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Integration of Data from NIPPON DATA80/90 and National Nutrition Survey in Japan: For Cohort Studies of Representative Japanese on Nutrition

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ABSTRACT

Background: Diet is one of the most important lifestyle factors that a affect healthy life expectancy through onset of various lifestyle-related diseases. Large-scale cohort studies with sufficient baseline nutritional information are scarce. NIPPON DATA80/90 is cohort study of representative Japanese population, and the cohorts also participated in the National Nutrition Survey in Japan (NNSJ) at the baseline. The corresponding datasets could be combined.
Methods: Individual records of NIPPON DATA and NNSJ were compared and integrated. Intakes of nutrients and food groups for individual participants were calculated by distributing intakes in the each household in NNSJ, considering age and sex of the individuals. The results from an international cooperative epidemiological study (INTERMAP) were utilized to estimate intakes of 75 nutrients for NNSJ80 and 70 nutrients for NNSJ90. Nutrient intakes calculated utilizing INTERMAP data were compared with those in the NNSJ datasets.
Results: NIPPON DATA80/90 datasets were enhanced with detailed baseline nutrient intake data (the numbers of participants combined were 10422 and 8342 for NIPPON DATA80 and 90, respectively). The mean nutrient intakes calculated through utilizing INTEMRAP data and those calculated from the NNSJ datasets were similar, and the calculated values were strongly correlated with those calculated from NNSJ datasets (Pearson's correlation coefficients greater than 0.8 [$P < 0.001$]). Detailed nutrient intakes (eg, cholesterol, fatty acids, amino acids, and dietary fiber) were complemented.
Conclusions: The nutrient intakes calculated from NNSJ datasets for the participants of NIPPON DATA are appropriate as the baseline nutrient intake data. The enhanced cohort datasets are suitable for investigations of baseline dietary habits and the consequent health status.

Key words: nutrition; epidemiology; Japan

INTRODUCTION

Diet is one of the most important factors that affects a healthy life expectancy through its association with the onset of cardiovascular diseases (CVD) and other lifestyle-related diseases.[1,2] The National Integrated Project for Prospective Observation of Non-communicable Disease And its Trends in Aged (NIPPON DATA) is a set of cohort studies of representative Japanese; the baseline cohorts were the participants of the 3rd and 4th National Survey on Circulatory Disorders, Japan (NSCD), conducted in 1980 and 1990, respectively.[3] The effects of CVD risk factors on mortality and impaired activities of daily living in Japan have been investigated through this project.[4,5] Several dietary factors are known to be associated with CVD risk factors,[6,7] and it is necessary to clarify the associations between dietary factors and CVD risk for the prevention of CVD by adopting favorable dietary habits.

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The NIPPON DATA80 and 90 cohorts were also participants in the National Nutrition Survey in Japan (NNSJ) conducted in the same year as the NIPPON DATA baseline survey (the 3rd and 4th NSCD), in which weighing record method was employed and nutrient intakes were calculated for each household. In this study, we estimated nutrient intakes of each household member of NNSJ by proportional distribution method, and combined NIPPON DATA datasets with corresponding NNSJ datasets to produce integrated cohort datasets with baseline nutrient intake data.

Intakes of limited nutrients were calculated and published for NNSJ80 and 90[8,9]; however, more nutrients, ie, dietary cholesterol, n-3 polyunsaturated fatty acids, potassium, etc. are known to have effects on CVDs,[10,11] so it is desirable to add them to the nutrient data. We supplemented nutrient intakes relevant to the CVD risk or CVD risk factors applying the INTERMAP Food Table in Japan, an integrated food database developed for an international cooperative epidemiological study.[12–15] With these integrated cohort datasets including detailed dietary variables, dietary features promoting healthy life expectancy can be investigated.

In this paper, we describe the methods by which we estimated individual nutrient intakes for NNSJ datasets, combined NIPPON DATA and NNSJ datasets, and supplemented them with nutrient data necessary to investigate the dietary effects on CVD.

METHOD

NIPPON DATA80, 90

NIPPON DATA80/90 are follow-up studies of mortality from CVD and activities of daily living in representative Japanese men and women aged 30 years and older, and the complete details of the study population have been described elsewhere.[16,17] Participants in NIPPON DATA80 and 90 were those persons surveyed for the 3rd and 4th NSCD, conducted in 1980 and 1990, respectively. They were the residents of 300 randomly selected districts throughout Japan. The surveys consisted of history-taking, physical examinations, blood tests, and a self-administered questionnaire on the lifestyle, including dietary habits using the food-frequency method. The numbers of follow-up participants were 10 546 for NIPPON DATA80, and 8383 for NIPPON DATA90. A follow-up survey was conducted first in 1994 for NIPPON DATA80, and in 1995 for NIPPON DATA90. Follow-ups have subsequently been conducted every 5 years, and the vital status, causes of death, and activities of daily living have been surveyed.

National Nutrition Survey in Japan

National Nutrition Survey in Japan (NNSJ) has been conducted involving households in randomly selected survey areas throughout Japan every year since 1948, and the details of the survey have been described elsewhere.[18,19] In the decennial NSCD years, NNSJ has been conducted employing the same participants as the NSCD. Three hundred areas throughout Japan were randomly selected in 1980 and 1990. All residents in the areas: 6400 households in 1980 and 6000 households in 1990, were the participants of the survey.

A dietary survey was carried out employing the weighing record method for three consecutive days in each household. Trained dietitians visited participants, and they were asked to weigh and record all foods and beverages that any of the household members consumed during the survey period. Dietitians visited participants' homes at least once a day and confirmed the records during the survey.

Dietary records were coded using the Standard Tables for Foods in Japan, 3rd edition[8] for NNSJ80 and 4th edition[9] for NNSJ90, and intakes of nutrients and food groups were calculated for every household. The dietary records did not include information on the portion of each food that each household member actually ate. Nutrient intakes per person were calculated as intakes per household simply divided by the number of household members, and the values were used for analysis and tabulated for annual reports for NNSJ.[8,9]

Since NNSJ conducted in 1995, information on food consumption of individual households was collected and used to estimate nutrient intakes of individual household members.[20,21] Averaged nutrient and food group intakes by sex and age group have been published since then.

We obtained NNSJ80 and NNSJ90 datasets from the Ministry of Health, Labour, and Welfare, which included nutrient and food group intakes per household, and the anthropometrics of individual household members. The NNSJ90 dataset included some nutrients that were not published in the annual report, eg vegetable protein, phosphorus, potassium, cholesterol, etc. (Table 1).

Estimation of nutrient intakes of individuals by calculating proportional distribution, and integration of NIPPON DATA and NNSJ datasets

We estimated the nutrient intakes of each household member by dividing the household intake data of NNS80 and 90 using average intakes by sex and age groups calculated for NNSJ95. The average intakes in NNSJ95 were calculated by a combined method using household-based food-weighing records and an approximation of the proportions of each dish or food shared in the household.[21] An example of proportional distribution calculation for total energy intake is summarized in Figure 1. Other nutrient and food group intakes of individuals were calculated in the same manner.

For nutrients used as energy sources, densities were calculated as %kcal in both proportionally distributed and simple averaged densities. For other nutrient and food group intakes, densities were calculated as g/1000 kcal, mg/1000 kcal, etc. Simple averaged densities of intakes for nutrients and food groups were also estimated by dividing the intakes of the household by the total energy intake.

Table 1. Nutrient compositions calculated as representatives of food groups in the National Nutrition Survey in Japan using INTERMAP Food Table Japan and INTERMAP Japan recall data

	Unit	Publication in NNSJ80	Publication in NNSJ90	Source for integrated NIPPON DATA80	Source for integrated NIPPON DATA90
Total energy	kcal/100 g	Y[a]	Y	NNSJ[d]	NNSJ
Total protein	g/100 g	Y	Y	NNSJ	NNSJ
Animal protein	g/100 g	N[b]	Y	RCF[e]	RCF
Vegetable protein	g/100 g	N	C[c]	RCF	RCF
Amino acids (18 items)	mg/100 g	N	N	RCF	RCF
Total fat	g/100 g	Y	Y	NNSJ	NNSJ
Cholesterol	mg/100 g	N	C	RCF	RCF
Saturated fatty acid	g/100 g	N	C	RCF	RCF
Polyunsatudated fatty acid	g/100 g	N	C	RCF	RCF
Monounsaturated fatty acid	g/100 g	N	C	RCF	RCF
Fatty acids (42 items)	mg/100 g	N	N	RCF	RCF
Total carbohydrate	g/100 g	Y	Y	NNSJ	NNSJ
Starch	g/100 g	N	N	RCF	RCF
Sucrose	g/100 g	N	N	RCF	RCF
Avairable carbohydrate	g/100 g	N	N	RCF	RCF
Total dietary fiber	g/100 g	N	C	RCF	RCF
Phosphorus	mg/100 g	N	C	RCF	NNSJ
Calcium	mg/100 g	Y	Y	NNSJ	NNSJ
Iron	mg/100 g	Y	Y	NNSJ	NNSJ
Potassium	mg/100 g	N	C	RCF	NNSJ
Sodium	mg/100 g	Y	Y	NNSJ	NNSJ
Magnesium	mg/100 g	N	C	RCF	NNSJ
Vitamin A	IU/100 g	N	C	NNSJ	NNSJ
Vitamin B1	mg/100 g	Y	Y	NNSJ	NNSJ
Vitamin B2	mg/100 g	Y	Y	NNSJ	NNSJ
Vitamin C	mg/100 g	Y	Y	NNSJ	NNSJ
Vitamin E	mg/100 g	N	C	RCF	NNSJ
Niacin	mg/100 g	N	C	RCF	NNSJ

[a]Y: data published in NNSJ annual report.
[b]N: data not published in NNSJ annual report.
[c]C: calculated data included in NNSJ dataset but not publised in the annual report.
[d]NNSJ: National Nutrition Survey for Japan.
[e]RCF: Representative compositions for food groups.

Individual records in corresponding NIPPON DATA and NNSJ datasets were compared based on the area code, household code, age, sex, height, and weight. Individuals in NIPPON DATA and NNSJ were combined if they were identified as the same person.

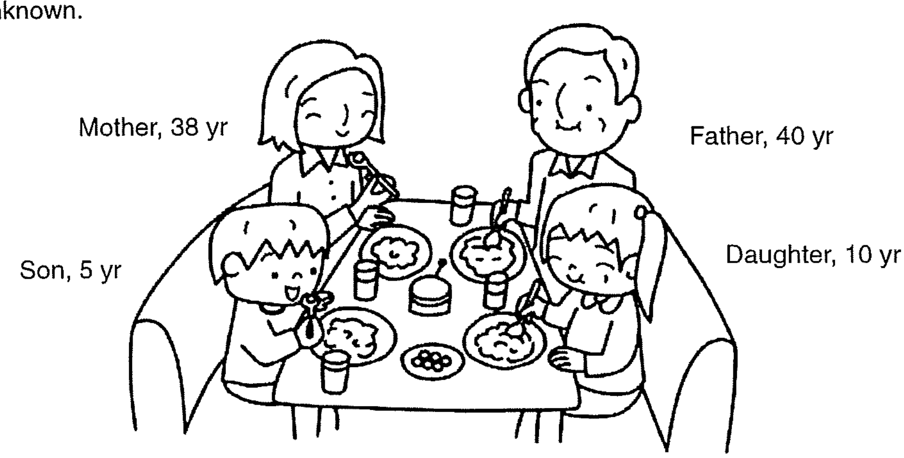
Enhancement of nutrients using INTERMAP food database

Intakes of energy, macronutrients, and other nutrients (calcium, sodium, iron, and vitamins A, B1, B2, and C) were calculated and published in the annual reports of NNSJ80 and 90.[8,9,18] We included other nutrients known to have effects on CVD risk factors by utilizing food group intakes data per household in NNSJ80 and 90 datasets, the INTERMAP Food Table, and INTERMAP Japan dietary survey data. These nutrients are shown as those calculated using RCF (representative compositions for food groups, described below) in Table 1.

INTERMAP (the International Study of Macro- and Micronutrients and Blood Pressure) is an international cooperative epidemiological study, and the participants were men and women ages 40 to 59 from 17 centers in four countries (Japan, China, UK, and US). Details of the study have been described elsewhere.[12,14] Dietary data were obtained through four times of 24-hr dietary recalls conducted for each participant with internationally standardized quality control procedures. We used dietary recall data for participants of the INTERMAP Japan survey to calculate representative food consumption patterns in Japan.

The INTERMAP Japan survey was conducted from 1996 to 1998, and the participants were 1145 men and women ages 40 to 59, randomly selected in four research centers in Japan (299 from Sapporo, 297 from Toyama, 258 from Aito, and 288 from Wakayama). A total of 277 638 food intakes were recorded for the 4580 dietary recalls, and these foods were coded using the INTERMAP Food Table, an integrated food database based on Standard Tables for Japanese Food, 4th edition.[13,22] The INTERMAP Food Table consists of 2931 foods, and all foods are enhanced with a detailed nutrient composition not fully tabulated in the Standard Tables for Japanese Food, 4th edition, ie, cholesterol, fatty acids (42 items including trans fatty acids), amino acids (18 items), dietary fiber, magnesium, zinc, copper, selenium, retinol, sucrose, starch, and available carbohydrate.[13]

A. A family enrolled in the NNSJ80/90 and the total energy intake of this family was calculated as 9,000 kcal/day in the survey: distribution of each family member unknown.



B. Average intakes by sex and age classes were calculated for NNSJ95. Total energy intake for a family of similar structure is calculated as 7,793 kcal/day, and the percentages of each family member to the total were calculated.

Family member (age)	Corresponding group and it's average intake in NNSJ95			Percentage to the total family
	Sex	Age class	Total energy (kcal/day)	
Father (40)	Male	40 to 49	2,370	30.4
Mother (38)	Female	30 to 39	1,895	24.3
Daughter (10)	Female	7 to 14	2,165	27.8
Son (5)	Male	1 to 6	1,363	17.5
Total family			7,793	100

C. Total energy intake of each family member enrolled in NNSJ80/90 was calculated using proportional distribution based on percentage to the total family.

← 9,000kcal/day →			
← 30.4% →	← 24.3% →	← 27.8% →	← 17.5% →
Father 2,737 kcal/day	Mother 2,189 kcal/day	Daughter 2,500kcal/day	Son 1,574 kcal/day

Figure 1. Calculation of nutrient intakes of individual household members based on the total intake of the household by proportional distribution (an example using total energy)

We calculated a representative nutrient composition for food groups (RCF) used in NNSJ using INTERMAP recall data as an average food consumption pattern of the Japanese population. Namely, foods recorded in the INTERMAP dietary recalls were assigned to any of the 89 (NNSJ80) or 85 (NNSJ90) food groups, proportions of foods making up each food group were calculated, and RCF for NNSJ80 and 90 were calculated as the weighted mean of constituent foods.

Nutrient intakes for households were calculated using food group intakes in NNSJ and RCF. Nutrient intakes for individual household members were calculated by proportional distribution using average intakes by age and sex class in NNSJ95, as mentioned above (Figure 1).[20]

Means of nutrient intakes of individuals calculated by the proportional distribution from the original NNSJ dataset and re-calculation using RCF were compared using *t*-tests. Correlations between nutrient intakes of individuals calculated from NNSJ datasets and those estimated using RCF were examined using Pearson's correlations coefficient. The significance level was set at 0.05. All analyses were performed using SPSS for Windows 15.00 (SPSS Inc., Chicago, IL, USA).

Table 2. Comparison of nutrient intakes of individuals calculated by proportional distribution from (a) NNSJ80 dataset and (b) calculated values using representative compositions for food groups (RCF). Follow-up participants for NIPPON DATA80, 10422 men and women, aged 30 years and over, 1980, Japan

	NNSJ80		RCF80		% difference of (b) from (a)
	Mean (a)	(SD)	Mean (b)	(SD)	
Total energy (kcal/day)	2137	(506)	2156	(510)	+0.9
Total protein (%kcal)	15.3	(2.1)	16.0	(2.1)	+4.5
Total fat (%kcal)	21.0	(5.6)	21.7	(5.1)	+3.5
Carbohydrate (%kcal)	61.0	(6.8)	58.7	(6.6)	−3.8
Sodium (mg/1000 kcal)	2588	(851)	2439	(773)	−5.8
Calcium (mg/1000 kcal)	255	(70)	258	(69)	+1.0
Iron (mg/1000 kcal)	6.7	(1.3)	5.4	(0.9)	−19.4

NNSJ, National Nutrition Survey in Japan; RCF, Representative compositions for food groups.
Nutrient intakes of each family member were estimated by dividing the household intake data of NNS80 using average intakes by age and sex groups calculated for NNSJ95.

RESULTS

NNSJ80 included nutrition survey data from 6456 households, and NNSJ90 included data from 5561 households. Nutrient intakes of individual family members based on the proportional distribution were calculated for 22341 and 17986 individuals for NNSJ80 and 90, respectively. Simple densities were also calculated by dividing nutrient intakes per household by 1000 kcal. The numbers of individuals aged 30 years and over were 12947 and 11196 for NNSJ80 and NNSJ90, respectively. Individual records in corresponding NIPPON DATA and NNSJ datasets were compared. A total of 10422 individuals in NNSJ80 and 8342 individuals in NNSJ90 were identified as the same person, and their data were combined.

RCF for NNSJ80 and 90 with detailed nutrients was calculated using food tables and dietary recall data for the INTERMAP Japan Study. The nutrients included in the RCF are listed in Table 1. The mean nutrient intakes of individuals calculated for NIPPON DATA80/90 are tabulated in Appendix tables. The mean major nutrient intakes of individuals calculated by proportional distribution from the original NNSJ80 data (a) and estimated values using RCF80 (b) were compared for NNSJ80 (Table 2). Percent differences of (b) from (a) were within ±5% for total energy and macronutrients. The percent difference was over ±10% only for the iron intake. Correlation coefficients for the nutrient intakes of individuals between those calculated from NNSJ80 and from RCF are shown in Table 3. The values were highly correlated for all nutrients; all coefficients were greater than 0.9 ($P < 0.0001$).

For NNSJ90, the average intakes of individuals calculated from the original NNSJ90 data (a) and estimated values using RCF90 (b) were compared (Table 4). Percentage differences of (b) from (a) were within ±5% for total energy, total fat, carbohydrates, iron, potassium, and the P/S ratio; within ±10% for total protein, calcium, vegetable protein, cholesterol, saturated fatty acids, monounsaturated fatty acids,

Table 3. Correlations between nutrient intakes of individuals estimated from (a) original NNSJ80 and (b) calculated values using representative nutrient composition for food groups. Follow-up participants for NIPPON DATA80, 10422 men and women, aged 30 years and over, 1980, Japan

	r^a	P
Total energy (kcal/day)	0.986	<0.001
Total protein (%kcal)	0.922	<0.001
Total fat (%kcal)	0.944	<0.001
Carbohydrate (%kcal)	0.951	<0.001
Sodium (mg/1000 kcal)	0.969	<0.001
Calcium (mg/1000 kcal)	0.955	<0.001
Iron (mg/1000 kcal)	0.906	<0.001

[a]Pearson's correlation coefficient.
NNSJ: National Nutrition Survey in Japan.
Nutrient intakes of each family member were estimated by dividing the household intake data of NNSJ80 using average intakes by age and sex groups calculated for NNSJ95.

and polyunsaturated fatty acids. The average animal protein intake calculated using RCF90 was 18% higher than the value using NNSJ90. Table 5 shows the correlation coefficients for nutrient intakes of individuals between those calculated from NNSJ90 and RCF90. Correlation coefficients were greater than 0.9 ($P < 0.0001$) for total energy, total protein, total fat, carbohydrates, potassium, animal protein, cholesterol, monounsaturated fatty acids, and polyunsaturated fatty acids, and all coefficients were greater than 0.8 ($P < 0.0001$).

Medians were also calculated for NNSJ80 and 90, and the median values were somewhat lower (within five percent) than the mean values in most nutrients, showing slightly skewed, nonnormal distributions with right tails (data not shown). Some of the estimated nutrient intakes were extremely higher or lower as intakes of a general adult, ie, total energy intakes were less than 500 kcal/day for seven participants and one participants in NNSJ80 and 90, respectively, and more than 5000 kcal/day for eight participants and one participant in NNSJ80 and 90, respectively (data not shown).

Table 4. Comparison of nutrient intakes of individuals calculated by proportional distribution from (a) NNSJ90 dataset and (b) calculated values using representative nutrient compositioon for food groups. Follow-up pariticipants for NIPPON DATA90, 8342 men and women, aged 30 years and over, 1990, Japan

	NNSJ90		RCF90		% difference of (b) from (a)
	Mean (a)	(SD)	Mean (b)	(SD)	
Total energy (kcal/day)	2050	(467)	2026	(458)	−1.2
Total protein (%kcal)	15.8	(2.0)	16.8	(2.1)	+6.2
Total fat (%kcal)	23.5	(4.9)	23.2	(4.6)	−1.3
Carbohydrate (%kcal)	58.0	(6.1)	56.5	(5.9)	−2.6
Calcium (mg/1000 kcal)	266.7	(83.2)	286.3	(79.5)	+7.3
Iron (mg/1000 kcal)	5.8	(1.2)	5.8	(1.0)	−1.4
Sodium (mg/1000 kcal)	2633	(750)	2439	(648)	−7.3
Potassium (mg/1000 kcal)	1415	(299)	1435	(274)	+1.4
Animal protein (%kcal)	8.1	(2.0)	9.5	(2.0)	+18.0
Vegetable protein (%kcal)	7.7	(1.0)	7.2	(1.0)	−7.1
Cholesterol (mg/1000 kcal)	183	(57.39)	193	(57.39)	+5.7
Saturated fatty acids (%kcal)	6.75	(1.71)	6.24	(1.50)	−7.6
Monounsaturated fatty acids (%kcal)	7.72	(1.89)	8.34	(1.91)	+8.0
Polyunsaturated fatty acids (%kcal)	6.32	(1.42)	5.86	(1.49)	−7.3
P/S ratio	0.970	(0.224)	0.975	(0.260)	+0.6

NNSJ, National Nutrition Survey in Japan; RCF, Representative compositions for food groups; P/S, polyunsaturated fatty acids/saturated fatty acids.
Nutrient intakes of each family member were estimated by dividing the household intake data of NNS90 using average intakes by age and sex groups calculated for NNSJ95.

DISCUSSION

In this study, NIPPON DATA80 and 90 were enhanced with baseline nutrient intake data of individuals by combining the nutrient intakes of individuals calculated from the corresponding NNSJ dataset. The nutrient intakes of individual household members were estimated by calculating the proportional distributions of the intakes per household concerning the age and sex of the individual members. To our knowledge, there is no study that used this method for researches in nutritional epidemiology. However, a similar method was applied to estimate disease-specific costs using health insurance claims in a health economic study showing good valitidy.[23,24] In this study, The values were calculated as weighted averages using the average nutrient intake pattern according to the sex and age in 1995, and individual habits in the food distribution within the household were not considered, ie, a household in which the husband ate fish and wife did not. However, familial resemblance in nutrient intake has been reported in spouses, and also in parents and their children,[25–27] and we think that the proportional distribution method used in this study is appropriate for most households. Distributions of the estimated nutrient intakes were checked, and the median values were slightly lower than the mean values. This kind of nonnormal distribution is often observed in many nutrients, and the distribution pattern is also different by nutrients.[28] In our further researches, the nonnormal distribution of nutrient intake should be taken into consideration. Some estimated nutrient intakes were extremely higher or lower as intakes of a general adult, and these outliers are kept in the combined datasets. Cutoff values should also be considered according to the objective of analysis.

Studies on nutrient intakes of Japanese with average intakes by age classes in the 1980s are scarce. There is a possibility that the food distribution pattern among generations might have changed from 1980 to 1995. In Japan, the major trend in postwar dietary habits has been westernization, ie, an increase in intakes of meat, milk and dairy products, and a decrease of rice, and fish, bringing about an increase of serum cholesterol level in Japanese.[29,30] Generally, younger people are more sensitive to change, and westernization of the diet would have had a more prominent effect on the younger generation than those born earlier, which is concordant with the trend in the serum cholesterol level of Japanese in the postwar period; a higher cholesterol level in those born later.[31,32] In NNSJ, a more westernized diet in younger people (more meat and less fish than the elderly) was observed in both 1995[20] and 2005.[29] It might well be that dietary westernization has occurred in the younger generation first, influencing the older generation, and those people getting older, since the postwar era to the present in Japan. It can be inferred that the basic order in the food distribution among generations remained mostly unchanged in this period, and the proportional distribution using average intakes in NNSJ95 is fairly reasonable.

Stroke mortality in Japan was highest in 1960s, and it has declined drastically since then without rising coronary heart disease mortality, with Japanese diet drawing attention as a healthy diet.[33–35] Some features of the Japanese diet have already been suggested to influence CVD risks, ie, a higher salt intake associated with a higher blood pressure,[36] and a

Table 5. Correlations between nutrient intakes of individuals estimated from (a) NNSJ90 and (b) calculated value using representative nutrient compositions for food groups. Follow-up pariticipants for NIPPON DATA90, 8342 men and women, aged 30 years and over, 1990, Japan

	r^a	P
Total energy (kcal/day)	0.983	<0.001
Total protein (%kcal)	0.916	<0.001
Total fat (%kcal)	0.933	<0.001
Carbohydrate (%kcal)	0.956	<0.001
Calcium (mg/1000 kcal)	0.874	<0.001
Iron (mg/1000 kcal)	0.807	<0.001
Sodium (mg/1000 kcal)	0.821	<0.001
Potassium (mg/1000 kcal)	0.917	<0.001
Animal protein (%kcal)	0.936	<0.001
Vegetable protein (%kcal)	0.868	<0.001
Cholesterol (mg/1000 kcal)	0.924	<0.001
Saturated fatty acids (%kcal)	0.892	<0.001
Monounsaturated fatty acids (%kcal)	0.915	<0.001
Polyunsaturated fatty acids (%kcal)	0.905	<0.001
P/S ratio	0.831	<0.001

[a]Pearson's correlation coefficient.
NNSJ, National Nutrition Survey in Japan; P/S, polyunsaturated fatty acids/saturated fatty acids.
Nutrient intakes of each family member were estimated by dividing the household intake data of NNS90 using average intakes by age and sex groups calculated for NNSJ95.

higher long chain n-3 polyunsaturated fatty acid intake associated with a lower incidence of coronary heart disease.[33] The original NNSJ datasets were not thought to be sufficient for investigation of the nutrition-disease relation, because of the limited kinds of nutrients, and should be enhanced with other nutrients. The INTERMAP Food Table Japan and INTERAMP Japan recall data were used to calculate RCF for NNSJ, and to enhance nutrients of the NNSJ. The INTERMAP Food Table was enhanced with detailed data on nutrient compositions, ie, fatty acids and amino acids.[13] The RCF included these detailed nutrients, and the intakes were calculated for the participants.

In the present report, the nutrient intakes of individuals calculated from the NNSJ dataset and RCF were compared. The mean iron intake calculated from NNSJ80 was 6.7 mg/day, and the value calculated from RCF was 5.4 mg/day, 20% lower than former (Table 2). However, the correlation coefficient between intakes by the two methods was large ($r = 0.919$, Table 3). The lower iron intake estimated from RCF seemed to be related to the food table used to calculate nutrient intakes for NNSJ. For NNSJ80, the 3rd revised edition of the standard tables of food composition in Japan was used, and the 4th edition was used for the NNSJ conducted in 1985. Comparisons of nutrient intakes using NNSJ82 data were made, in which nutrient intakes were calculated using the 3rd and 4th editions of the food table.[37] In this report, the total energy intake calculated using the 4th edition was 1.7% higher than the value calculated with the 3rd edition, 5.6% higher for total fat intake, and 19.4% lower for iron intake. The difference in iron intake is consistent with our results.

For other nutrients, mean intakes calculated with RCF using INTERMAP data showed some differences compared with the values obtained from NNSJ (Tables 2 and 4). Possible reasons for these differences are as follows. First, the INTERMAP Japan survey was conducted in 1996–98, years after NIPPON DATA80 and 90. The food consumption pattern constituting the food groups might have changed due to alterations of the dietary habit during this period in Japan.[38] Second, INTERMAP participants were aged 40–59, and those of NNSJ were all residents in the surveyed area. Children, young people, and the elderly were not included in INTERMAP. The dietary characteristics of these people were therefore not reflected in the RCF.

These factors might have caused the differences between nutrient intakes calculated by RCF and those obtained from the original NNSJ. However, the nutrient values of individuals calculated with RCF were highly correlated with those values calculated from NNSJ (Tables 3 and 5), which may indicate that RCF was appropriate for both animal and vegetable foods, and the estimated detailed nutrient intakes of individuals are useful for the investigation of dietary factors affecting the CVD risk within the cohort. However, some attention is necessary when we assess changes in nutrient intakes over time.

Although alcohol intake is an important dietary factor,[39,40] it was not included in the integrated datasets. Intakes of alcoholic beverages were recorded for NNSJ, and the alcohol intake per household was included in the NNSJ datasets. However, we thought that calculation of the alcohol intake of individuals from the intake per household would not be appropriate for investigation of the alcohol-disease association, due to the large inter-individual differences in alcohol consumption within a household. Information on alcohol consumption could not be enhanced in this study. It would be appropriate to use data derived from a question asking about the frequency of alcohol consumption in NIPPON DATA.

The combination of nutrient values obtained from NNSJ datasets and those calculated with RCF based on the INTERMAP Japan survey would be appropriate for the investigation of dietary factors affecting CVD risk. The adopted sources of detailed nutrient intakes are tabulated in Table 1, decided on considering the consistency of nutrients with a more detailed classification; ie, saturated, monounsaturated, or polyunsaturated fatty acids and each fatty acid.

In conclusion, NIPPON DATA80/90, large-scale cohort datasets in Japan, were enhanced with the detailed baseline nutrient intake data obtained by the weighing record method in NNSJ80 and 90. Nutrients related to CVD risk factors, eg, potassium, cholesterol, n-3 polyunsaturated fatty acids, were also incorporated to enhance the datasets. The integrated cohort datasets would be useful for studies on CVD prevention through favorable dietary habits.

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NIPPON DATA 80 ならびに NIPPON DATA 90 における総摂取エネルギー量および 3大栄養素摂取量等に関する検討 －性・年齢階級・Body Mass Index を考慮して－

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背景

NIPPON DATA 80 と 90 の対象者について、体格と総エネルギー摂取量ならび３大栄養素摂取状況の相互関係を検討した。

方法

NIPPON DATA 80 と 90 のデータセットを用い、Body mass index（BMI）をもとに判定した体格（低体重、普通体重、肥満）と個別に推計された総エネルギー摂取量、３大栄養素の摂取量及び３大栄養素からの摂取エネルギー摂取比率との相互の関係を明らかにした。

結果

男性においては両調査年とも、低体重群から肥満群となるのにしたがい、総摂取エネルギー量、たんぱく質摂取量、脂質摂取量、炭水化物摂取量、たんぱく質エネルギー比率、脂肪エネルギー比率は高値を示したが、逆に炭水化物エネルギー比率は低値を示した。女性では、調査年の違いにより異なった結果が得られた。80 年では低体重群から肥満群となるのにしたがい、総摂取エネルギー量、たんぱく質摂取量、脂質摂取量、炭水化物摂取量、たんぱく質エネルギー比率は高値を示したが、他に差はみられなかった。一方、90 年では総摂取エネルギー量、たんぱく質摂取量、炭水化物摂取量、たんぱく質エネルギー比率、炭水化物エネルギー比率は高値を示したが、脂質摂取量と脂肪エネルギー比率は低値を示した。

逆に両調査年の性別に総エネルギー摂取量の４分位によりおのおの４群を設定し、この群と BMI の関係も検討した。男性では、何れの調査年とも総エネルギー摂取量が高い群となるにしたがい BMI も高値を示した。しかし、女性は 80 年の成績では、総エネルギー摂取量が高い群となるにしたがい BMI も高値となる傾向を示したが、90 年ではその関係は認められなかった（Table１）。

結語

男性では体格と総エネルギー摂取量の間に正の関係が認められた。しかし、女性では調査年により男性とは異なる傾向も認められた。

Table 1. Means of body mass index, hight and weight according to the quartiles of total energy intake in NIPPON DATA80 (1980) and NIPPON DATA90 (1990)

				Q1	Q2	Q3	Q4	*P* value
NIPPON DATA80	Men	Energy	(kcal/day)	(−2,085.2)	(2,085.3−2,374.2)	(2,374.3−2,680.5)	(2,680.6−)	
	(n=4,576)	n		1,144	1,144	1,143	1,145	—
		BMI	(kg/m^2)	21.9 ± 3.0	22.5 ± 2.8	22.6 ± 2.7	23.0 ± 2.8	<0.001
		Hight	(cm)	160.4 ± 6.8	161.9 ± 6.6	163.0 ± 6.4	163.5 ± 6.5	<0.001
		Weight	(kg)	56.6 ± 9.4	59.0 ± 8.7	60.2 ± 8.8	61.5 ± 9.1	<0.001
		Age	(years)	56.2 ± 15.3	50.0 ± 13.4	47.2 ± 11.5	46.5 ± 10.6	<0.001
	Women	Energy	(kcal/day)	(−1,669.5)	(1,669.6−1906.8)	(1,906.9−2,153.7)	(2,153.8−)	
	(n=5,829)	n		1,456	1,458	1,458	1,457	—
		BMI	(kg/m^2)	22.8 ± 3.5	22.7 ± 3.4	22.8 ± 3.3	23.0 ± 3.2	0.060
		Hight	(cm)	148.2 ± 6.5	149.9 ± 6.1	151.0 ± 5.7	151.3 ± 5.9	<0.001
		Weight	(kg)	50.1 ± 8.7	51.0 ± 8.4	52.1 ± 8.0	52.6 ± 7.9	<0.001
		Age	(years)	55.6 ± 15.2	49.9 ± 13.7	47.6 ± 12.2	47.1 ± 10.7	<0.001
NIPPON DATA90	Men	Energy	(kcal/day)	(−2,010.2)	(2,010.3−2,287.0)	(2,287.1−2,585.5)	(2,585.6−)	
	(n=3,483)	n		869	872	871	871	—
		BMI	(kg/m^2)	22.6 ± 3.1	22.8 ± 3.0	23.1 ± 2.9	23.3 ± 2.9	<0.001
		Hight	(cm)	161.7 ± 7.3	163.8 ± 6.6	164.5 ± 6.7	164.9 ± 6.3	<0.001
		Weight	(kg)	59.2 ± 10.2	61.3 ± 9.5	62.6 ± 9.5	63.4 ± 9.4	<0.001
		Age	(years)	59.6 ± 15.1	53.0 ± 13.8	50.3 ± 12.3	50.1 ± 11.2	<0.001
	Women	Energy	(kcal/day)	(−1,617.4)	(1,617.5−1835.2)	(1,835.3−2,072.1)	(2,072.2−)	
	(n=4,847)	n		1,211	1,212	1,212	1,212	—
		BMI	(kg/m^2)	22.9 ± 3.4	22.6 ± 3.4	22.9 ± 3.3	22.9 ± 3.3	0.154
		Hight	(cm)	149.0 ± 7.0	151.1 ± 6.5	152.1 ± 6.1	152.8 ± 6.0	<0.001
		Weight	(kg)	50.8 ± 8.5	51.7 ± 8.3	52.9 ± 8.0	53.5 ± 8.3	<0.001
		Age	(years)	58.9 ± 15.5	52.4 ± 14.3	50.3 ± 13.0	49.5 ± 11.2	<0.001

Values are means ± S.D.
P values are by analysis of variance.
Q1 to Q4 are the quartiles of total energy intake in each group.

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Total Energy Intake and Intake of Three Major Nutrients by Body Mass Index in Japan: NIPPON DATA80 and NIPPON DATA90

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ABSTRACT

Background: This paper investigated the relationship between body mass index (BMI) and total energy intake as well as intake of three major nutrients in representative Japanese populations enrolled in the National Nutrition Surveys of Japan in 1980 and 1990.
Methods: A total of 10 422 participants (4585 men and 5837 women) and 8342 participants (3488 men and 4854 women) aged 30 or older from 300 randomly selected districts participated in the National Survey of Circulatory Disorders and the National Nutrition Survey in Japan in 1980 and 1990, respectively. The nutrition surveys were performed with weighing record method for three consecutive days to each household. Individually estimated total energy intake and intakes of three major nutrients (carbohydrate, protein, and fat) were compared by the categories of BMI and by 10-year age groups.
Results: In men, total energy intake (kcal/day), intakes of three major nutrients (g/day) and energy intake ratio from protein and fat (%) increased as BMI increased in each age group, whereas energy intake ratio from carbohydrate (%) decreased. In women, total energy intake, intakes of three major nutrients, and energy intake ratio from protein increased as BMI increased. Energy intake ratio from carbohydrate and fat decreased as BMI increased in women in 1990. When participants were categorized into quartiles according to total energy intake in each sex group, BMI increased as total energy intake increased in men in both 1980 and 1990.
Conclusions: A positive relationship was observed between body mass index and total energy intake in Japanese men. The relationship was weaker in Japanese women.

Key words: total energy intake; three major nutrients; body mass index; national nutrition survey, Japan

INTRODUCTION

Proper intake of nutrients is essential for maintaining and enhancing health as well as for the prevention and treatment of diseases. Thus, in order to discuss health- and disease-related issues from a diversified perspective and to obtain reliable findings, it is important to investigate the intake of specific nutrients in target individuals and groups.[1,2] It is of particular importance to determine the total energy intake and the intake of protein, fat and carbohydrate (three major energy nutrients), and to elucidate their possible inter-relationships as a basis for assessment of the overall nutrient intake. At the same time, it has been pointed out that assessment of body mass not only serves as an index for habitual energy intake and energy expenditure, but is also associated with the onset and progress of various lifestyle-related diseases and with mortality.[3]

Thus, in this study, we examined body mass, total energy intake and intake of three major nutrients at the time of the National Nutrition Survey, Japan (NNSJ) carried out on the subjects enrolled in the NIPPON DATA 80 and NIPPON DATA 90 studies, which are large-scale representative cohort studies of Japanese, and attempted to elucidate relationships between body mass and energy and major nutrients intake.

METHODS

Participants

The participants in this study were those in the National Survey on Circulatory Disorders of Japan in 1980 and 1990.[4] Community-based participants aged 30 years and over in 300 randomly selected health districts throughout Japan participated in the survey. The numbers of participants were 10 422 (4585 men and 5837 women) in 1980 and 8342 (3488

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men and 4854 women) in 1990. Cohort studies of these two populations have been named as the National Integrated Project for Prospective Observation of Non-communicable Disease and Its Trends in the Aged (NIPPON DATA80 and NIPPON DATA90). Details of NIPPON DATA80 and 90 have been described previously.[5–7]

Nutritional survey

Detailed methods of the nutritional survey and the estimation of individual intake of nutrients and food groups were described elsewhere.[8–10] Food intake survey by weighed food records in three consecutive representative days were conducted by specially trained dietary interviewers. Dietary interviewers visited participants' houses at least once during the survey. Weekends and holydays were avoided. Up-dated Standard Tables for Food Composition in Japan, 4th edition, with matched fatty acid values and micronutrients, were used to calculate Japanese nutrient intakes.

Nutrient intakes of each household member were estimated by dividing household intake data of NNSJ80 and NNSJ90 conducted in 1980 and 1990, respectively, proportionally using average intakes by sex and age groups calculated for NNSJ95 conducted in 1995.[11] The average intakes in NNSJ95 were calculated by a combination method of household-based food weighing record and an approximation of proportions by which family members shared each dish or food in the household. For each person, means of the estimated individual nutrients from the three days records were used in the analyses.

Statistical analyses

To calculate the percentages of energy intake from protein and carbohydrate to total energy intake (protein energy ratio and carbohydrate energy ratio), intake of 1 g protein and 1 g carbohydrate was multiplied by 4 kcal. An intake of 1 g fat was multiplied by 9 kcal to calculate fat energy ratio. The total energy intake values includes energy intake from sources other than the three major nutrients, such as alcohol. Therefore, the data for many individuals does not sum to 100% when energy ratios of protein, fat and carbohydrate are added together.

Body mass index (BMI [kg/m^2] = [weight (kg)]/[height (m)]^2) was classified in accordance with the criteria of the Japan Society for the Study of Obesity (JASSO)[12]: "lean (or low weight)", BMI < 18.5 (kg/m^2); "normal (or normal weight)", 18.5 ≤ BMI < 25.0 (kg/m^2); and "obese (or high weight)", BMI ≥ 25.0 (kg/m^2).

The analysis excludes subjects whose BMI values were not obtained due to lack of data on either height, weight or both, and included individuals with a daily energy intake of between 500 kcal and 5000 kcal.

Characteristics and intakes of energy and nutrients were compared among the three categories of BMI in each of age, sex groups for NIPPON DATA80 and NIPPON DATA90, respectively. Also, mean values of BMI, height and weight were compared among the quintiles of total energy intake in men and women, separately. Analysis of variance was used to test the statistical differences among the categories.

RESULTS

Nutrient intakes by BMI in NIPPON DATA80

Tables 1 and 2 show nutrient intakes and characteristics by BMI groups in NIPPON DATA80 for men and women, respectively. In total men, the group with higher BMI had significantly higher values for total energy, protein, fat and carbohydrate intakes. Protein energy ratio and fat energy ratio were also higher in the higher BMI group, whereas carbohydrate energy ratio was lower. Results were almost similar in all age groups from 30–39 yeas to 70 years or over. In total women, the group with higher BMI had significantly higher values for total energy, protein, and carbohydrate intakes. Protein energy ratio was also higher in the higher BMI group, although fat energy ratio and carbohydrate energy ratio were not significantly different among BMI groups. Results were similar in all age groups of women, although total energy intake was not the highest in the obese group in women aged 60 years or over.

Nutrient intakes by BMI in NIPPON DATA90

Tables 3 and 4 show nutrient intakes and characteristics by BMI groups in NIPPON DATA90 for men and women, respectively. In total men of NIPPON DATA90, the group with higher BMI had significantly higher values for total energy, protein, fat and carbohydrate intakes. Protein energy ratio and fat energy ratio were also higher in the higher BMI group, whereas carbohydrate energy ratio was lower. Results were similar in each age group, although total energy intake was not the highest in the obese group of men aged 40–49 and 50–59. In total women, total energy, protein, fat and carbohydrate intakes were the lowest in the lean group; however, those in the obese group were similar to the normal weight group. Fat energy ratio was the lowest and carbohydrate energy ratio was the highest in the obese group. Total energy intake was not the highest in the obese group in women aged 40–49 and 50–59 years.

Nutrient-specific energy intake by sex and BMI

Figure 1 and Figure 2 show nutrient-specific energy intake by sex and BMI in NIPPON DATA80 and NIPPON DATA90. In men, 100–130 kcal/day of energy intake came from sources other than the three major nutrients. In women, 11–19 kcal/day of energy intake came from sources other than the three major nutrients.

DISSCUSSION

The results obtained in this study show that in men in both survey years, total energy increases from low body weight/

Table 1. Mean intakes of energy and nutrients according to body mass index in men: NIPPON DATA80, 1980

	Lean (BMI < 18.5 kg/m^2)	Normal (18.5 ≤ BMI < 25.0 kg/m^2)	Obese (BMI ≥ 25.0 kg/m^2)	*P* value	Total
(30–39 years)	(*n* = 59)	(*n* = 922)	(*n* = 236)		(*n* = 1217)
Energy (kcal/day)	2282.6 ± 418.1	2467.9 ± 450.1	2530.0 ± 475.9	0.001	2471.0 ± 456.0
Protein (g/day)	81.8 ± 18.2	90.3 ± 19.3	93.1 ± 19.2	<0.001	90.5 ± 19.3
Fat (g/day)	55.6 ± 15.6	60.5 ± 18.6	63.2 ± 18.7	0.013	60.8 ± 18.6
Carbohydrate (g/day)	335.9 ± 67.2	357.3 ± 73.8	364.3 ± 77.6	0.031	357.6 ± 74.4
Protein energy ratio (%)	14.3 ± 1.7	14.7 ± 2.1	14.8 ± 1.9	0.283	14.7 ± 2.0
Fat energy ratio (%)	21.9 ± 4.3	22.0 ± 5.2	22.4 ± 4.8	0.551	22.1 ± 5.0
Carbohydrate energy ratio (%)	58.9 ± 4.7	57.9 ± 5.9	57.6 ± 5.3	0.304	57.9 ± 5.7
Age (y/o)	33.3 ± 2.6	34.2 ± 2.9	34.9 ± 2.9	<0.001	34.3 ± 2.9
Height (cm)	167.3 ± 6.0	165.9 ± 6.1	165.8 ± 5.5	0.215	166.0 ± 6.0
Body weight (kg)	49.7 ± 4.0	60.2 ± 6.4	73.7 ± 6.1	<0.001	62.3 ± 8.7
Body mass index (kg/m^2)	17.7 ± 0.6	21.8 ± 1.7	26.8 ± 1.6	—	22.6 ± 2.8
(40–49 years)	(*n* = 50)	(*n* = 869)	(*n* = 276)		(*n* = 1195)
Energy (kcal/day)	2358.4 ± 415.9	2473.9 ± 452.2	2503.4 ± 447.1	0.108	2475.9 ± 450.1
Protein (g/day)	85.7 ± 15.5	92.5 ± 19.8	95.2 ± 19.9	0.005	92.9 ± 19.7
Fat (g/day)	55.1 ± 17.3	55.8 ± 17.5	58.3 ± 17.4	0.108	56.3 ± 17.5
Carbohydrate (g/day)	347.3 ± 67.1	363.0 ± 73.7	363.9 ± 73.7	0.321	362.5 ± 73.4
Protein energy ratio (%)	14.6 ± 1.6	15.0 ± 2.0	15.3 ± 2.0	0.040	15.0 ± 2.0
Fat energy ratio (%)	20.8 ± 4.8	20.2 ± 4.7	20.9 ± 4.6	0.101	20.4 ± 4.7
Carbohydrate energy ratio (%)	59.2 ± 5.8	58.7 ± 5.7	58.1 ± 6.0	0.223	58.6 ± 5.8
Age (years)	44.5 ± 3.1	44.6 ± 2.9	44.4 ± 2.9	0.414	44.6 ± 2.9
Height (cm)	164.7 ± 5.0	163.1 ± 6.1	162.8 ± 6.7	0.160	163.1 ± 6.2
Body weight (kg)	47.8 ± 3.7	59.0 ± 6.4	71.4 ± 7.0	<0.001	61.4 ± 8.8
Body mass index (kg/m^2)	17.6 ± 1.0	22.1 ± 1.7	26.9 ± 1.8	—	23.0 ± 2.8
(50–59 years)	(*n* = 51)	(*n* = 763)	(*n* = 204)		(*n* = 1018)
Energy (kcal/day)	2440.1 ± 444.7	2472.3 ± 468.3	2544.6 ± 515.1	0.124	2485.1 ± 477.4
Protein (g/day)	91.2 ± 19.6	94.3 ± 20.7	98.2 ± 23.0	0.031	94.9 ± 21.1
Fat (g/day)	52.0 ± 15.7	53.0 ± 17.6	56.1 ± 18.9	0.075	53.6 ± 17.8
Carbohydrate (g/day)	372.0 ± 80.7	368.8 ± 79.2	378.3 ± 84.9	0.322	370.8 ± 80.4
Protein energy ratio (%)	15.0 ± 2.0	15.3 ± 2.2	15.5 ± 2.1	0.355	15.3 ± 2.2
Fat energy ratio (%)	19.2 ± 4.7	19.3 ± 5.1	19.8 ± 4.9	0.424	19.4 ± 5.0
Carbohydrate energy ratio (%)	60.9 ± 6.0	59.6 ± 6.4	59.4 ± 5.8	0.329	59.6 ± 6.2
Age (years)	54.6 ± 3.0	54.1 ± 2.8	53.6 ± 2.8	0.038	54.0 ± 2.8
Height (cm)	161.0 ± 6.1	160.9 ± 5.9	161.5 ± 5.4	0.409	161.1 ± 5.8
Body weight (kg)	45.7 ± 3.8	56.7 ± 6.2	70.0 ± 6.0	<0.001	58.8 ± 8.6
Body mass index (kg/m^2)	17.6 ± 0.8	21.8 ± 1.7	26.8 ± 1.5	—	22.6 ± 2.8
(60–69 years)	(*n* = 67)	(*n* = 514)	(*n* = 95)		(*n* = 676)
Energy (kcal/day)	2132.7 ± 387.2	2288.1 ± 459.1	2387.9 ± 529.9	0.003	2286.7 ± 466.6
Protein (g/day)	78.5 ± 16.0	87.1 ± 18.9	91.9 ± 19.9	<0.001	86.9 ± 19.0
Fat (g/day)	42.9 ± 14.6	46.4 ± 16.4	49.5 ± 17.6	0.042	46.5 ± 16.4
Carbohydrate (g/day)	332.9 ± 62.1	354.8 ± 81.0	368.3 ± 102.0	0.027	354.5 ± 83.0
Protein energy ratio (%)	14.8 ± 1.9	15.3 ± 2.1	15.6 ± 2.3	0.065	15.3 ± 2.1
Fat energy ratio (%)	18.0 ± 4.5	18.2 ± 4.9	18.8 ± 5.2	0.535	18.3 ± 4.9
Carbohydrate energy ratio (%)	62.7 ± 6.1	62.0 ± 6.5	61.5 ± 6.5	0.501	62.0 ± 6.5
Age (years)	64.9 ± 2.8	64.2 ± 2.6	63.8 ± 2.7	0.026	64.2 ± 2.7
Height (cm)	160.0 ± 5.9	158.7 ± 6.0	160.4 ± 5.6	0.017	159.1 ± 5.9
Body weight (kg)	44.7 ± 3.6	54.6 ± 5.9	69.3 ± 6.4	<0.001	55.7 ± 8.5
Body mass index (kg/m^2)	17.5 ± 0.9	21.6 ± 1.7	26.9 ± 1.5	—	22.0 ± 2.8
(70– years)	(*n* = 75)	(*n* = 341)	(*n* = 54)		(*n* = 470)
Energy (kcal/day)	1961.7 ± 387.0	1959.9 ± 405.7	2149.9 ± 407.2	0.005	1982.0 ± 406.6
Protein (g/day)	71.0 ± 15.4	73.7 ± 17.1	84.0 ± 21.2	<0.001	74.5 ± 17.7
Fat (g/day)	36.1 ± 12.8	37.8 ± 15.7	43.2 ± 16.7	0.028	38.2 ± 15.5
Carbohydrate (g/day)	322.3 ± 76.0	314.9 ± 67.8	338.6 ± 72.1	0.062	318.8 ± 69.9
Protein energy ratio (%)	14.6 ± 2.0	15.1 ± 2.2	15.6 ± 2.5	0.018	15.1 ± 2.2
Fat energy ratio (%)	16.7 ± 5.0	17.1 ± 4.8	18.1 ± 5.8	0.271	17.2 ± 4.9
Carbohydrate energy ratio (%)	65.6 ± 6.5	64.5 ± 6.7	63.0 ± 7.2	0.109	64.5 ± 6.7
Age (years)	76.2 ± 4.8	74.7 ± 4.3	74.0 ± 3.7	0.008	74.8 ± 4.4
Height (cm)	156.6 ± 4.7	156.8 ± 6.2	157.7 ± 7.4	0.533	156.9 ± 6.1
Body weight (kg)	42.7 ± 3.6	52.7 ± 6.0	66.6 ± 7.3	<0.001	52.7 ± 8.5
Body mass index (kg/m^2)	17.4 ± 0.9	21.4 ± 1.8	26.7 ± 1.6	—	21.4 ± 2.9
(Total)	(*n* = 302)	(*n* = 3409)	(*n* = 865)		(*n* = 4576)
Energy (kcal/day)	2208.8 ± 441.3	2392.5 ± 478.6	2485.6 ± 487.7	<0.001	2398.0 ± 481.9
Protein (g/day)	80.6 ± 18.1	89.6 ± 20.3	94.3 ± 20.8	<0.001	89.9 ± 20.5
Fat (g/day)	47.3 ± 16.9	53.2 ± 18.8	57.2 ± 18.9	<0.001	53.6 ± 18.8
Carbohydrate (g/day)	339.8 ± 72.3	356.7 ± 76.9	366.3 ± 81.2	<0.001	357.4 ± 77.7
Protein energy ratio (%)	14.6 ± 1.8	15.1 ± 2.1	15.2 ± 2.1	<0.001	15.1 ± 2.1
Fat energy ratio (%)	19.1 ± 5.0	19.9 ± 5.2	20.7 ± 5.1	<0.001	20.0 ± 5.2
Carbohydrate energy ratio (%)	61.8 ± 6.4	59.8 ± 6.5	58.9 ± 6.1	<0.001	59.7 ± 6.4
Age (years)	56.4 ± 16.0	49.9 ± 13.4	47.9 ± 11.7	<0.001	49.9 ± 13.4
Height (cm)	161.5 ± 6.7	162.1 ± 6.8	162.8 ± 6.4	0.007	162.2 ± 6.7
Body weight (kg)	45.9 ± 4.5	57.5 ± 6.7	71.2 ± 6.7	<0.001	59.3 ± 9.2
Body mass index (kg/m^2)	17.6 ± 0.9	21.8 ± 1.7	26.8 ± 1.6	—	22.5 ± 2.9

Values are mean ± S.D.
P values are by analysis of variance.

Table 2. Mean intakes of energy and nutrients according to body mass index in women: NIPPON DATA80, 1980

	Lean (BMI < 18.5 kg/m²)	Normal (18.5 ≤ BMI < 25.0 kg/m²)	Obese (BMI ≥ 25.0 kg/m²)	*P*-value	Total
(30–39 years)	(*n* = 121)	(*n* = 1228)	(*n* = 234)		(*n* = 1583)
Energy (kcal/day)	1886.3 ± 292.0	1960.5 ± 337.9	1975.2 ± 360.2	0.048	1957.0 ± 338.5
Protein (g/day)	70.8 ± 12.5	74.0 ± 14.9	74.4 ± 15.4	0.062	73.8 ± 14.8
Fat (g/day)	50.1 ± 13.3	52.6 ± 15.6	50.7 ± 15.7	0.068	52.1 ± 15.5
Carbohydrate (g/day)	278.6 ± 50.3	289.5 ± 56.8	296.3 ± 62.2	0.021	289.6 ± 57.3
Protein energy ratio (%)	15.0 ± 1.8	15.1 ± 1.9	15.1 ± 1.9	0.870	15.1 ± 1.9
Fat energy ratio (%)	23.9 ± 4.9	24.1 ± 5.4	23.0 ± 5.3	0.020	23.9 ± 5.4
Carbohydrate energy ratio (%)	59.1 ± 5.5	59.1 ± 5.8	60.0 ± 6.1	0.062	59.2 ± 5.8
Age (years)	33.3 ± 2.7	34.3 ± 2.9	34.9 ± 2.9	<0.001	34.3 ± 2.9
Height (cm)	154.0 ± 5.1	153.5 ± 5.1	152.0 ± 5.2	<0.001	153.3 ± 5.1
Body weight (kg)	41.8 ± 3.2	50.8 ± 5.2	63.5 ± 6.7	<0.001	52.0 ± 7.5
Body mass index (kg/m²)	17.6 ± 0.7	21.5 ± 1.7	27.5 ± 2.5	—	22.1 ± 3.1
(40–49 years)	(*n* = 72)	(*n* = 1038)	(*n* = 357)		(*n* = 1467)
Energy (kcal/day)	2050.1 ± 390.4	2015.0 ± 372.1	2046.0 ± 430.7	0.364	2024.3 ± 388.0
Protein (g/day)	76.7 ± 18.6	76.6 ± 16.3	79.7 ± 18.3	0.012	77.3 ± 16.9
Fat (g/day)	52.4 ± 15.9	51.2 ± 16.7	51.3 ± 16.8	0.834	51.3 ± 16.7
Carbohydrate (g/day)	312.0 ± 67.5	306.7 ± 63.3	312.1 ± 74.0	0.365	308.3 ± 66.3
Protein energy ratio (%)	15.0 ± 2.3	15.3 ± 2.0	15.6 ± 2.2	0.003	15.3 ± 2.1
Fat energy ratio (%)	23.0 ± 5.4	22.8 ± 5.5	22.6 ± 5.5	0.818	22.7 ± 5.5
Carbohydrate energy ratio (%)	60.9 ± 6.6	60.9 ± 6.1	61.0 ± 6.1	0.984	60.9 ± 6.1
Age (years)	44.9 ± 2.9	44.5 ± 2.9	44.9 ± 2.9	0.104	44.6 ± 2.9
Height (cm)	152.6 ± 5.3	151.8 ± 5.2	151.3 ± 5.1	0.118	151.7 ± 5.2
Body weight (kg)	40.7 ± 3.3	50.7 ± 5.2	63.8 ± 7.0	<0.001	53.4 ± 8.4
Body mass index (kg/m²)	17.5 ± 0.9	22.0 ± 1.7	27.8 ± 2.5	—	23.2 ± 3.4
(50–59 years)	(*n* = 87)	(*n* = 842)	(*n* = 387)		(*n* = 1316)
Energy (kcal/day)	1857.9 ± 385.5	1995.5 ± 397.4	1987.2 ± 394.7	0.008	1984.0 ± 397.0
Protein (g/day)	72.5 ± 15.4	77.9 ± 16.7	78.0 ± 18.0	0.016	77.6 ± 17.1
Fat (g/day)	44.2 ± 13.9	47.0 ± 15.1	46.6 ± 16.3	0.268	46.7 ± 15.4
Carbohydrate (g/day)	291.3 ± 67.9	312.8 ± 70.8	312.2 ± 70.2	0.024	311.2 ± 70.6
Protein energy ratio (%)	15.7 ± 2.0	15.7 ± 2.2	15.8 ± 2.4	0.803	15.7 ± 2.2
Fat energy ratio (%)	21.4 ± 5.0	21.2 ± 5.3	21.1 ± 5.5	0.850	21.2 ± 5.3
Carbohydrate energy ratio (%)	62.6 ± 5.9	62.7 ± 6.3	62.8 ± 6.7	0.941	62.7 ± 6.4
Age (years)	54.3 ± 2.9	54.4 ± 2.9	54.5 ± 3.0	0.684	54.4 ± 2.9
Height (cm)	150.0 ± 5.4	149.7 ± 5.1	149.1 ± 4.9	0.126	149.6 ± 5.1
Body weight (kg)	39.2 ± 3.3	49.5 ± 5.0	60.8 ± 6.0	<0.001	52.1 ± 8.1
Body mass index (kg/m²)	17.4 ± 0.9	22.1 ± 1.7	27.3 ± 2.0	—	23.3 ± 3.3
(60–69 years)	(*n* = 78)	(*n* = 602)	(*n* = 217)		(*n* = 897)
Energy (kcal/day)	1815.6 ± 383.0	1833.4 ± 379.8	1805.6 ± 413.8	0.649	1825.1 ± 388.3
Protein (g/day)	70.4 ± 19.4	71.7 ± 16.5	71.5 ± 18.9	0.835	71.5 ± 17.4
Fat (g/day)	39.7 ± 15.4	37.9 ± 14.7	39.7 ± 17.1	0.276	38.5 ± 15.3
Carbohydrate (g/day)	294.6 ± 71.2	300.7 ± 64.9	291.5 ± 68.9	0.194	298.0 ± 66.5
Protein energy ratio (%)	15.5 ± 2.1	15.7 ± 2.1	15.9 ± 2.2	0.457	15.7 ± 2.1
Fat energy ratio (%)	19.6 ± 6.1	18.4 ± 5.1	19.5 ± 5.8	0.014	18.8 ± 5.4
Carbohydrate energy ratio (%)	64.9 ± 8.1	65.8 ± 6.3	64.8 ± 7.3	0.143	65.5 ± 6.8
Age (years)	63.9 ± 2.8	64.2 ± 2.8	64.2 ± 2.8	0.695	64.2 ± 2.8
Height (cm)	149.1 ± 6.0	147.2 ± 5.4	146.5 ± 4.9	0.001	147.2 ± 5.4
Body weight (kg)	38.1 ± 4.1	47.8 ± 5.2	59.6 ± 6.2	<0.001	49.8 ± 8.2
Body mass index (kg/m²)	17.1 ± 1.2	22.1 ± 1.8	27.7 ± 2.2	—	23.0 ± 3.5
(70– years)	(*n* = 68)	(*n* = 375)	(*n* = 123)		(*n* = 566)
Energy (kcal/day)	1523.8 ± 267.6	1657.6 ± 338.5	1646.7 ± 376.1	0.011	1639.2 ± 341.7
Protein (g/day)	59.4 ± 13.1	64.3 ± 14.4	65.3 ± 19.0	0.027	63.9 ± 15.5
Fat (g/day)	30.1 ± 8.9	33.9 ± 11.9	35.7 ± 14.3	0.011	33.8 ± 12.3
Carbohydrate (g/day)	256.5 ± 53.2	276.3 ± 62.6	268.9 ± 68.4	0.047	272.3 ± 63.1
Protein energy ratio (%)	15.6 ± 2.4	15.6 ± 2.2	15.9 ± 2.4	0.573	15.7 ± 2.3
Fat energy ratio (%)	17.9 ± 4.4	18.4 ± 5.1	19.4 ± 5.8	0.077	18.5 ± 5.2
Carbohydrate energy ratio (%)	67.2 ± 5.9	66.6 ± 6.9	65.3 ± 7.7	0.115	66.4 ± 7.0
Age (years)	75.5 ± 4.7	75.5 ± 4.5	75.1 ± 4.2	0.642	75.4 ± 4.4
Height (cm)	142.4 ± 6.3	142.6 ± 6.3	142.7 ± 5.4	0.937	142.6 ± 6.1
Body weight (kg)	34.6 ± 3.5	44.5 ± 5.1	56.0 ± 6.0	<0.001	45.8 ± 8.1
Body mass index (kg/m²)	17.1 ± 1.2	21.9 ± 1.7	27.5 ± 2.2	—	22.5 ± 3.5
(Total)	(*n* = 426)	(*n* = 4085)	(*n* = 1318)		(*n* = 5829)
Energy (kcal/day)	1837.4 ± 376.4	1935.0 ± 380.6	1939.3 ± 418.2	<0.001	1928.9 ± 389.9
Protein (g/day)	70.2 ± 16.5	74.2 ± 16.3	75.6 ± 18.4	<0.001	74.2 ± 16.8
Fat (g/day)	44.2 ± 15.6	47.2 ± 16.6	46.4 ± 17.1	0.001	46.8 ± 16.7
Carbohydrate (g/day)	286.2 ± 63.7	299.1 ± 64.2	301.9 ± 70.7	<0.001	298.8 ± 65.8
Protein energy ratio (%)	15.4 ± 2.1	15.4 ± 2.0	15.6 ± 2.2	0.001	15.5 ± 2.1
Fat energy ratio (%)	21.5 ± 5.6	21.8 ± 5.7	21.4 ± 5.7	0.084	21.7 ± 5.7
Carbohydrate energy ratio (%)	62.5 ± 7.0	62.0 ± 6.7	62.4 ± 6.9	0.070	62.1 ± 6.8
Age (years)	51.9 ± 15.3	49.2 ± 13.6	51.9 ± 12.3	<0.001	50.0 ± 13.5
Height (cm)	150.2 ± 6.8	150.4 ± 6.2	149.2 ± 5.8	<0.001	150.1 ± 6.2
Body weight (kg)	39.3 ± 4.2	49.5 ± 5.5	61.5 ± 6.9	<0.001	51.5 ± 8.3
Body mass index (kg/m²)	17.4 ± 1.0	21.9 ± 1.7	27.6 ± 2.3	—	22.8 ± 3.4

Values are mean ± S.D.
P values are by analysis of variance.

Table 3. Mean intakes of energy and nutrients according to body mass index in men: NIPPON DATA90, 1990

	Lean (BMI < 18.5 kg/m²)	Normal (18.5 ≤ BMI < 25.0 kg/m²)	Obese (BMI ≥ 25.0 kg/m²)	*P*-value	Total
(30–39 years)	(*n* = 31)	(*n* = 473)	(*n* = 154)		(*n* = 658)
Energy (kcal/day)	2302.0 ± 325.7	2362.9 ± 428.2	2418.9 ± 412.5	0.224	2373.1 ± 420.7
Protein (g/day)	87.2 ± 16.1	87.7 ± 17.5	90.9 ± 16.6	0.123	88.4 ± 17.3
Fat (g/day)	63.8 ± 13.6	64.9 ± 17.2	65.3 ± 16.3	0.898	64.9 ± 16.8
Carbohydrate (g/day)	314.0 ± 49.1	325.8 ± 64.8	332.8 ± 62.0	0.258	326.9 ± 63.6
Protein energy ratio (%)	15.1 ± 1.5	14.9 ± 1.7	15.1 ± 1.7	0.369	15.0 ± 1.7
Fat energy ratio (%)	24.9 ± 3.6	24.7 ± 4.2	24.3 ± 4.3	0.566	24.6 ± 4.2
Carbohydrate energy ratio (%)	54.6 ± 4.2	55.2 ± 5.1	55.1 ± 5.2	0.801	55.2 ± 5.1
Age (years)	34.4 ± 3.2	35.0 ± 2.9	35.2 ± 2.7	0.252	35.0 ± 2.9
Height (cm)	171.2 ± 6.2	168.4 ± 5.9	169.1 ± 6.3	0.026	168.7 ± 6.1
Body weight (kg)	51.8 ± 4.1	62.3 ± 6.4	77.4 ± 7.9	<0.001	65.3 ± 9.7
Body mass index (kg/m²)	17.7 ± 0.7	22.0 ± 1.8	27.0 ± 1.8	—	22.9 ± 3.0
(40–49 years)	(*n* = 24)	(*n* = 582)	(*n* = 230)		(*n* = 836)
Energy (kcal/day)	2240.3 ± 397.8	2423.2 ± 432.3	2376.5 ± 413.6	0.059	2405.1 ± 427.2
Protein (g/day)	85.6 ± 21.3	93.5 ± 18.2	92.8 ± 17.2	0.108	93.1 ± 18.0
Fat (g/day)	59.7 ± 17.3	62.8 ± 15.6	60.0 ± 15.0	0.062	61.9 ± 15.5
Carbohydrate (g/day)	303.0 ± 49.6	331.2 ± 67.0	329.2 ± 63.7	0.117	329.9 ± 65.8
Protein energy ratio (%)	15.3 ± 2.6	15.5 ± 1.8	15.7 ± 1.9	0.298	15.6 ± 1.9
Fat energy ratio (%)	23.7 ± 3.6	23.3 ± 4.0	22.7 ± 3.6	0.090	23.2 ± 3.9
Carbohydrate energy ratio (%)	54.5 ± 5.6	54.7 ± 5.0	55.4 ± 4.6	0.141	54.9 ± 4.9
Age (years)	44.0 ± 2.9	44.0 ± 2.9	44.4 ± 3.1	0.159	44.1 ± 3.0
Height (cm)	167.9 ± 6.8	166.3 ± 5.9	165.9 ± 5.3	0.205	166.2 ± 5.8
Body weight (kg)	50.0 ± 4.0	61.6 ± 6.4	74.4 ± 6.8	<0.001	64.8 ± 9.0
Body mass index (kg/m²)	17.7 ± 0.6	22.2 ± 1.7	27.0 ± 1.9	—	23.4 ± 2.9
(50–59 years)	(*n* = 30)	(*n* = 551)	(*n* = 211)		(*n* = 792)
Energy (kcal/day)	2327.5 ± 341.7	2458.2 ± 493.1	2434.3 ± 441.7	0.308	2446.9 ± 475.2
Protein (g/day)	87.1 ± 11.9	97.3 ± 20.1	97.6 ± 22.6	0.028	97.0 ± 20.6
Fat (g/day)	54.1 ± 11.4	59.9 ± 17.1	60.0 ± 17.3	0.187	59.7 ± 17.0
Carbohydrate (g/day)	340.0 ± 54.1	344.7 ± 76.9	340.9 ± 66.2	0.783	343.5 ± 73.4
Protein energy ratio (%)	15.1 ± 2.0	15.9 ± 1.9	16.0 ± 2.1	0.060	15.9 ± 2.0
Fat energy ratio (%)	20.9 ± 3.0	21.9 ± 4.2	22.1 ± 4.3	0.312	21.9 ± 4.2
Carbohydrate energy ratio (%)	58.5 ± 4.3	56.1 ± 5.4	56.2 ± 5.8	0.070	56.2 ± 5.5
Age (years)	56.0 ± 2.2	54.5 ± 2.9	54.7 ± 2.9	0.024	54.7 ± 2.9
Height (cm)	161.8 ± 5.6	162.7 ± 5.9	163.0 ± 5.6	0.559	162.8 ± 5.8
Body weight (kg)	46.5 ± 3.4	59.0 ± 6.2	71.1 ± 6.8	<0.001	61.8 ± 8.8
Body mass index (kg/m²)	17.8 ± 0.6	22.3 ± 1.6	26.7 ± 1.8	—	23.3 ± 2.8
(60–69 years)	(*n* = 58)	(*n* = 512)	(*n* = 138)		(*n* = 708)
Energy (kcal/day)	2196.9 ± 512.2	2222.9 ± 395.6	2310.3 ± 429.7	0.065	2237.8 ± 414.0
Protein (g/day)	84.1 ± 19.0	86.8 ± 17.7	89.8 ± 19.1	0.096	87.2 ± 18.1
Fat (g/day)	52.6 ± 19.8	52.3 ± 15.7	54.7 ± 14.9	0.291	52.8 ± 15.9
Carbohydrate (g/day)	316.3 ± 84.0	323.4 ± 63.4	336.9 ± 72.2	0.061	325.4 ± 67.2
Protein energy ratio (%)	15.4 ± 2.0	15.7 ± 1.9	15.6 ± 1.9	0.644	15.6 ± 1.9
Fat energy ratio (%)	21.3 ± 5.3	21.0 ± 4.5	21.3 ± 4.6	0.765	21.1 ± 4.6
Carbohydrate energy ratio (%)	57.7 ± 6.5	58.3 ± 5.8	58.3 ± 5.5	0.754	58.3 ± 5.8
Age (years)	64.3 ± 2.8	64.1 ± 2.8	64.1 ± 2.7	0.856	64.1 ± 2.8
Height (cm)	162.3 ± 6.8	160.9 ± 5.8	160.6 ± 5.9	0.148	160.9 ± 5.9
Body weight (kg)	45.8 ± 4.1	57.1 ± 6.3	70.0 ± 8.2	<0.001	58.7 ± 9.1
Body mass index (kg/m²)	17.4 ± 0.9	22.0 ± 1.7	27.1 ± 2.1	—	22.6 ± 3.1
(70– years)	(*n* = 65)	(*n* = 342)	(*n* = 82)		(*n* = 489)
Energy (kcal/day)	1974.9 ± 399.7	1979.3 ± 407.6	2016.7 ± 455.3	0.747	1985.0 ± 414.3
Protein (g/day)	75.4 ± 16.7	77.7 ± 17.6	80.0 ± 19.4	0.303	77.8 ± 17.8
Fat (g/day)	44.4 ± 14.6	44.7 ± 14.4	46.9 ± 15.4	0.445	45.0 ± 14.6
Carbohydrate (g/day)	302.8 ± 65.4	299.4 ± 67.2	299.5 ± 67.7	0.929	299.9 ± 66.9
Protein energy ratio (%)	15.3 ± 1.9	15.8 ± 2.2	15.9 ± 2.0	0.213	15.7 ± 2.1
Fat energy ratio (%)	20.2 ± 4.9	20.3 ± 4.5	20.7 ± 4.3	0.678	20.3 ± 4.5
Carbohydrate energy ratio (%)	61.4 ± 5.8	60.5 ± 6.2	59.8 ± 6.5	0.269	60.5 ± 6.2
Age (years)	76.6 ± 4.9	75.8 ± 4.6	74.4 ± 4.6	0.011	75.7 ± 4.7
Height (cm)	159.3 ± 6.6	157.8 ± 6.1	159.5 ± 5.7	0.025	158.3 ± 6.2
Body weight (kg)	43.9 ± 4.3	54.2 ± 6.1	68.4 ± 6.2	<0.001	55.2 ± 9.0
Body mass index (kg/m²)	17.3 ± 0.9	21.7 ± 1.8	26.8 ± 1.4	—	22.0 ± 3.1
(Total)	(*n* = 208)	(*n* = 2460)	(*n* = 815)		(*n* = 3483)
Energy (kcal/day)	2167.0 ± 435.7	2316.0 ± 463.2	2352.1 ± 443.3	<0.001	2315.6 ± 458.6
Protein (g/day)	82.5 ± 17.8	89.6 ± 19.3	91.9 ± 19.7	<0.001	89.7 ± 19.4
Fat (g/day)	52.8 ± 17.3	57.8 ± 17.5	58.8 ± 16.6	<0.001	57.7 ± 17.3
Carbohydrate (g/day)	313.6 ± 66.7	327.2 ± 69.5	331.2 ± 66.8	0.004	327.3 ± 68.8
Protein energy ratio (%)	15.3 ± 2.0	15.6 ± 1.9	15.7 ± 2.0	0.032	15.6 ± 1.9
Fat energy ratio (%)	21.7 ± 4.7	22.4 ± 4.5	22.4 ± 4.3	0.110	22.3 ± 4.5
Carbohydrate energy ratio (%)	58.2 ± 6.1	56.7 ± 5.8	56.5 ± 5.6	0.001	56.7 ± 5.8
Age (years)	60.1 ± 15.3	53.2 ± 13.8	51.7 ± 12.5	<0.001	53.3 ± 13.7
Height (cm)	163.3 ± 7.7	163.6 ± 6.9	164.2 ± 6.5	0.064	163.7 ± 6.9
Body weight (kg)	46.7 ± 4.9	59.2 ± 6.9	72.8 ± 7.8	<0.001	61.6 ± 9.8
Body mass index (kg/m²)	17.5 ± 0.8	22.1 ± 1.7	26.9 ± 1.9	—	22.9 ± 3.0

Values are mean ± S.D.
P values are by analysis of variance.

Table 4. Mean intakes of energy and nutrients according to body mass index in women: NIPPON DATA90, 1990

	Lean (BMI < 18.5 kg/m^2)	Normal (18.5 ≤ BMI < 25.0 kg/m^2)	Obese (BMI ≥ 25.0 kg/m^2)	*P* value	Total
(30–39 years)	(*n* = 103)	(*n* = 788)	(*n* = 140)		(*n* = 1031)
Energy (kcal/day)	1850.1 ± 300.7	1872.7 ± 315.5	1944.5 ± 308.3	0.026	1880.2 ± 313.9
Protein (g/day)	72.5 ± 13.4	71.3 ± 13.0	73.7 ± 13.1	0.109	71.7 ± 13.1
Fat (g/day)	57.0 ± 13.1	57.1 ± 14.0	58.0 ± 14.7	0.778	57.2 ± 14.0
Carbohydrate (g/day)	254.3 ± 44.7	260.9 ± 48.8	274.5 ± 47.5	0.002	262.1 ± 48.5
Protein energy ratio (%)	15.7 ± 1.8	15.3 ± 1.7	15.2 ± 1.8	0.038	15.3 ± 1.7
Fat energy ratio (%)	27.7 ± 4.5	27.4 ± 4.3	26.7 ± 4.6	0.173	27.3 ± 4.4
Carbohydrate energy ratio (%)	55.1 ± 4.9	55.8 ± 4.8	56.6 ± 5.3	0.058	55.8 ± 4.9
Age (years)	34.1 ± 2.6	34.9 ± 2.8	34.9 ± 2.8	0.027	34.8 ± 2.8
Height (cm)	156.3 ± 5.6	155.9 ± 5.1	154.2 ± 5.3	0.001	155.7 ± 5.2
Body weight (kg)	43.1 ± 3.5	51.9 ± 5.0	65.1 ± 6.7	<0.001	52.8 ± 7.5
Body mass index (kg/m^2)	17.6 ± 0.7	21.4 ± 1.7	27.3 ± 2.2	—	21.8 ± 3.0
(40–49 years)	(*n* = 59)	(*n* = 867)	(*n* = 244)		(*n* = 1170)
Energy (kcal/day)	1929.3 ± 303.1	1970.8 ± 348.9	1953.8 ± 366.2	0.578	1965.1 ± 350.3
Protein (g/day)	76.1 ± 14.2	78.4 ± 15.3	78.2 ± 15.6	0.550	78.2 ± 15.3
Fat (g/day)	55.8 ± 12.2	56.7 ± 14.4	55.2 ± 14.4	0.349	56.4 ± 14.3
Carbohydrate (g/day)	273.3 ± 49.7	280.1 ± 55.2	279.6 ± 57.8	0.660	279.7 ± 55.5
Protein energy ratio (%)	15.8 ± 2.0	16.0 ± 1.9	16.1 ± 2.0	0.549	16.0 ± 1.9
Fat energy ratio (%)	26.1 ± 4.8	25.8 ± 4.2	25.4 ± 4.1	0.282	25.8 ± 4.2
Carbohydrate energy ratio (%)	56.6 ± 5.2	56.9 ± 5.1	57.2 ± 5.0	0.569	56.9 ± 5.1
Age (years)	43.8 ± 3.2	44.1 ± 2.9	45.1 ± 2.9	<0.001	44.3 ± 3.0
Height (cm)	154.8 ± 5.3	153.6 ± 5.2	152.6 ± 4.8	0.005	153.4 ± 5.2
Body weight (kg)	42.3 ± 3.5	51.4 ± 5.2	64.4 ± 6.9	<0.001	53.7 ± 8.1
Body mass index (kg/m^2)	17.6 ± 0.8	21.8 ± 1.7	27.6 ± 2.4	—	22.8 ± 3.2
(50–59 years)	(*n* = 40)	(*n* = 694)	(*n* = 298)		(*n* = 1032)
Energy (kcal/day)	1918.4 ± 387.7	1928.5 ± 351.5	1925.6 ± 401.8	0.982	1927.3 ± 367.7
Protein (g/day)	76.5 ± 14.2	78.1 ± 15.6	78.7 ± 18.8	0.714	78.2 ± 16.5
Fat (g/day)	51.2 ± 13.4	51.7 ± 14.3	50.4 ± 15.6	0.415	51.3 ± 14.6
Carbohydrate (g/day)	281.7 ± 66.0	285.4 ± 59.3	287.9 ± 63.8	0.760	286.0 ± 60.8
Protein energy ratio (%)	16.1 ± 2.1	16.3 ± 2.0	16.4 ± 2.0	0.655	16.3 ± 2.0
Fat energy ratio (%)	24.0 ± 4.5	24.1 ± 4.7	23.4 ± 4.8	0.127	23.9 ± 4.7
Carbohydrate energy ratio (%)	58.7 ± 5.4	59.2 ± 5.7	60.0 ± 6.2	0.114	59.4 ± 5.8
Age (years)	54.6 ± 2.9	54.5 ± 2.8	54.7 ± 2.8	0.543	54.5 ± 2.8
Height (cm)	151.5 ± 7.2	151.4 ± 5.1	151.3 ± 5.2	0.992	151.4 ± 5.2
Body weight (kg)	39.7 ± 4.4	50.6 ± 5.0	62.3 ± 6.5	<0.001	53.6 ± 8.1
Body mass index (kg/m^2)	17.3 ± 1.0	22.1 ± 1.7	27.2 ± 2.2	—	23.4 ± 3.2
(60–69 years)	(*n* = 64)	(*n* = 564)	(*n* = 287)		(*n* = 915)
Energy (kcal/day)	1749.1 ± 323.4	1810.5 ± 367.6	1818.9 ± 398.5	0.397	1808.9 ± 374.7
Protein (g/day)	68.7 ± 14.3	72.6 ± 15.2	73.5 ± 18.5	0.110	72.6 ± 16.2
Fat (g/day)	43.8 ± 13.1	45.8 ± 14.0	44.1 ± 14.5	0.210	45.1 ± 14.1
Carbohydrate (g/day)	267.8 ± 53.9	276.2 ± 63.4	281.0 ± 67.8	0.281	277.1 ± 64.3
Protein energy ratio (%)	15.8 ± 1.8	16.1 ± 2.1	16.2 ± 2.3	0.315	16.1 ± 2.1
Fat energy ratio (%)	22.5 ± 4.9	22.7 ± 4.8	21.7 ± 5.0	0.023	22.4 ± 4.8
Carbohydrate energy ratio (%)	61.3 ± 5.6	61.1 ± 6.3	61.9 ± 6.5	0.191	61.3 ± 6.3
Age (years)	65.5 ± 2.6	63.9 ± 2.8	64.2 ± 2.9	<0.001	64.1 ± 2.8
Height (cm)	148.8 ± 5.2	148.7 ± 5.8	148.3 ± 5.4	0.523	148.6 ± 5.6
Body weight (kg)	38.2 ± 3.1	49.0 ± 5.4	60.5 ± 6.7	<0.001	51.8 ± 8.6
Body mass index (kg/m^2)	17.3 ± 0.8	22.1 ± 1.7	27.5 ± 2.4	—	23.5 ± 3.6
(70– years)	(*n* = 71)	(*n* = 446)	(*n* = 182)		(*n* = 699)
Energy (kcal/day)	1576.4 ± 306.5	1609.0 ± 327.6	1646.9 ± 329.0	0.236	1615.5 ± 326.1
Protein (g/day)	61.8 ± 14.5	64.1 ± 13.9	66.3 ± 14.9	0.053	64.4 ± 14.3
Fat (g/day)	37.0 ± 10.3	38.7 ± 12.5	37.6 ± 11.5	0.377	38.3 ± 12.0
Carbohydrate (g/day)	249.5 ± 54.7	250.9 ± 54.8	260.2 ± 58.8	0.143	253.2 ± 55.9
Protein energy ratio (%)	15.7 ± 1.9	16.0 ± 2.0	16.2 ± 2.2	0.242	16.0 ± 2.1
Fat energy ratio (%)	21.3 ± 4.9	21.5 ± 4.5	20.6 ± 4.9	0.066	21.2 ± 4.7
Carbohydrate energy ratio (%)	63.2 ± 5.3	62.5 ± 6.1	63.2 ± 6.3	0.373	62.7 ± 6.0
Age (years)	76.6 ± 5.2	76.2 ± 4.9	75.3 ± 4.8	0.073	76.0 ± 4.9
Height (cm)	144.3 ± 5.7	144.3 ± 6.2	144.2 ± 6.7	0.968	144.3 ± 6.3
Body weight (kg)	35.7 ± 3.4	45.6 ± 5.3	56.6 ± 6.5	<0.001	47.5 ± 8.3
Body mass index (kg/m^2)	17.1 ± 1.1	21.8 ± 1.8	27.2 ± 1.8	—	22.8 ± 3.4
(Total)	(*n* = 337)	(*n* = 3359)	(*n* = 1151)		(*n* = 4847)
Energy (kcal/day)	1795.2 ± 341.1	1864.1 ± 360.6	1863.2 ± 386.6	0.004	1859.1 ± 366.0
Protein (g/day)	70.6 ± 14.9	73.8 ± 15.4	74.7 ± 17.4	<0.001	73.8 ± 15.9
Fat (g/day)	49.4 ± 14.7	51.5 ± 15.4	48.8 ± 15.9	<0.001	50.7 ± 15.5
Carbohydrate (g/day)	262.4 ± 53.2	272.2 ± 57.3	278.4 ± 61.6	<0.001	273.0 ± 58.2
Protein energy ratio (%)	15.8 ± 1.9	15.9 ± 2.0	16.1 ± 2.1	0.006	15.9 ± 2.0
Fat energy ratio (%)	24.7 ± 5.3	24.7 ± 4.9	23.4 ± 5.1	<0.001	24.4 ± 5.0
Carbohydrate energy ratio (%)	58.7 ± 6.1	58.5 ± 6.0	60.0 ± 6.4	<0.001	58.9 ± 6.1
Age (years)	53.2 ± 16.9	51.7 ± 14.0	55.9 ± 12.9	<0.001	52.8 ± 14.1
Height (cm)	151.5 ± 7.3	151.6 ± 6.5	150.1 ± 6.3	<0.001	151.2 ± 6.6
Body weight (kg)	40.1 ± 4.5	50.2 ± 5.5	61.8 ± 7.2	<0.001	52.2 ± 8.3
Body mass index (kg/m^2)	17.4 ± 0.9	21.8 ± 1.7	27.4 ± 2.2	—	22.8 ± 3.3

Values are mean ± S.D.
P values are by analysis of variance.

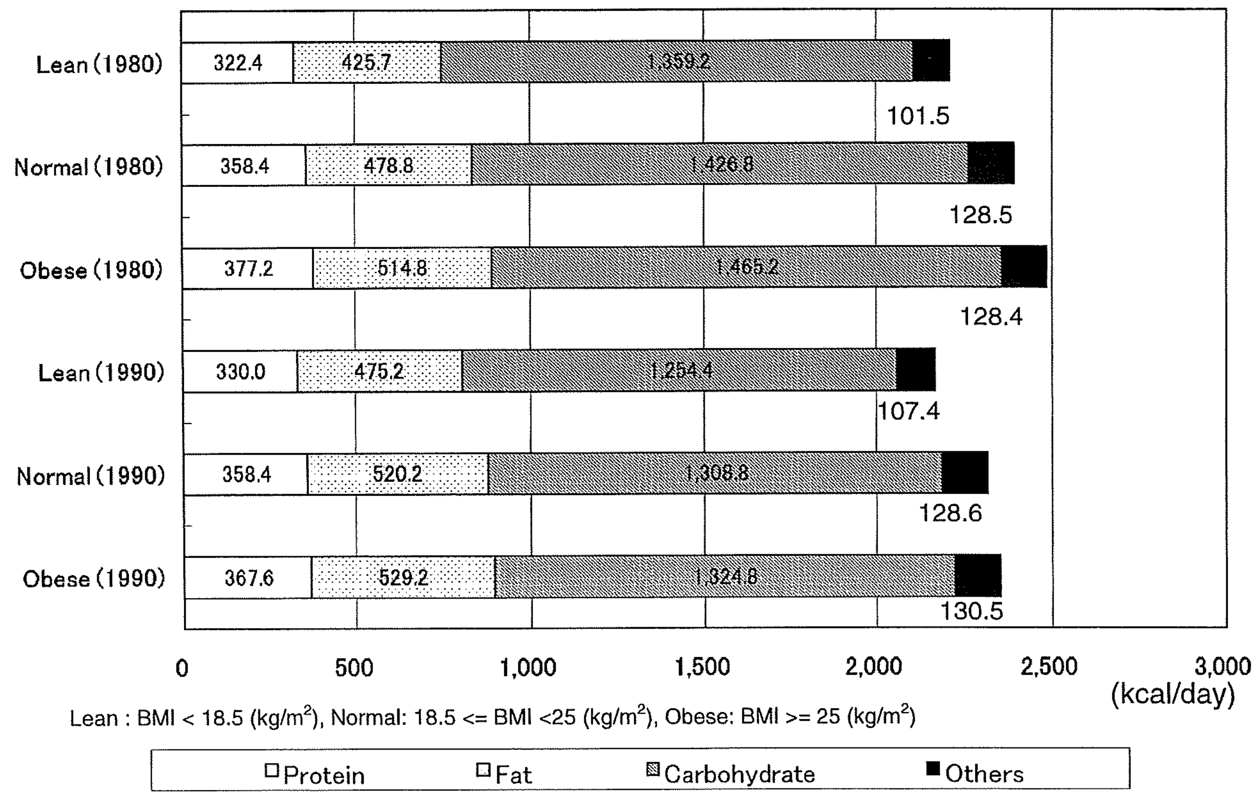

Figure 1. Mean energy intakes from protein, fat, and carbohydrate according to body mass index in men: NIPPON DATA80 (1980) and NIPPON DATA90 (1990)

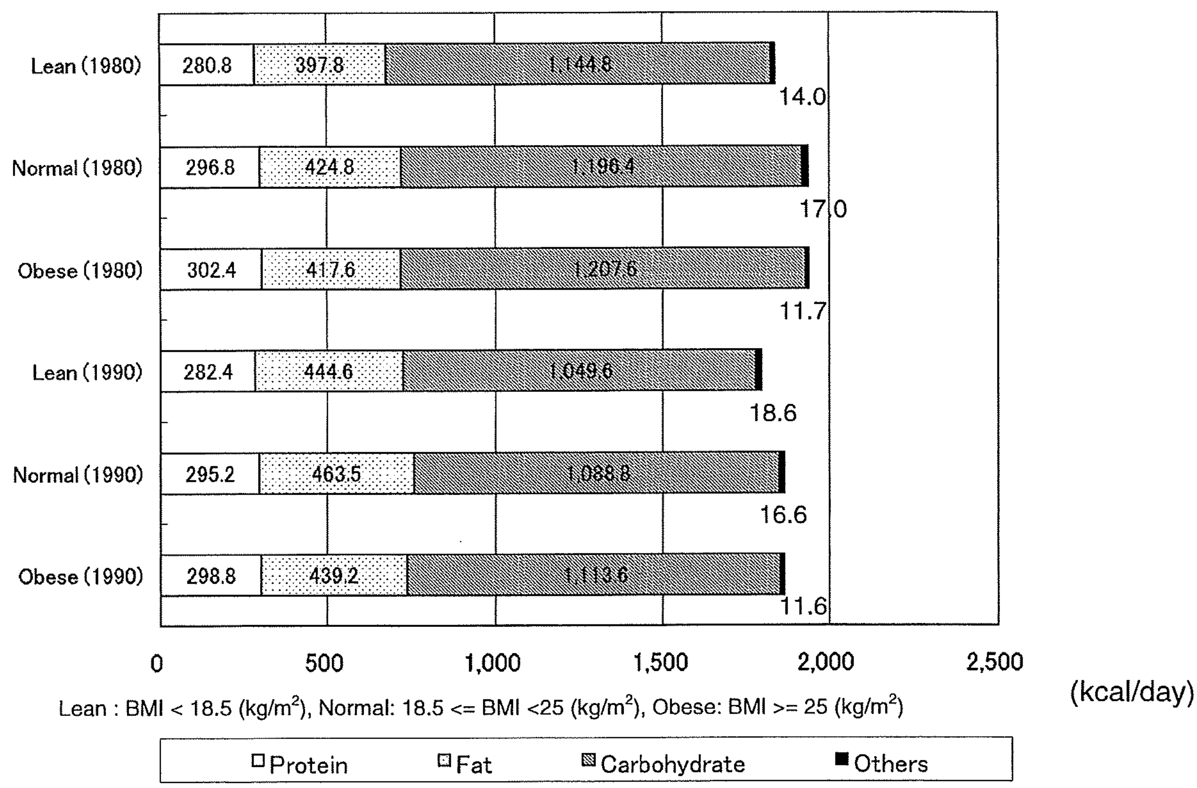

Figure 2. Mean energy intakes from protein, fat, and carbohydrate according to body mass index in women: NIPPON DATA80 (1980) and NIPPON DATA90 (1990)

low BMI to high weight/high BMI. On the other hand, when looking into the results for 1990 in women and the details by sex/age, such a tendency was not necessarily observed in all cases. This may possibly be attributed to the fact that the number of evaluable subjects decreased and a characteristic of Japanese women whereby they intentionally reduce the amount of food intake during a survey period due to wanting to be defined as a small eater. Nonetheless, we have concluded that there is an overall tendency towards those with high BMI having high total energy intake.

We then categorized total energy intake by sex in each year into the quartiles to see the relationship with BMI, and found that, in men, the group with higher total energy intake had higher BMI in both 1980 and 1980. This indicates the existence of the same relationship in the opposite direction as the aforementioned relationship with the total energy intake viewed from BMI. However, the same result was not obtained in women. Although the reason is not entirely clear, it is considered that the drive for slimness[17] commonly found in adolescent women in Japan that is associated with the aforementioned reason may possibly have an impact on this result.

In the last twenty years, the prevalence of obesity among Japanese male adults has increased in every age group and there is an associated risk of increases in the number of patients with diabetes, hypertension, hyperlipidemia, or more serious diseases such as ischemic heart disease and stroke. On the other hand, in Japanese female adults, the prevalence of obesity decreases with younger age, with an increasing number of female young adults classified as "lean".[13] Low weight in early life does not simply mean that energy intake is lower than appropriate, but it poses an increased risk of diseases caused by low intake of the three major nutrients, vitamins and minerals, due to low overall food intake. Also, we face such issues as an increase in the number of low-birth weight infants due to insufficient nutrient intake during pregnancy, and an increase in the associated risks, such as metabolic syndrome in their future life.[14,15] Thus, an examination of body mass, energy and nutrient intake and the balance of intake of the three major nutrient types may provide important clues to the prevention and treatment of various diseases, primarily lifestyle-related diseases. Changes in weight in healthy adults can serve as an objective indicator of the relationship between usual energy intake and energy expenditure during a given time period.[16] In other words, if the energy balance is positive, body weight will increase and if the balance is negative, it will decline. It is our interpretation that weight and body mass are defined at a given time during the long term in which changes in weight take place. Therefore, some relevance is attached to the energy intake defined by this study if a higher energy intake is observed in people with higher BMI when moving from the lean group to the obese group, assuming that the average level of physical activity and related conditions do not differ significantly between groups.

The nutrient intake surveys used in this study were obtained from the National Nutrition Survey, Japan conducted nationwide in 1980 and 1990. In between these two survey years, the food database was drastically renewed, as was the survey method.[8,9] From this, one might argue that it is problematic to simply compare the results of the two years. Nevertheless, it is generally observed that the total energy intake in 1990 is on a declining trend compared with 1980. However, fat energy ratio tended to be higher in total participants for both men and women in 1990 compared with that in 1980. Thus, the fat energy ratio increased by about 1–3% during the 10 years. This tendency seems to indicate the process of transition of the average dietary patterns of the Japanese from the traditional Japanese diet to a more western diet.[13]

Energy intake from nutrients other than the three major nutrients accounted for 100–130 kcal in men, much of which is assumed to be energy intake derived from alcohol. Japanese men are ranked as consuming a relatively high volume of alcohol compared with other major countries and an association with various diseases, including hypertension, has been reported.[18] Since excessive alcohol consumption has a large impact on the customary nutrient intakes and their ratios,[19,20] detailed analyses from this perspective are warranted in the future. A report by Ueda, et al studied the relationship between obesity and the nutrient intake survey results in men aged 40–59 years obtained by the INTERMAP Study conducted in Japan, and found that there was a significant positive relationship between fat energy ratio and BMI, being independent from other factors.[21] The results of this study demonstrate a similar tendency.

Because the results in this study have been estimated based on the data of the National Nutrition Survey, Japan in 1980 and 1990, it may not be entirely appropriate to treat the obtained knowledge as a precise indicator of the current state of nutrition in Japan. Nonetheless, the results in this study are highly likely to be useful for elucidating in a multilateral manner the relationships between various risk factors, including those of cardiovascular diseases, related data or death and nutrition/diet. These efforts will be further enhanced by linking these findings with follow-up data from future NIPPON DATA studies, and hence we expect further exploration of the relationship between nutrient intake and body mass in the Japanese population.

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