**	158·4	170***	9·8	116**	4·9	6·4	0·16
	1994–1997	381	448	16·8	3609	153·2	149*	9·4	129	4·8	6·7	0·16
	1998–2001	423	491*	15·9	3682	145·2	138	8·9	115***	4·5	6·6	0·15
Women												
Ikawa												
	1974–1977	253	435	23·9	4106	203·9	83	16·4	90	3·8	5·5	0·16
	1978–1981	132	490	32·9	4346	281·1	123	22·7	116***	5·2	6·1	0·23
	1982–1985	273	578***	22·9	5100**	195·3	145*	15·7	119***	3·6	7·3***	0·16
	1986–1989	266	547**	23·2	5247***	197·9	157**	16·0	114***	3·7	7·0***	0·16
	1990–1993	325	576***	21·0	5437***	179·4	163**	14·5	123***	3·3	7·2***	0·14
	1994–1997	318	626***	21·2	5417***	181·0	185***	14·6	114***	3·4	6·9***	0·14
	1998–2000	242	609***	24·3	5390***	207·5	170**	16·7	121***	3·9	6·7***	0·17
Kyowa												
	1982–1986	572	499	13·7	4525	124·7	119	7·3	154	4·0	6·6	0·12
	1990–1993	433	515	15·7	4230	143·3	157**	8·4	154	4·6	6·7	0·14
	1994–1997	449	518	15·5	4592	140·9	135	8·3	156	4·6	6·6	0·14
	1998–2001	463	603***	15·2	4533	138·5	153**	8·1	150	4·5	7·1*	0·14

RE, retinol equivalents.
Intake of green tea was not taken into account; intakes of nutrients were evaluated in conditions before cooking.
Mean values were significantly different from those of the first survey: *$P<0·05$, **$P<0·01$, ***$P<0·001$.

Table 2 Trends for sex-specific age-adjusted mean dietary intakes of β-carotene, retinol, vitamin C and vitamin E by food group in men and women aged 40–69 years in Ikawa and Kyowa, Japan

Nutrient/sex/ community	Survey years	Green/yellow vegetables		Other vegetables		Fruits		Cereals		Potatoes		Algae		Fish/shellfish		Meats		Eggs		Milk/dairy products		Fats/oils		Green tea	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
β-Carotene (μg/d)																									
Men																									
Ikawa	1974–1977	4057	195·5	59	7·5	186	27·8	0·0	0·86	0·1	0·09	149	12·1	3·2	1·28	–		4·4	0·35	2·8	0·62	0·4	0·24		
	1978–1981	4078	256·2	55	9·9	145	36·5	0·0	1·13	0·3	0·12	111	15·9	1·9	1·68	–		5·0	0·46	5·3	0·82	0·4	0·32		
	1982–1985	5119***	176·7	77	6·8	103	25·1	0·0	0·78	0·3	0·08	152	11·0	3·4	1·16	–		6·2***	0·32	5·6**	0·56	0·6	0·22		
	1986–1989	4292	194·3	88*	7·5	135	27·6	1·0	0·86	0·1	0·09	84***	12·0	3·1	1·28	–		6·5***	0·35	5·6**	0·62	0·7	0·24		
	1990–1993	4476	210·7	83	8·1	128	30·0	4·4**	0·93	0·1	0·10	50***	13·1	6·4	1·38	–		6·0**	0·38	7·6***	0·67	0·8	0·26		
	1994–1997	4766	204·9	99**	7·9	125	29·2	2·6	0·90	0·2	0·10	51***	12·7	3·3	1·35	–		5·5	0·37	8·7***	0·65	0·4	0·25	0	0
	1998–2000	4187	227·2	93*	8·8	44**	32·3	2·0	1·00	0·2	0·11	96*	14·1	2·6	1·49	–		5·3	0·41	8·1***	0·72	1·5**	0·28	0	0
Kyowa	1982–1986	2500	107·1	81	5·1	1004	51·9	2·2	1·13	2·3	0·22	104	11·0	1·9	0·80	–		4·4	0·24	4·4	0·48	1·4	0·30		
	1990–1993	2147	142·0	93	6·7	735**	68·8	3·8	1·49	1·8	0·30	131	14·6	3·8	1·06	–		5·3*	0·32	5·6	0·63	2·4	0·40		
	1994–1997	2550	137·3	92	6·5	837	66·6	4·3	1·44	2·1	0·29	91	14·1	4·8	1·02	–		4·9	0·31	6·2	0·61	1·7	0·39	0	3
	1998–2001	2668	130·2	110***	6·1	739**	63·1	5·3	1·37	2·2	0·27	112	13·4	4·8	0·97	–		4·4	0·29	6·1	0·58	1·5	0·37	5	3
Women																									
Ikawa	1974–1977	3572	199·9	79	7·9	312	33·0	0·6	0·76	0·2	0·20	135	10·5	0·6	1·89	–		4·1	0·36	1·7	0·62	0·3	0·37		
	1978–1981	3843	275·6	67	10·9	228	45·5	0·2	1·04	1·1*	0·28	154	14·5	6·7	2·61	–		5·7*	0·49	3·8	0·86	1·0	0·51		
	1982–1985	4582**	191·5	105	7·6	200	31·6	0·8	0·72	0·8	0·19	140	10·1	4·2	1·81	–		5·1	0·34	5·0***	0·60	0·5	0·35		
	1986–1989	4200	194·1	86	7·7	170*	32·0	0·2	0·73	0·5	0·19	66***	10·2	5·2	1·84	–		5·5*	0·35	5·8***	0·60	1·6	0·36		
	1990–1993	4520**	175·9	100	7·0	179*	29·0	1·4	0·66	0·3	0·18	55***	9·2	5·2	1·66	–		5·3*	0·31	8·3***	0·55	1·4	0·32		
	1994–1997	4867***	177·5	103	7·0	144***	29·3	1·1	0·67	0·4	0·18	50***	9·3	2·7	1·68	–		5·2	0·32	9·4***	0·55	1·4	0·33	2	3
	1998–2000	4996***	203·5	91	8·0	103***	33·6	2·1	0·77	0·5	0·20	66***	10·7	4·0	1·93	–		3·9	0·36	8·4***	0·63	2·3***	0·38	5	4
Kyowa	1982–1986	3049	112·4	87	5·1	1208	54·5	1·1	0·90	3·8	0·31	114	13·7	1·2	0·40	–		4·6	0·23	4·9	0·51	2·0	0·34		
	1990–1993	2749	129·2	94	5·9	1165	62·7	3·1	1·03	3·5	0·36	152	15·7	2·9*	0·46	–		5·1	0·26	8·4***	0·59	2·0	0·39		
	1994–1997	3234	127·0	107*	5·8	1089	61·6	3·6	1·01	2·6*	0·35	124	15·4	2·9*	0·46	–		3·9	0·25	7·3**	0·58	1·6	0·39	1	0
	1998–2001	3099	124·8	108*	5·7	1134	60·6	2·6	1·00	3·4	0·35	144	15·2	1·8	0·45	–		4·3	0·25	7·9***	0·57	2·8	0·38	0	0
Retinol (μg/d)																									
Men																									
Ikawa	1974–1977	–		–		–		–		–		–		45	7·2	27	11·7	36	2·9	17	2·8	1·6	1·36		
	1978–1981	–		–		–		–		–		–		41	9·5	23	15·4	41	3·8	28	3·7	2·1	1·78		
	1982–1985	–		–		–		–		–		–		37	6·5	20	10·6	52***	2·6	32***	2·6	3·1	1·23		
	1986–1989	–		–		–		–		–		–		51	7·2	21	11·7	53***	2·9	34***	2·8	4·2	1·35		
	1990–1993	–		–		–		–		–		–		53	7·8	46	12·6	50**	3·1	43***	3·1	4·3	1·47		
	1994–1997	–		–		–		–		–		–		55	7·6	11	12·3	45	3·0	48***	3·0	2·1	1·42	–	
	1998–2000	–		–		–		–		–		–		83**	8·4	21	13·6	44	3·3	39***	3·3	7·9*	1·58	–	
Kyowa	1982–1986	–		–		–		–		–		–		39	6·0	9	2·5	36	2·0	24	1·8	7·7	1·82		
	1990–1993	–		–		–		–		–		–		62	7·9	13	3·4	44	2·6	31*	2·4	13·2	2·41		
	1994–1997	–		–		–		–		–		–		52	7·7	6	3·3	41	2·6	32**	2·3	9·4	2·33	–	
	1998–2001	–		–		–		–		–		–		47	7·3	6	3·1	37	2·4	27	2·2	8·2	2·21	–	
Women																									
Ikawa	1974–1977	–		–		–		–		–		–		23	7·3	10	13·9	33	2·9	11	2·8	1·2	2·16		
	1978–1981	–		–		–		–		–		–		34	10·1	5	19·1	47	4·0	23*	3·8	6·0	2·98		
	1982–1985	–		–		–		–		–		–		26	7·0	35	13·3	42	2·8	29***	2·7	2·2	2·07		
	1986–1989	–		–		–		–		–		–		40	7·1	25	13·5	45*	2·8	31***	2·7	8·8	2·10		
	1990–1993	–		–		–		–		–		–		30	6·5	26	12·2	43*	2·6	45***	2·4	7·8	1·90		
	1994–1997	–		–		–		–		–		–		49*	6·5	24	12·3	42	2·6	52***	2·5	8·4	1·92	–	
	1998–2000	–		–		–		–		–		–		51*	7·5	16	14·1	32	3·0	47***	2·8	11·9**	2·20	–	
Kyowa	1982–1986	–		–		–		–		–		–		23	5·3	11	3·5	38	1·9	27	2·0	11·3	1·99		
	1990–1993	–		–		–		–		–		–		48**	6·1	7	4·0	42	2·2	38**	2·3	11·0	2·29		
	1994–1997	–		–		–		–		–		–		35	6·0	5	4·0	32	2·1	40***	2·3	7·9	2·25	–	
	1998–2001	–		–		–		–		–		–		32	5·9	12	3·9	36	2·1	37**	2·2	15·3	2·21	–	

Table 2 *Continued*

Nutrient/sex/community	Survey years	Green/yellow vegetables		Other vegetables		Fruits		Cereals		Potatoes		Algae		Fish/shellfish		Meats		Eggs		Milk/dairy products		Fats/oils		Green tea	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Vitamin C (mg/d)																									
Men																									
Ikawa	1974–1977	33	2·1	15	1·1	19	1·9	–		9·0	0·82	–		–		1·7	0·22	–		–		–			
	1978–1981	36	2·7	19	1·4	24	2·4	–		11·0	1·08	–		–		1·9	0·28	–		–		–			
	1982–1985	58***	1·9	15	1·0	19	1·7	–		4·9*	0·74	–		–		1·7	0·20	–		–		–			
	1986–1989	35	2·0	18	1·1	15	1·8	–		7·7	0·82	–		–		2·0	0·22	–		–		–			
	1990–1993	35	2·2	20**	1·2	13	2·0	–		7·4	0·88	–		–		2·3	0·23	–		–		–			
	1994–1997	39	2·2	20*	1·1	15	1·9	–		9·3	0·86	–		–		2·2	0·23	–		–		–		14	1·1
	1998–2000	40	2·4	20**	1·3	11*	2·2	–		12·4*	0·95	–		–		1·9	0·25	–		–		–		12	1·2
Kyowa	1982–1986	19	1·4	30	1·1	65	3·0	–		10·2	0·72	–		–		2·4	0·23	–		–		–			
	1990–1993	20	1·9	32	1·5	46***	4·0	–		9·2	0·95	–		–		2·9	0·31	–		–		–			
	1994–1997	25*	1·8	34	1·5	54	3·9	–		10·2	0·92	–		–		2·5	0·30	–		–		–		36	1·0
	1998–2001	22	1·7	32	1·4	43***	3·7	–		10·5	0·87	–		–		2·8	0·28	–		–		–		33	0·9
Women																									
Ikawa	1974–1977	26	2·1	16	1·1	35	2·6	–		9·6	0·89	–		–		0·7	0·19	–		–		–			
	1978–1981	37**	2·9	16	1·5	44	3·6	–		10·5	1·23	–		–		1·2	0·26	–		–		–			
	1982–1985	47***	2·0	15	1·0	37	2·5	–		6·6	0·85	–		–		1·4	0·18	–		–		–			
	1986–1989	35**	2·1	16	1·0	27	2·5	–		7·1	0·86	–		–		1·8***	0·18	–		–		–			
	1990–1993	39***	1·9	21**	0·9	28	2·3	–		8·3	0·78	–		–		2·0***	0·17	–		–		–			
	1994–1997	44***	1·9	22***	0·9	24**	2·3	–		10·4	0·79	–		–		1·8***	0·17	–		–		–		11	0·7
	1998–2000	47***	2·2	23***	1·1	27	2·6	–		13·1*	0·91	–		–		1·8***	0·19	–		–		–		13	0·8
Kyowa	1982–1986	26	1·6	27	1·0	77	3·4	–		13·0	0·80	–		–		2·6	0·21	–		–		–			
	1990–1993	24	1·8	32***	1·1	77	3·9	–		11·4	0·92	–		–		2·3	0·24	–		–		–			
	1994–1997	32	1·8	29	1·1	76	3·8	–		12·0	0·90	–		–		2·7	0·24	–		–		–		32	0·9
	1998–2001	30	1·7	29	1·1	72	3·8	–		12·0	0·89	–		–		2·5	0·23	–		–		–		34	0·8
Vitamin E (mg/d)																									
Men																									
Ikawa	1974–1977	1·78	0·102	0·14	0·030	0·27	0·020	0·43	0·024	–		–		2·06	0·099	0·21	0·015	0·26	0·021	0·04	0·008	0·31	0·042		
	1978–1981	1·59	0·134	0·15	0·039	0·24	0·026	0·38	0·032	–		–		2·03	0·130	0·17	0·020	0·29	0·027	0·08	0·011	0·46	0·055		
	1982–1985	2·99***	0·092	0·32***	0·027	0·23	0·018	0·42	0·022	–		–		1·99	0·090	0·19	0·014	0·37***	0·019	0·09***	0·007	0·55***	0·038		
	1986–1989	2·13	0·101	0·38***	0·030	0·21	0·020	0·39	0·024	–		–		2·03	0·099	0·19	0·015	0·38***	0·021	0·10***	0·008	0·71***	0·042		
	1990–1993	2·12	0·110	0·28**	0·032	0·18*	0·021	0·50	0·026	–		–		2·05	0·107	0·23	0·016	0·36**	0·022	0·13***	0·009	0·64***	0·045		
	1994–1997	2·20*	0·107	0·30**	0·031	0·23	0·021	0·42	0·025	–		–		2·11	0·104	0·19	0·016	0·32	0·022	0·14***	0·009	0·57***	0·044	–	
	1998–2000	1·91	0·119	0·24	0·035	0·19	0·023	0·43	0·028	–		–		1·89	0·116	0·21	0·018	0·31	0·024	0·11***	0·010	0·82***	0·049	–	
Kyowa	1982–1986	0·99	0·055	0·29	0·020	0·41	0·022	0·49	0·024	0·26	0·022	–		1·23	0·058	0·15	0·009	0·26	0·014	0·07	0·005	1·27	0·054		
	1990–1993	0·89	0·074	0·31	0·027	0·34	0·029	0·52	0·031	0·17*	0·029	–		1·47*	0·077	0·18	0·011	0·32*	0·019	0·09*	0·007	1·13	0·071		
	1994–1997	1·09	0·071	0·32	0·026	0·36	0·028	0·50	0·030	0·19	0·028	–		1·41	0·075	0·17	0·011	0·29	0·018	0·09**	0·007	1·32	0·069	–	
	1998–2001	1·05	0·067	0·35	0·024	0·35	0·026	0·45	0·029	0·21	0·026	–		1·22	0·071	0·17	0·010	0·26	0·017	0·08	0·006	1·40	0·065	–	
Women																									
Ikawa	1974–1977	1·35	0·102	0·17	0·024	0·46	0·028	0·42	0·022	0·03	0·015	–		1·63	0·082	0·08	0·010	0·24	0·021	0·03	0·008	0·54	0·050		
	1978–1981	1·63	0·140	0·17	0·033	0·48	0·038	0·28**	0·030	0·10*	0·021	–		1·36	0·113	0·10	0·013	0·33*	0·029	0·07*	0·012	0·70	0·069		
	1982–1985	2·55***	0·097	0·29**	0·023	0·42	0·027	0·30***	0·021	0·06	0·014	–		1·48	0·079	0·13**	0·009	0·30	0·020	0·08***	0·008	0·66	0·048		
	1986–1989	2·08***	0·099	0·33***	0·023	0·37	0·027	0·32***	0·021	0·05	0·015	–		1·46	0·080	0·14***	0·009	0·32*	0·020	0·10***	0·008	0·85***	0·049		
	1990–1993	2·20***	0·089	0·28**	0·021	0·34**	0·024	0·35	0·019	0·02	0·013	–		1·49	0·072	0·13**	0·008	0·31*	0·018	0·13***	0·007	0·86***	0·044		
	1994–1997	2·12***	0·090	0·30***	0·021	0·31***	0·025	0·29***	0·019	0·04	0·013	–		1·60	0·073	0·11	0·008	0·30	0·019	0·15***	0·008	0·76**	0·045	–	
	1998–2000	2·12***	0·103	0·24	0·025	0·33**	0·023	0·34	0·022	0·05	0·015	–		1·42	0·084	0·11	0·010	0·23	0·021	0·13***	0·009	0·63***	0·051	–	
Kyowa	1982–1986	1·28	0·061	0·38	0·024	0·51	0·026	0·38	0·019	0·34	0·024	–		0·82	0·047	0·12	0·007	0·27	0·013	0·08	0·006	1·29	0·053		
	1990–1993	1·10	0·070	0·32	0·027	0·56	0·025	0·35	0·022	0·30	0·028	–		1·16	0·053	0·13	0·008	0·30	0·015	0·11***	0·007	1·23	0·061		
	1994–1997	1·38	0·069	0·33	0·027	0·49	0·025	0·40	0·021	0·23*	0·028	–		1·02***	0·053	0·13	0·007	0·23	0·015	0·12***	0·007	1·31	0·060	–	
	1998–2001	1·32	0·068	0·36	0·026	0·54	0·023	0·35	0·021	0·28	0·027	–		0·92**	0·052	0·13	0·007	0·26	0·015	0·11***	0·006	1·38	0·059	–	

Intake of green tea was not taken into account; intakes of nutrients were evaluated in conditions before cooking.
Mean values were significantly different from those of the first survey: $^{*}P < 0·05$, $^{**}P < 0·01$, $^{***}P < 0·001$.

Ikawa, and did not change substantially among men and women from 1982–1986 to 1990–1993 in Kyowa. Mean intake of retinol from, eggs, milk/dairy products and fats/oils increased among men and women from 1974–1977 to 1998–2000 in Ikawa. In Kyowa, mean intake of retinol from milk/dairy products increased from 1982–1986 to 1990–1993, and then plateaued thereafter.

Mean intake of vitamin C from green/yellow and other vegetables, primary food sources, increased among men and women from 1974–1977 to 1982–1985 and plateaued thereafter in Ikawa, while that from fruits tended to decrease after the 1980s. In Kyowa, mean intake of vitamin C from green/yellow and other vegetables and fruits did not change substantially among men and women from 1982–1986 to 1998–2001.

Mean intake of vitamin E from green/yellow and other vegetables and fats/oils increased among men and women from 1974–1977 to 1982–1985, and plateaued thereafter in Ikawa, while intake from these foods did not change substantially among men and women in Kyowa.

The proportions of β-carotene intake according to food group in the latest survey period (1998–2001 for Ikawa, 1998–2000 for Kyowa) are shown in Fig. 1. The major food sources for β-carotene intake were green/yellow (92–93%) and other vegetables (1–2%) and fruits (1–2%) among men and women in Ikawa, with 68–72%, 3% and 20–25%, respectively, among men and women in Kyowa. The retinol intake comprised 30–41% from fish/shellfish, 19–22% from eggs and 19–28% from milk/dairy products among men and women in Ikawa. The respective proportions in Kyowa were 21–34%, 24–27% and 20–24%.

Vitamin C intake consisted of 35–37% from green/yellow vegetables, 17–18% from other vegetables, 10–20% from fruits and 10–11% from green tea among men and women in Ikawa. The respective proportions in Kyowa were 15–16%, 16–22%, 29–39% and 19–22%.

The vitamin E intake comprised 27–31% from green/yellow vegetables, 3% from other vegetables, 21–27% from fish/shellfish and 11–12% from fats/oils among men and women in Ikawa. The respective proportions in Kyowa were 15–18%, 6%, 13–18% and 20–21%.

Discussion

The present study of long-term nutritional trends in Japan revealed that both men and women in Ikawa had increased dietary intakes of β-carotene and vitamin C, primarily from green/yellow and other vegetables; increased intake of retinol from fish/shellfish, eggs, milk/dairy products and fats/oils; and increased intake of vitamin E from green/yellow and other vegetables, milk/dairy products and fats/oils between the 1970s and the 1990s. In Kyowa, mean intake of retinol from fish/shellfish and milk/dairy products increased among men and women; while mean intake of vitamin C from fruits decreased among men between the 1980s and the 1990s.

Ikawa comprises areas of plains and mountains where people have traditionally worked mainly on rice farms. New factories for heavy industry were founded in the late 1970s and many farmers changed to work in these factories. According to local government statistics, 67% of the population worked on farms and 12% in factories in 1975, but this had changed to 41% and 42%, respectively, by 1980. Consequently, the mean income of people in this community increased from the 1970s to the 1980s, which improved eating habits in terms of nutrition. In contrast, Kyowa is located on the plains where a large percentage of people worked on fruit and vegetable farms or for light-industry companies; there have been no substantial changes in industry since the 1980s.

Mean intakes of vitamins A, C and E in Ikawa and Kyowa were similar to those of the national samples in Japan. According to the national nutritional survey[23,24], the daily per capita intake of total vitamin A increased from 1974 (552 μg RE) to 2001 (981 μg RE). The daily per capita intake of vitamin C remained over 100 mg: 120 mg in 1974 and 106 mg in 2001. The daily per capita intake of vitamin E was 8.5 mg in 2001[24].

For ages 30–69 years, the Estimated Average Requirement for total vitamin A is 500–550 μg RE/d for men and 450 μg RE/d for women, and that for vitamin C is 55 mg/d for both sexes. The Adequate Intake of vitamin E is 8–9 mg/d for men and 8 mg/d for women[25]. Therefore, mean intakes of vitamins A and C in the present study samples were higher than the Estimated Average Requirement except for slightly lower vitamin A in Kyowa men. Mean intake of vitamin E was lower than the Adequate Intake among men and women in both communities.

Mean daily intakes of vitamins C among Americans according to the National Health and Nutrition Examination Survey (NHANES) in 1999–2000[26] were 107 mg among men aged 40–59 years, 110 mg among men aged ≥60 years, 91 mg among women aged 40–59 years and 99 mg among women aged ≥60 years. The respective intakes of vitamin E were 10.4 mg, 9.2 mg, 9.1 mg and 7.6 mg. Mean intakes of vitamin A could not be compared with the US data because of different methods of calculation. That report and the present findings suggest that the mean intake of vitamin C around 2000 was similar for men and higher for women, and that the mean intake of vitamin E was lower for both sexes of the Japanese samples than for the US samples.

The strength of the present study lay in the 24 h dietary recall method used in the surveys, with a sample large enough to statistically estimate sex-specific long-term trends. However, our study has several limitations. First, we evaluated nutrient intakes only for raw foods because there was no systematic database available to assess nutrient loss by cooking. Since the survival proportion of vitamins C in vegetables following cooking is approximately 50–90%[22],

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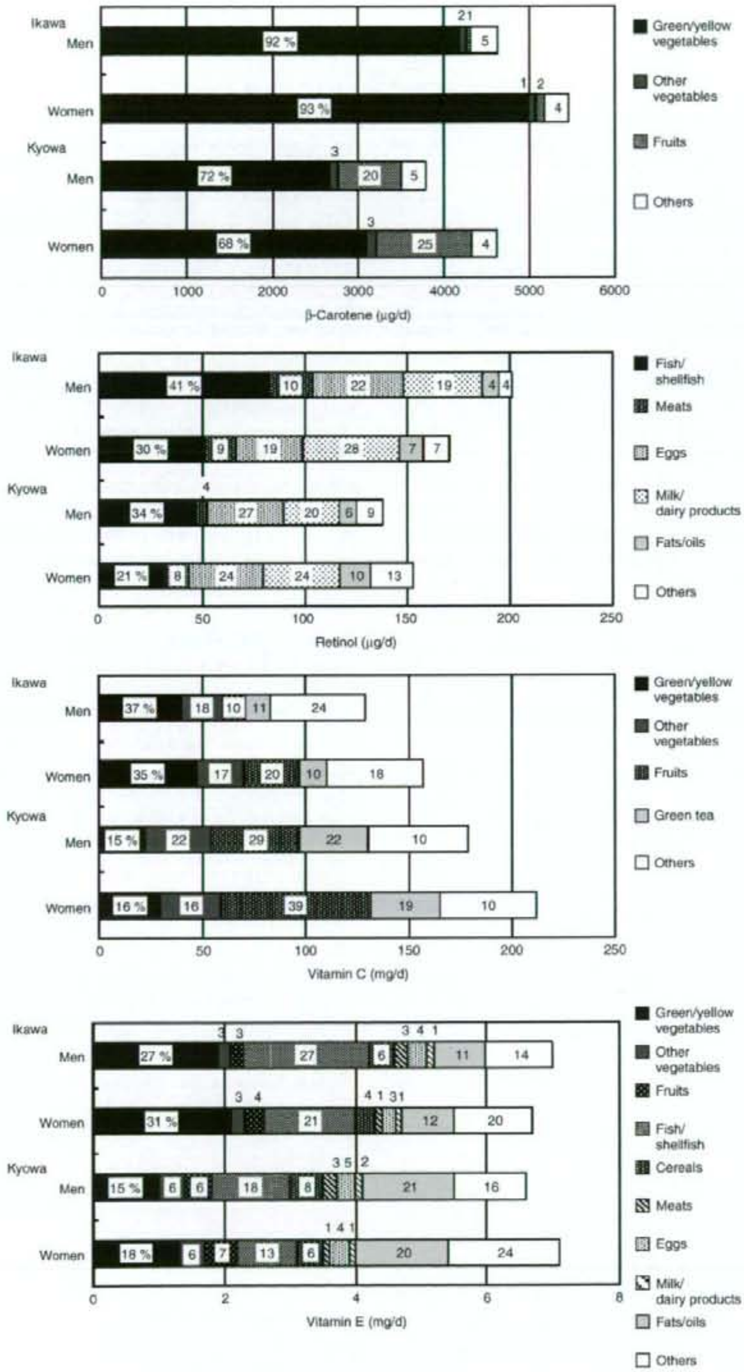

Fig. 1 Sex-specific age-adjusted mean dietary intakes of β-carotene, retinol, vitamin C and vitamin E by food group, in men and women aged 40–69 years in Ikawa and Kyowa, Japan, in the latest survey period (1998–2000 in Ikawa, 1998–2001 in Kyowa). The numbers in bars are the proportions of the vitamin intakes by food group

dietary intake of vitamin C may be overestimated systematically in the present study. Second, we did not have data on vitamin supplements in addition to dietary intake. However, this limitation is unlikely to have a large impact on the prediction of risk trends for CVD because the use of vitamin supplements may be low in these communities as vitamin supplements have been available for purchase in convenience stores only since 2004.

In summary, we investigated long-term trends in dietary intakes of vitamins A, C and E among Japanese middle-aged adults in two rural communities. Increases occurred for vitamins A, C and E between the 1970s and the 1990s except for decreased vitamin C among Kyowa men. The lower mean intake of vitamin E than the Adequate Intake should be considered a potential public health issue for the prevention of CVD.

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Author contributions: Y.K. analysed the data and wrote the first draft. H.I. designed the study, chaired the steering committee, managed the study and edited the manuscript. S.I. and K.M. assisted in conducting the analysis design and preparing the manuscript. M.I., M.O., K. Yokota, S.M., T.Y., M. Kishi and M. Kurokawa participated in the field surveys. M.U. and E.M. analysed the data. K. Yamagishi, T.T. and S.S. managed the surveillance, analysed and edited the manuscript. T.S. was a member of the steering committee who monitored and managed the study.

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RESEARCH

The joint impact on being overweight of self reported behaviours of eating quickly and eating until full: cross sectional survey

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ABSTRACT

Objective To examine whether eating until full or eating quickly or combinations of these eating behaviours are associated with being overweight.

Design and participants Cross sectional survey.

Setting Two communities in Japan.

Participants 3287 adults (1122 men, 2165 women) aged 30-69 who participated in surveys on cardiovascular risk from 2003 to 2006.

Main outcome measures Body mass index (overweight ≥25.0) and the dietary habits of eating until full (lifestyle questionnaire) and speed of eating (validated brief self administered questionnaire).

Results 571 (50.9%) men and 1265 (58.4%) women self reported eating until full, and 523 (45.6%) men and 785 (36.3%) women self reported eating quickly. For both sexes the highest age adjusted mean values for height, weight, body mass index, and total energy intake were in the eating until full and eating quickly group compared with the not eating until full and not eating quickly group. The multivariable adjusted odds ratio of being overweight for eating until full was 2.00 (95% confidence interval 1.53 to 2.62) for men and 1.92 (1.53 to 2.40) for women and for eating quickly was 1.84 (1.42 to 2.38) for men and 2.09 (1.69 to 2.59) for women. The multivariable odds ratio of being overweight with both eating behaviours compared with neither was 3.13 (2.20 to 4.45) for men and 3.21 (2.41 to 4.29) for women.

Conclusion Eating until full and eating quickly are associated with being overweight in Japanese men and women, and these eating behaviours combined may have a substantial impact on being overweight.

INTRODUCTION

Obesity or being overweight is an important risk factor for lifestyle related diseases such as cancer, cardiovascular diseases, and diabetes.[1] In recent years the prevalence of overweight and obesity has increased both worldwide and among Japanese men.[2] Weight gain is caused by energy intake in excess of energy expenditure.[3,4] Eating quickly, gorging, and binge eating have been associated with total energy intake,[5-7] and eating quickly and binge eating have been associated with satiety[8,9] and insulin resistance[10,11] All these eating behaviours may lead to being overweight or obese.[12-14] In addition, the positive association of eating quickly with body mass index was observed independent of total energy intake.[15,16]

Eating until full refers to eating a large quantity of food in one meal and is unrelated to eating disorders, whereas gorging is characterised by few meals but a large quantity consumed during one meal[5,13] and binge eating by the ingestion of abnormally large quantities of food many times a day.[17]

We examined whether eating until full and eating quickly are associated with being overweight in a population based sample of adults in Japan. We also examined the combined effect of eating until full and speed of eating on being overweight.

METHODS

We carried out a cross sectional study of 4140 adults (1496 men, 2644 women) aged 30 to 69 in two Japanese communities who participated in surveys on cardiovascular risk from 2003 to 2006 under the Japan health law. The surveys were carried out in Ikawa, a rural community in the north east of Japan, and Yao, a suburb in the south west.

Overall, 3650 (88.2%) participants responded to self administered questionnaires on diet history and 489 (12%) refused. Overweight and body mass index were similar between the two groups.

We excluded participants with a history of cardiovascular diseases (n=308), excessively high (>4000 kcal) or low (<500 kcal) total reported daily energy intake (n=20), and lacking data related to eating until full or speed of eating (n=35). The data for the remaining 3287 participants (1122 men, 2165 women) were used for the analyses.

Measurements

To avoid measurement bias we used standardised methods to carry out the surveys, the details of which are described elsewhere.[18 19] We measured the participants' height without footwear and weight in light clothing and calculated their body mass index (weight (kg)/(height (m)^2). For the purposes of the analysis we considered a body mass index of 25.0 or more as indicating overweight. We also interviewed participants to ascertain data on smoking status, the number of cigarettes smoked daily, occupation, and the use of regular physical exercise for 15 minutes or more a week.

Dietary assessments

We used a validated, self administered, brief questionnaire on diet history to assess the participants' dietary habits during the previous month.[20-22] The participants were asked whether they usually eat until full (yes or no) and speed of eating was self reported according to one of five qualitative categories: very slow, slow, medium, fast, and very fast. Owing to small numbers of participants in the very fast category we combined the very fast and fast categories into the category for eating quickly. We validated the self reported speed of eating as used previously.[15] Self reported speed of eating showed a high level of agreement with speed of eating as reported by a friend: the percentages of exact and adjunct categories of answers (for example, very fast and fast were regarded as agreed) were 46% and 47%, respectively.[15] After we had combined the categories for very fast and fast and also combined the categories for medium, slow, and very slow, the percentage of agreement was reasonably good (75.3%), with a moderate κ statistics (0.35). We tested the repeatability for self reporting eating until full and eating quickly (very fast and fast combined) by repeating the questionnaire survey after one year in a subsample of the participants (1062 men, 1816 women). The κ statistics for eating until full were 0.60 in men and 0.63 in women, and for eating quickly were 0.63 in men and 0.67 in women.

Table 1 | Characteristics of participants according to combination of eating until full and eating quickly. Values are means (standard errors) unless stated otherwise

Characteristics	Not eating until full, not eating quickly	Eating until full, not eating quickly	Not eating until full, eating quickly	Eating until full, eating quickly	Total
Men:	n=352	n=258	n=199	n=313	n=1122
Mean (SD) age (years)	58.1 (10.0)	54.8 (10.3)	57.0 (9.7)	51.4 (11.3)	55.3 (10.7)
Height (cm)	164.8 (0.3)	165.8 (0.4)	165.9 (0.4)	166.6 (0.3)	165.7 (0.2)
Weight (kg)	63.1 (0.5)	66.8 (0.6)	64.9 (0.7)	69.6 (0.5)	66.1 (0.3)
Body mass index (kg/m^2)	23.2 (0.2)	24.3 (0.2)	23.6 (0.2)	25.0 (0.2)	24.0 (0.1)
Total energy intake (kcal)	2190 (30)	2296 (35)	2143 (40)	2296 (32)	2236 (17)
Total protein intake (% energy)	14.1 (0.1)	13.8 (0.2)	14.2 (0.2)	13.7 (0.1)	13.9 (0.1)
Total fat intake (% energy)	23.2 (0.3)	22.6 (0.3)	23.0 (0.4)	22.7 (0.3)	22.9 (0.2)
Carbohydrate intake (% energy)	53.2 (0.4)	53.2 (0.5)	53.2 (0.6)	53.8 (0.5)	53.4 (0.2)
Total dietary fibre intake (g/1000 kcal)	5.5 (0.1)	5.4 (0.1)	5.6 (0.1)	5.4 (0.1)	5.5 (0.0)
Alcohol intake (% energy)	7.7 (0.4)	8.6 (0.5)	7.7 (0.6)	7.9 (0.5)	8.0 (0.2)
Overweight (%)	23.1	33.1	30.2	48.7	33.8
Current smoker (%)	51.0	46.7	52.6	40.6	47.4
Desk worker (%)	10.5	11.8	9.4	10.3	10.5
Regular physical activity (%)	35.6	32.7	36.5	36.3	35.3
Women:	n=668	n=712	n=232	n=553	n=2165
Mean (SD) age (years)	54.6 (11.0)	51.2 (11.0)	53.2 (11.0)	50.9 (10.9)	52.4 (11.1)
Height (cm)	153.5 (0.2)	153.9 (0.2)	154.1 (0.3)	154.7 (0.2)	154.0 (0.1)
Weight (kg)	51.6 (0.3)	53.7 (0.3)	53.4 (0.5)	57.5 (0.3)	54.0 (0.2)
Body mass index (kg/m^2)	21.9 (0.1)	22.7 (0.1)	22.5 (0.2)	24.0 (0.1)	22.8 (0.1)
Total energy intake (kcal)	1693 (17)	1812 (17)	1719 (29)	1840 (19)	1773 (10)
Total protein intake (% energy)	15.7 (0.1)	15.2 (0.1)	15.4 (0.2)	15.4 (0.1)	15.4 (0.1)
Total fat intake (% energy)	27.6 (0.2)	27.0 (0.2)	27.5 (0.3)	27.3 (0.2)	27.3 (0.1)
Carbohydrate intake (% energy)	53.9 (0.3)	55.0 (0.3)	54.7 (0.4)	55.0 (0.3)	54.6 (0.1)
Total dietary fibre intake (g/1000 kcal)	6.9 (0.1)	6.7 (0.1)	7.1 (0.1)	6.8 (0.1)	6.8 (0.0)
Alcohol intake (% energy)	1.4 (0.2)	1.4 (0.1)	1.1 (0.3)	1.0 (0.2)	1.3 (0.1)
Overweight (%)	14.0	19.9	19.9	34.3	21.8
Current smoker (%)	10.5	8.5	11.2	10.7	10.0
Desk worker (%)	4.0	5.5	5.8	6.2	5.2
Regular physical activity (%)	39.0	35.5	41.7	38.9	38.1

All values are adjusted for age except for number of overweight, current smoker, desk worker, and engaging in regular physical activity.

Table 2 | Age adjusted and multivariable adjusted odds ratios and 95% confidence intervals for overweight according to eating until full and eating quickly

Variable	Eating until full	Eating quickly
Men (n=1122):	n=571	n=512
No (%) overweight	234 (41.0)	210 (41.0)
Age adjusted odds ratio	2.04 (1.57 to 2.64)	1.85 (1.44 to 2.38)
Multivariable odds ratio*	2.00 (1.53 to 2.62)	1.84 (1.42 to 2.38)
Women (n=2165):	n=1265	n=785
No (%) overweight	324 (25.6)	233 (29.7)
Age adjusted odds ratio	1.93 (1.54 to 2.40)	2.11 (1.71 to 2.60)
Multivariable odds ratio*	1.92 (1.53 to 2.40)	2.09 (1.69 to 2.59)

*Adjusted for age; smoking status; regular physical activity; occupation; intake of total energy, total dietary fibre, and alcohol; and survey area.

Statistical analysis

We calculated age adjusted mean values for participants' characteristics using analysis of covariance and age adjusted proportions by using logistic regression according to the combination of eating until full and eating quickly.

We calculated odds ratios and 95% confidence intervals by using the logistic regression model for age adjusted odds ratios and multivariable adjusted odds ratios. The multivariable adjustment included age (years), total energy intake (kcal/day), total fibre and alcohol intake (g/day), smoking status (non-smoker; former smoker; and 1-20, 21-40, and ≥41 cigarettes consumed daily), occupation (desk worker, service business, manual labour, unemployed), regular physical activity (yes or no), and survey area (Ikawa or Yao).

We also tried to determine whether there was a supra-additive association (additive interaction) between eating until full and eating quickly. The relative excess risk due to interaction is the excess risk as a result of joint exposure. In terms of the model coefficients, the relative excess risk due to interaction is calculated as $\text{exponent}(\beta_1+\beta_2+\beta_3)-\text{exponent}(\beta_1)-\text{exponent}(\beta_2)+1$ where $\beta1$, $\beta2$, and $\beta3$ are the coefficients from the model for specified levels of eating until full and eating quickly, as well as their interaction. Thus, the relative excess risk due to interaction equals the odds ratio(eating until full +eating quickly)−odds ratio(eating until full)−odds ratio(eating quickly)+1. We divided the statistic by the square root of its estimated variance to test the hypothesis that the relative excess risk due to interaction equalled zero with a z test (normal distribution) approximation.[23 24] This increase in excess risk due to interaction of the two categories as a percentage of the increase in risk as a result of joint exposure (relative excess risk due to interaction percentage) is then expressed as (relative excess risk due to interaction/ [odds ratio(eating until full+eating quickly)−1])×100. The percentage relative excess risk due to interaction is defined as the proportion of disease burden caused by two factors that can be attributed to their interaction. We also calculated the attributable proportion due to interaction=relative excess risk due to interaction/odds ratio(eating until full+eating quickly)×100—that is, the proportion of overweight among those both eating until full and eating quickly that is attributable to interaction.

Probability values for statistical tests were two tailed and we regarded $P<0.05$ as statistically significant. We used the SAS statistical package version 9.1 for the analyses.

RESULTS

Table 1 shows the baseline characteristics of the participants. The mean (standard deviation) age of participants was 55.3 (10.7) for men and 52.4 (11.1) for women, with 379 (33.8%) men and 472 (21.8%) women being overweight. Overall, 571 (50.9%) men and 1265 (58.4%) women reported eating until full and 523 (45.6%) men and 785 (36.3%) women reported eating quickly (very fast and fast categories combined). For both sexes the eating until full and eating quickly group had the highest age adjusted mean values for height, weight, body mass index, and total energy intake than did the group with neither of these eating behaviours.

Table 3 | Age adjusted and multivariable adjusted odds ratios and 95% confidence intervals for overweight according to combinations of eating until full and eating quickly

Variable	Not eating until full, not eating quickly	Eating until full, not eating quickly	Not eating until full, eating quickly	Eating until full, eating quickly	RERI (RERI%)*
Men (n=1122):	n=352	n=258	n=199	n=313	
No (%) overweight	84 (23.8)	85 (32.9)	61 (30.7)	149 (47.6)	—
Age adjusted odds ratio	1.00	1.64 (1.14 to 2.35)	1.43 (0.97 to 2.11)	3.17 (2.25 to 4.47)	1.10 (50.7)
Multivariable odds ratio†	1.00	1.61 (1.11 to 2.32)	1.42 (0.96 to 2.11)	3.13 (2.20 to 4.45)	1.10 (51.6)
Women (n=2165):	n=668	n=712	n=232	n=553	
No (%) overweight	100 (15.0)	138 (19.4)	47 (20.3)	186 (33.6)	—
Age adjusted odds ratio	1.00	1.50 (1.13 to 2.00)	1.51 (1.02 to 2.22)	3.23 (2.44 to 4.28)	1.22 (54.9)
Multivariable odds ratio†	1.00	1.48 (1.10 to 1.98)	1.47 (0.99 to 2.17)	3.21 (2.41 to 4.29)	1.27 (57.4)

RERI=relative excess risk due to interaction.
*P<0.05 (z test).
†Adjusted for age; smoking status; regular physical activity; occupation; intake of total energy, total dietary fibre, and alcohol; and survey area.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Eating quickly, independent of total energy intake and other confounders, is associated with overweight

WHAT THIS STUDY ADDS

Both eating quickly and eating until full were associated with being overweight, independent of total energy intake and other confounders

These eating behaviours combined may have a substantial impact on being overweight

The eating until full group had higher age adjusted odds ratios for overweight than the not eating until full group for both men and women. The odds ratios were not changed substantially by further adjustment for intake of total energy, total fibre, and alcohol; smoking status; physical activity; and survey area: 2.00 (95% confidence interval 1.53 to 2.62) for men and 1.92 (1.53 to 2.40) for women. The eating quickly group had higher age adjusted odds ratios for overweight than did the not eating quickly group for both sexes. The multivariable adjusted odds ratios for overweight for the eating quickly group was 1.84 (1.42 to 2.38) for men and 2.09 (1.69 to 2.59) for women (table 2).

The multivariable adjusted odds ratio for overweight for the eating until full and eating quickly group compared with the group with neither of these eating behaviours was 3.13 (2.20 to 4.45) for men and 3.21 (2.41 to 4.29) for women (table 3). On the basis of the multivariable adjusted model, the relative excess risk due to interaction for men was 1.10, indicating an excess burden of being overweight of 51.6% (percentage relative excess risk due to interaction, $P<0.05$) for eating until full and eating quickly, and for women was 1.27, indicating an excess burden of being overweight of 57.4% (percentage relative excess risk due to interaction, $P<0.01$; table 3). The attributable proportion due to interaction was 35.1% for men and 39.6% for women.

DISCUSSION

Eating until full and eating quickly were significantly associated with overweight in Japanese men and women after adjustment for total energy intake and other potential confounding factors. The combination of the two eating behaviours had a supra-additive effect (additive interaction) on being overweight.

Eating quickly is positively associated with body mass index and increased body weight among Japanese[15 16] and Western populations.[12] The questionnaire for evaluation of speed of eating used in the present study was the same as the one used in previous studies,[15 16] and the findings of the present and previous studies showed essentially the same trends. One study examined associations between the speed of eating and body mass index in Japanese women aged 18; the speed of eating (very slow, slow, medium, fast, and very fast) was found to be significantly and positively associated with body mass index.[15] Another study also examined associations between the speed of eating and body mass index but in Japanese men and women aged 35-69 years.[16] Furthermore, the speed of eating was positively associated with the homeostasis model assessment of insulin resistance for middle aged Japanese men and women without diabetes, especially for those who were not obese.[10] Speed of eating was significantly and positively correlated with total energy intake, but the odds ratio for overweight did not change substantially after adjustment for total energy intake and other confounding variables. Therefore the effect of speed of eating may be unrelated to that of total energy intake.

One study investigated whether gorging was associated with overweight or obesity, but the epidemiological evidence was at best weak.[13] Moreover, the present study observed that the combination of eating until full and eating quickly was strongly associated with being overweight.

The strength of our study is that we analysed the association of eating behaviour patterns with overweight using population based data for a large number of participants. The study does, however, have several potential limitations. Firstly, eating patterns were self reported and we did not determine the validity for self reporting of eating until full. The participants who reported eating until full, however, had higher total energy intake than the other participants, including those who reported gorging[5] and binge eating, which supports the validity of the questionnaire.[7] Secondly, we assessed eating behaviours as simplistic dichotomous outcomes. The validity and reproducibility of eating quickly and the reproducibility of eating until full were, however, reasonably good, and these eating behaviours as simplistic dichotomous outcomes were significantly associated with being overweight. Thirdly, we cannot deny the possibility that other potential confounding factors, such as educational history, may have had an effect on the observed associations. Fourthly, the cross sectional nature of the study indicates that the observed association between these eating behaviours and overweight does not necessarily indicate causality. It is unlikely, however, that people who are obese then change their eating habits. A cohort study of firefighters over seven years showed that eating quickly was associated with weight gain.[12]

In conclusion, eating until full and eating quickly were associated with being overweight in Japanese men and women, and the combination of the two eating behaviours may have a substantial impact on being overweight. As it is difficult to estimate these causal effects in a cross sectional study, prospective cohort and intervention studies will be needed to validate these associations between eating behaviour patterns and being overweight.

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Contributors: KM analysed and interpreted the data, drafted the manuscript, and provided statistical expertise. YK, SN, MK, and SS acquired the data and critically revised the manuscript. SS, TO, KM, HN, AK, MK, TO, HI, MN, YI, and HI conceived and designed the study, acquired and interpreted the data, and critically revised the manuscript. HI is guarantor for the paper.

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Original Article

Body Fat Distribution and the Risk of Hypertension and Diabetes among Japanese Men and Women

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To identify anthropometrical indices of body fat distribution for predicting the risk of hypertension and diabetes, a population-based prospective study was designed. Subjects in two communities (*n*=2,422 and 3,195), who were free of hypertension and diabetes, respectively, were followed-up. The area and gender-specific risk of hypertension and diabetes were compared among tertiles of body mass index (BMI) and body fat distribution, including waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), and subscapular skinfold-thickness (SSF). During the 10-year follow-up for hypertension and diabetes, the incident cases of hypertension were 72 for Yao men, 125 for Kyowa men, 160 for Yao women and 193 for Kyowa women and those of diabetes were 27, 64, 37 and 77, respectively. One SD differences in BMI and WC were associated with 1.2 to1.6-fold higher risk of hypertension, and that of SSF was associated with 1.4 to 1.6-fold higher risk of diabetes for both men and women in Yao and for women, but not men, in Kyowa. One SD differences of BMI, WC and WHtR were also associated with 1.4 to 2.0-fold higher risk of diabetes for Yao and Kyowa women. In conclusion, the significant predictors for hypertension were BMI and WC and those for diabetes were BMI and SSF in both genders in both communities, except for men in Kyowa. WC and WHtR were also predictors for diabetes in women but not in men. (*Hypertens Res* 2008; 31: 851–857)

***Key Words*: hypertension, diabetes, body mass index, waist circumference, waist-to-height ratio**

Introduction

Cardiovascular disease mortality has been reported as the top-3 cause of deaths in Japan since 1958 (*1*). It is well known that the prevention and control of hypertension and diabetes could substantially reduce the risk of cardiovascular disease (*2*). Thus, it is important from the view of public health and clinical practice to find a simple and valid measurement to predict the risk of hypertension and diabetes. At present, cross-sectional studies have shown that waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) and

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body mass index (BMI) are associated with the prevalence of hypertension and diabetes (*3–12*). However, the results have not been consistent between genders and among various ethnic groups (*3–12*). In Japan, cross-sectional studies have shown that WHtR was a stronger correlate for these cardiovascular risk factors than BMI and WC (*3, 4*). A recent prospective study in the United States has reported that WC is a better predictor for the risk of diabetes than WHR and BMI (*13*). However, no prospective study has been undertaken to study systematically the association of WC, WHR, WHtR and subscapular skinfold thickness (SSF) with hypertension and diabetes in Asian populations.

To obtain better measures for the prediction of the risk of hypertension and diabetes for men and women in Asian communities, we examined gender and population-specific relationships between anthropometric measurements (BMI, WC, WHR, WHtR, SSF), and the risk of hypertension and diabetes in two populations in Japan.

Methods

Study Populations

The surveyed population included residents in two communities (aged 40–69 years) who participated in cardiovascular risk surveys between 1988 and 1993 in Minami-Takayasu, a southwest urban suburb, a district of Yao City of Osaka Prefecture, or between 1990 and 1993 in Kyowa, a rural community of Ibaraki Prefecture. After exclusion of persons with hypertension (n=1,314) or diabetes (n=314), and 353 persons who did not undergo anthropometric measurements at baseline, a total of 3,214 study subjects (Kyowa: 549 men and 992 women; Yao: 585 men and 1,088 women) and 4,214 study subjects (Kyowa: 763 men and 1,374 women; Yao: 700 men and 1,377 women) who were free of hypertension and diabetes at baseline, respectively, were followed. These subjects were followed between 1997 and 2001. The follow-up rate was 75.4% (n=2,422) for hypertension and 75.6% (n=3,195) for diabetes. The average follow-up period was 10.4 years (10.0 years for men and 10.6 years for women) for hypertension and 10.4 years (10.1 years for men and 10.6 years for women) for diabetes. The study protocol was approved by the Human Ethics Review Committee of the University of Tsukuba.

Measurement

Height in stocking feet and weight in light clothing were measured. BMI was calculated as weight (kg) divided by the square of the height (m^2). Subscapular skinfold thickness was measured to the nearest mm using keys calipers by trained physician epidemiologists with standard methods. Trained observers also measured WC and hip circumference in subjects in a standing position and breathing normally at the level of the umbilicus and at the symphysis pubis at the maximum protrusion of the hips, respectively, to the nearest 1 cm using a tape measure. These measurements were used to calculate WHR and WHtR.

Blood pressures were measured by trained technicians and/or physician epidemiologists with standardized methods, using mercury sphygmomanometers on the right arm of seated participants after at least 5 min of rest. Blood pressure was measured twice for the subjects with systolic blood pressure (SBP) of ≥140 mmHg, and/or diastolic blood pressure (DBP) of ≥90 mmHg. Hypertension was defined as SBP of ≥160 mmHg and/or DBP of ≥95 mmHg and/or current treatment with antihypertensive medication at the baseline and annual follow-up surveys.

Blood was drawn from seated participants into a plain, siliconized glass tube, and serum was separated. Serum glucose was measured by the hexokinase method. Diabetes was defined as a fasting glucose level of ≥126 mg/dL and/or a non-fasting glucose level of ≥200 mg/dL and/or use of medication for diabetes at the baseline and annual follow-up surveys.

An interview was conducted to ascertain the alcohol intake per day, the number of cigarettes smoked per day, use of medication for diabetes mellitus and hypertension, and past history of stroke and coronary heart disease. Persons who smoked ≥1 cigarette per day were defined as current smokers, and those who had not smoked for ≥3 months were defined as ex-smokers.

Statistical Analysis

The gender and population-specific area and gender-specific risks of hypertension and diabetes were compared among tertiles of BMI and body fat distribution including measurements of WC, WHtR, WHR and SSF. The odds ratio (OR) of hypertension and diabetes and their respective 95% confidence intervals (95% CI) were calculated with reference to the first tertile of each of these measurements, using the logistic regression model. We adjusted for age, alcohol intake (for men: never, former, current <23, 23–45, ≥46 g/d ethanol; for women: non-drinker and current drinker), and smoking status (for men: never, former, current 1–19, ≥20 cigarettes per day; for women: non-smoker and current smoker). Furthermore, we also adjusted baseline SBP for hypertension analysis and baseline glucose level and fasting status (yes or no) for diabetes analysis. The increased risks of hypertension and diabetes associated with a 1 SD difference of BMI and body fat distribution measurements were examined by using the logistic regression model, adjusted for age and other confounding variables. All statistical analyses were conducted using SAS, version 8.0 (SAS Japan Inc., Tokyo, Japan), and the statistical testing was two-tailed.

Results

During the average 10.4-year follow-up, we documented 550

Table 1. Gender and Population–Specific Means±SD and Proportions of Risk Characteristics and Anthropometric Measures among the Japanese Men and Women in Two Communities for Examining the Risk of Hypertension

	Men		Women	
	Yao	Kyowa	Yao	Kyowa
n	389	519	911	971
Age	56±6	56±9	56±7‡	54±9
Alcohol intake, g/d	32±20	32±22	9±9	9±11
Smoking, %	45	52	7†	4
Systolic blood pressure, mmHg	117±12‡	128±12	111±13‡	125±13
Diastolic blood pressure, mmHg	73±8‡	77±8	69±8‡	74±9
Glucose, mmol/L	6.27±1.49‡	6.97±2.27	5.91±1.09‡	6.26±1.61
Body mass index, kg/m^2	22.8±2.6†	23.2±2.7	22.6±2.8‡	23.3±2.9
Waist circumference, cm	82.7±7.6	82.9±8.0	81.6±8.9‡	79.9±9.0
Waist-to-height ratio	0.50±0.05*	0.51±0.05	0.54±0.06	0.53±0.06
Waist-to-hip ratio	0.92±0.05	0.91±0.06	0.91±0.07‡	0.87±0.07
Subscapular skinfold thickness, mm	14.4±5.8	14.6±5.6	18.2±6.6‡	21.5±7.8

Data are means±SD. Differences from the rural population: $^{*}p<0.05$, $^{\dagger}p<0.01$, $^{\ddagger}p<0.0001$.

incident cases of hypertension (2.2%) and 205 incident cases of diabetes (0.6%).

Table 1 shows the gender- and population-specific means±SD and proportions of risk characteristics and anthropometric parameters in the subjects for examining risk of hypertension. The mean levels of SBP, DBP and glucose were higher in the Kyowa than in the Yao population for both genders. The proportion of current smokers was higher among Kyowa men than Yao men, while the opposite trend was observed for women. There was no difference in mean alcohol intake between the two populations for either gender. The mean BMI was higher in the Kyowa population than the Yao population for both genders. The mean value of WHtR for Kyowa men was higher than that for Yao men. The mean values of WC and WHR were lower among Kyowa women than Yao women, while the mean SSF was higher among Kyowa women than Yao women. Similar trends were observed for the risk of diabetes (data not shown).

The incidence of hypertension was 72 for Yao men (2.2%), 125 for Kyowa men (2.8%), 160 for Yao women (2.0%) and 193 for Kyowa women (2.1%) (Table 2). For Yao men, the multivariable OR of hypertension for the highest *vs.* lowest tertiles of anthropometric measures was statistically significant for BMI (OR [95% CI]=2.28 [1.12–4.65], p=0.02), and marginally significant for WC (OR [95% CI]=1.88 [0.90–3.92], p=0.09). One SD differences of BMI, WC, WHtR, WHR and SSF were significantly associated with 1.3 to 1.6-fold higher risk of hypertension. The multivariable OR of hypertension in the highest *vs.* lowest tertiles of anthropometric measures and those associated with 1 SD difference of anthropometric measures were not statistically significant for Kyowa men. For Yao women, the multivariate OR for the highest *vs.* lowest tertiles of anthropometric measures was statistically significant for BMI (OR [95% CI]=1.68 [1.05–2.68], p=0.03) and marginally significant for WC (OR [95% CI]=1.60 [0.98–2.62], p=0.06). One SD differences of BMI and WC were marginally significantly or significantly associated with 1.2-fold higher risk of hypertension. For Kyowa women, the risk of hypertension increased with higher tertiles in most of the anthropometric parameters: the multivariable OR of hypertension in the highest *vs.* lowest tertiles of anthropometric measures was statistically significant for BMI (OR [95% CI]=1.81 [1.16–2.84], p=0.001), WHtR (OR [95% CI]=1.59 [1.05–2.39], p=0.03), and SSF (OR [95% CI]=1.60 [1.04–2.46], p=0.03), and marginally significant for WC (OR [95% CI]=1.45 [0.96–2.19], p=0.08), and WHR (OR [95% CI]=1.48 [0.96–2.30)], p=0.08). One SD differences of BMI, WC, WHtR, and SSF were significantly associated with 1.2 to 1.3-fold higher risk of hypertension.

The risk of hypertension for subjects with BMI ≥27.0 kg/m^2 compared to those with BMI<22.0 kg/m^2 was examined; the multivariate OR (95% CI) was 2.83 (0.96–8.31; p=0.06) for Yao men, 2.32 (1.14–4.73; p=0.02) for Yao women and 2.42 (1.33–4.40; p=0.004) for Kyowa women, but no significant association was observed for Kyowa men (data not shown).

The incidence of diabetes was 27 for Yao men (0.7%), 64 for Kyowa men (1.0%), 37 for Yao women (0.4%) and 77 for Kyowa women (0.6%) (Table 3). For Yao men, the multivariable OR of diabetes for the highest *vs.* lowest tertiles of anthropometric measures was significant for BMI (OR [95% CI]=3.24 [1.08–9.71], p=0.04), but not for the other anthropometric measures. One SD difference of SSF was marginally significantly associated with 1.4-fold higher risk of diabetes. The multivariable OR of diabetes in highest *vs.* lowest tertiles of anthropometric measures and those associated with 1 SD difference of anthropometric measures was not statistically significant for Kyowa men. However, for Kyowa women, the multivariable OR of diabetes for the highest *vs.* lowest tertiles of anthropometric measures was statistically

Table 2. Multivariable-Adjusted Odds Ratio for Hypertension According to Anthropometric Measures among Japanese Men and Women in Two Communities

	Men							
	Yao				Kyowa			
	No. of case (n=72)	No. at risk (n=325)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD	No. of case (n=125)	No. at risk (n=452)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD
BMI								
T1 (15.3–22.0)	22	114	1.00		38	145	1.00	
T2 (22.0–24.1)	20	114	0.89 (0.43–1.85)	1.52 (1.12–2.05)‡	29	145	0.67 (0.37–1.22)	1.10 (0.88–1.37)
T3 (24.1–33.2)	30	97	2.28 (1.12–4.65)†		58	162	1.33 (0.78–2.28)	
Waist circumference								
T1 (60–79)	16	93	1.00		33	147	1.00	
T2 (80–86)	26	122	1.33 (0.63–2.81)	1.56 (1.14–2.14)‡	44	159	1.21 (0.69–2.11)	1.04 (0.83–1.29)
T3 (87–111)	30	110	1.88 (0.90–3.92)*		48	146	1.44 (0.82–2.53)	
Waist-to-height ratio								
T1 (0.38–0.49)	19	101	1.00		36	169	1.00	
T2 (0.49–0.53)	28	137	1.01 (0.50–2.03)	1.56 (1.11–2.19)†	34	111	1.51 (0.83–2.73)	1.09 (0.86–1.39)
T3 (0.53–0.66)	25	87	1.76 (0.84–3.70)		55	172	1.50 (0.89–2.55)	
Waist-to-hip ratio								
T1 (0.75–0.89)	21	98	1.00		37	161	1.00	
T2 (0.89–0.94)	23	118	0.91 (0.45–1.86)	1.38 (1.04–1.84)†	50	147	1.44 (0.83–2.50)	0.90 (0.73–1.10)
T3 (0.94–1.09)	28	109	1.22 (0.61–2.43)		38	144	1.04 (0.59–1.83)	
Subscapular skinfold thickness								
T1 (5.0–11.0)	22	102	1.00		35	145	1.00	
T2 (12.0–16.0)	25	129	0.97 (0.48–1.97)	1.34 (1.02–1.77)†	43	161	1.14 (0.65–2.00)	1.13 (0.90–1.42)
T3 (17.0–45.0)	25	94	1.40 (0.67–2.91)		47	146	1.51 (0.85–2.68)	

	Womem							
	Yao				Kyowa			
	No. of case (n=160)	No. at risk (n=772)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD	No. of case (n=193)	No. at risk (n=873)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD
BMI								
T1 (15.2–21.5)	46	298	1.00		37	250	1.00	
T2 (21.5–24.0)	55	248	1.64 (1.02–2.61)†	1.20 (0.99–1.45)*	59	301	1.16 (0.72–1.87)	1.29 (1.09–1.54)‡
T3 (24.0–36.8)	59	226	1.68 (1.05–2.68)†		97	322	1.81 (1.16–2.84)‡	
Waist circumference								
T1 (57–76)	32	225	1.00		60	357	1.00	
T2 (77–84)	51	257	1.28 (0.77–2.15)	1.21 (1.00–1.47)†	57	248	1.25 (0.81–1.92)	1.23 (1.03–1.47)†
T3 (85–110)	77	290	1.60 (0.98–2.62)*		76	268	1.45 (0.96–2.19)*	
Waist-to-height ratio								
T1 (0.38–0.50)	35	228	1.00		58	351	1.00	
T2 (0.50–0.56)	56	281	1.16 (0.71–1.91)	1.14 (0.94–1.38)	42	222	0.96 (0.60–1.53)	1.28 (1.08–1.53)‡
T3 (0.56–0.75)	69	263	1.40 (0.86–2.29)		93	300	1.59 (1.05–2.39)†	
Waist-to-hip ratio								
T1 (0.68–0.85)	29	182	1.00		66	368	1.00	
T2 (0.85–0.92)	44	256	1.04 (0.61–1.80)	1.11 (0.92–1.32)	66	299	1.12 (0.75–1.69)	1.16 (0.97–1.39)
T3 (0.92–1.15)	87	334	1.40 (0.84–2.31)		61	206	1.48 (0.96–2.30)*	
Subscapular skinfold thickness								
T1 (5.0–16.0)	60	337	1.00		42	245	1.00	
T2 (17.0–22.0)	54	257	1.05 (0.68–1.63)	1.16 (0.94–1.42)	43	267	0.73 (0.44–1.20)	1.27 (1.08–1.49)‡
T3 (23.0–60.0)	46	178	1.34 (0.83–2.15)		108	361	1.60 (1.04–2.46)†	

*$p<0.1$, †$p<0.05$, ‡$p<0.01$. OR, odds ratio; 95% CI, 95% confidence interval. Multivariate-adjusted: age (years), baseline systolic blood pressure levels (mmHg), alcohol intake (never, former, current <23, 23–45, ≥46 g/d ethanol for men; non-drinker and current-drinker for women) and smoking status (never, former, current 1–19 and ≥20 cigarettes per day for men; non-smoker and current smoker for women).

Table 3. Multivariable-Adjusted Odds Ratio for Diabetes According to Anthropometric Measures among Japanese Men and Women in Two Communities

	Men							
	Yao				Kyowa			
	No. of case (n=27)	No. at risk (n=392)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD	No. of case (n=64)	No.at risk (n=628)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD
BMI								
T1 (15.3–22.3)	6	137	1.00		23	205	1.00	
T2 (22.3–24.4)	7	140	1.16 (0.35–3.82)	1.33 (0.90–1.97)	16	197	0.74 (0.36–1.51)	1.08 (0.82–1.43)
T3 (24.4–34.5)	14	115	3.24 (1.08–9.71)†		25	226	1.22 (0.63–2.34)	
Waist circumference								
T1 (60–80)	5	129	1.00		16	215	1.00	
T2 (81–87)	11	139	2.65 (0.81–8.65)	1.39 (0.90–2.13)	22	216	1.56 (0.76–3.22)	1.15 (0.87–1.51)
T3 (88–112)	11	124	2.10 (0.65–6.79)		26	197	1.71 (0.85–3.42)	
Waist-to-height ratio								
T1 (0.38–0.49)	4	130	1.00		17	209	1.00	
T2 (0.49–0.54)	13	150	3.56 (1.01–12.56)†	1.27 (0.81–2.00)	20	191	1.22 (0.59–2.54)	1.12 (0.83–1.50)
T3 (0.54–0.67)	10	112	3.09 (0.84–11.44)*		27	228	1.30 (0.66–2.56)	
Waist-to-hip ratio								
T1 (0.71–0.90)	7	131	1.00		16	202	1.00	
T2 (0.90–0.94)	8	137	1.01 (0.33–3.10)	1.19 (0.78–1.82)	22	213	1.22 (0.59–2.51)	1.04 (0.82–1.34)
T3 (0.94–1.09)	12	124	1.70 (0.61–4.73)		26	213	1.34 (0.66–2.70)	
Subscapular skinfold thickness								
T1 (5.0–11.0)	4	114	1.00		18	181	1.00	
T2 (12.0–16.0)	12	156	2.81 (0.82–9.67)	1.35 (0.95–1.93)*	24	220	1.19 (0.59–2.40)	1.10 (0.83–1.46)
T3 (17.0–40.0)	11	122	3.01 (0.84–10.77)*		22	227	1.13 (0.55–2.32)	

	Women							
	Yao				Kyowa			
	No. of case (n=37)	No. at risk (n=970)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD	No. of case (n=77)	No. at risk (n=1,205)	Multivariable OR (95% CI)	OR (95% CI) changed per 1 SD
BMI								
T1 (15.2–21.8)	8	386	1.00		17	339	1.00	
T2 (21.9–24.4)	10	317	1.44 (0.54–3.81)	2.00 (1.48–2.70)‡	16	406	0.81 (0.39–1.68)	1.53 (1.21–1.93)‡
T3 (24.4–36.8)	19	267	3.34 (1.40–7.95)‡		44	460	1.64 (0.89–3.03)	
Waist circumference								
T1 (57–77)	8	302	1.00		15	454	1.00	
T2 (78–85)	11	322	1.32 (0.51–3.42)	1.67 (1.19–2.35)‡	21	354	1.58 (0.78–3.19)	1.68 (1.31–2.16)‡
T3 (86–120)	18	346	2.07 (0.85–5.06)		41	397	2.83 (1.49–5.39)‡	
Waist-to-height ratio								
T1 (0.38–0.51)	11	307	1.00		16	406	1.00	
T2 (0.51–0.57)	11	358	0.82 (0.34–1.97)	1.59 (1.14–2.22)‡	16	376	0.96 (0.46–2.01)	1.46 (1.16–1.84)‡
T3 (0.57–0.81)	15	305	1.39 (0.59–3.28)		45	423	2.26 (1.19–4.29)†	
Waist-to-hip ratio								
T1 (0.68–0.86)	7	246	1.00		14	449	1.00	
T2 (0.86–0.93)	14	321	1.43 (0.55–3.69)	1.26 (0.89–1.78)	25	414	1.90 (0.95–3.90)*	1.56 (1.21–2.02)‡
T3 (0.93–1.15)	16	403	1.46 (0.56–3.82)		38	342	3.21 (1.63–6.30)‡	
Subscapular skinfold thickness								
T1 (5.0–16.0)	6	399	1.00		13	316	1.00	
T2 (17.0–23.0)	17	351	3.10 (1.19–8.09)†	1.61 (1.15–2.27)‡	23	391	1.44 (0.69–2.98)	1.38 (1.10–1.73)‡
T3 (24.0–60.0)	14	220	3.58 (1.33–9.64)†		41	498	2.06 (1.05–4.04)†	

*$p<0.1$, †$p<0.05$, ‡$p<0.01$. OR, odds ratio; 95% CI, 95% confidence interval. Multivariate-adjusted: age (years), baseline glucose levels (mmol/L), fasting status (yes or no), alcohol intake (never, former, current <23, 23–45, ≥46 g/d ethanol for men; non-drinker and current-drinker for women) and smoking status (never, former, current 1–19 and ≥20 cigarettes per day for men; non-smoker and current smoker for women).