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

Katsushi Yoshita1, Yusuke Arai1, Miho Nozue1, Kumi Komatsu1, Hirohumi Ohnishi2, Shigeyuki Saitoh2, and Katsuyuki Miura3, for the NIPPON DATA80/90 Research Group

1Project for the National Health and Nutrition Survey, Nutritional Epidemiology Program, National Institute of Health and Nutrition, Tokyo, Japan
2Second Department of Internal Medicine, Sapporo Medical University, Sapporo, Japan
3Department of Health Science, Shiga University of Medical Science, Otsu, Japan

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

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 (4,585 men and 5,837 women) and 8,342 participants (3,488 men and 4,854 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 (4,585 men and 5,837 women) in 1980 and 8,342 (3,488 men and 4,854 women) in 1990.
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 holidays 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 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/m²]) = [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/m²); “normal (or normal weight)”, 18.5 ≤ BMI < 25.0 (kg/m²); and “obese (or high weight)”, BMI ≥ 25.0 (kg/m²).

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 years 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.

DISCUSSION

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

| (30–39 years) | (40–49 years) | (50–59 years) | (60–69 years) | (70+ years) | Total |
|---------------|---------------|---------------|---------------|-------------|-------|
| BMI (kg/m²)   | BMI (kg/m²)   | BMI (kg/m²)   | BMI (kg/m²)   | BMI (kg/m²) |       |
| (≤18.5)       | (18.5 ≤ BMI ≤ 25.0) | (BMI > 25.0) | P value       | Total       |
| (n=59)        | (n=236)       | (n=1217)      |               | (n=51)      |       |
| Energy (kcal/day) | Energy (kcal/day) | Energy (kcal/day) | Energy (kcal/day) | Energy (kcal/day) |       |
| 2282.6 ± 418.1 | 2467.9 ± 450.1 | 2530.4 ± 475.9 | 0.001 | 24710.4 ± 456.0 |       |
| Protein (g/day) | Protein (g/day) | Protein (g/day) | Protein (g/day) | 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 | 68.0 ± 18.6 |       |
| Carbohydrate (g/day) | 335.9 ± 67.2 | 357.3 ± 73.8 | 364.3 ± 77.8 | 0.031 | 357.4 ± 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 | 0.552 | 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 ± 6.7 |       |
| Body mass index (kg/m²) | 17.7 ± 0.6 | 21.8 ± 1.7 | 26.8 ± 1.6 |       | 22.6 ± 2.8 |       |

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

| BMI Category | (30–39 years) | (40–49 years) | (50–59 years) | (60–69 years) | (70+ years) |
|-------------|---------------|---------------|---------------|---------------|-------------|
| Energy (kcal/day) | 1975.2 ± 360.2 | 2046.0 ± 430.7 | 1982.7 ± 394.7 | 1825.1 ± 388.3 | 1646.7 ± 376.1 |
| Fat (g/day) | 74.4 ± 15.4 | 71.5 ± 18.9 | 71.5 ± 18.9 | 71.5 ± 17.4 | 71.5 ± 17.4 |
| Carbohydrate (g/day) | 291.5 ± 68.9 | 291.5 ± 68.9 | 291.5 ± 68.9 | 291.5 ± 68.9 | 291.5 ± 68.9 |
| Protein energy ratio (%) | 15.9 ± 2.2 | 15.9 ± 2.2 | 15.9 ± 2.2 | 15.9 ± 2.2 | 15.9 ± 2.2 |
| Fat energy ratio (%) | 15.8 ± 2.4 | 15.8 ± 2.4 | 15.8 ± 2.4 | 15.8 ± 2.4 | 15.8 ± 2.4 |
| Carbohydrate energy ratio (%) | 64.8 ± 7.3 | 64.8 ± 7.3 | 64.8 ± 7.3 | 64.8 ± 7.3 | 64.8 ± 7.3 |
| Protein energy ratio (%) | 15.0 ± 1.9 | 15.0 ± 1.9 | 15.0 ± 1.9 | 15.0 ± 1.9 | 15.0 ± 1.9 |
| Fat energy ratio (%) | 15.0 ± 1.9 | 15.0 ± 1.9 | 15.0 ± 1.9 | 15.0 ± 1.9 | 15.0 ± 1.9 |
| Carbohydrate energy ratio (%) | 62.8 ± 6.7 | 62.8 ± 6.7 | 62.8 ± 6.7 | 62.8 ± 6.7 | 62.8 ± 6.7 |
| Body weight (kg) | 60.9 ± 6.1 | 60.9 ± 6.1 | 60.9 ± 6.1 | 60.9 ± 6.1 | 60.9 ± 6.1 |
| Body mass index (kg/m²) | 17.5 ± 2.0 | 22.1 ± 1.7 | 27.3 ± 2.0 | 23.3 ± 3.3 | 23.3 ± 3.3 |

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

**Note:** Total Energy Intake and Intake of Three Major Nutrients in Japan

---

**Lean (BMI < 18.5 kg/m²)**  
**Normal (18.5 ≤ BMI < 25.0 kg/m²)**  
**Obese (BMI ≥ 25.0 kg/m²)**  
**P-value**  
**Total**
Table 3. Mean intakes of energy and nutrients according to body mass index in men: NIPPON DATA90, 1990

| Body mass index (kg/m²) | (30–39 years) (n = 31) | (40–49 years) (n = 58) | (50–59 years) (n = 50) | (60–69 years) (n = 58) | (70+ years) (n = 65) | Pvalue | Total |
|------------------------|------------------------|------------------------|------------------------|------------------------|---------------------|--------|--------|
| Energy (kcal/day)       | 2302.0 ± 325.7         | 2423.2 ± 432.3         | 2376.5 ± 413.6         | 2376.5 ± 413.6         | 2373.1 ± 420.7      | 0.224  | 2373.1 ± 420.7 |
| Protein (g/day)         | 87.2 ± 16.1            | 87.7 ± 17.5            | 90.9 ± 16.6            | 90.9 ± 16.6            | 88.4 ± 17.3         | 0.123  | 88.4 ± 17.3 |
| Fat (g/day)             | 63.8 ± 13.6            | 64.9 ± 17.2            | 65.3 ± 16.3            | 65.3 ± 16.3            | 64.9 ± 16.8         | 0.898  | 64.9 ± 16.8 |
| Carbohydrate (g/day)    | 314.0 ± 49.1           | 325.8 ± 64.8           | 332.8 ± 62.8           | 332.8 ± 62.8           | 329.5 ± 60.6        | 0.258  | 329.5 ± 60.6 |
| Protein energy ratio (%)| 15.1 ± 1.5             | 14.9 ± 1.7             | 15.1 ± 1.7             | 15.1 ± 1.7             | 15.0 ± 1.7          | 0.369  | 15.0 ± 1.7 |
| Fat energy ratio (%)    | 24.9 ± 3.6             | 24.7 ± 4.2             | 24.3 ± 4.3             | 24.3 ± 4.3             | 24.6 ± 4.2          | 0.566  | 24.6 ± 4.2 |
| Carbohydrate energy ratio (%) | 54.6 ± 4.2  | 55.2 ± 5.1             | 55.1 ± 5.2             | 55.1 ± 5.2             | 55.2 ± 5.1          | 0.801  | 55.2 ± 5.1 |
| Age (years)             | 34.4 ± 3.2             | 35.0 ± 2.9             | 35.2 ± 2.7             | 35.2 ± 2.7             | 35.0 ± 2.9          | 0.252  | 35.0 ± 2.9 |
| Height (cm)             | 171.2 ± 6.2            | 168.4 ± 5.9            | 169.1 ± 6.3            | 169.1 ± 6.3            | 168.7 ± 6.1         | 0.026  | 168.7 ± 6.1 |
| Body weight (kg)        | 51.8 ± 4.1             | 62.3 ± 6.4             | 77.4 ± 7.9             | 77.4 ± 7.9             | 65.3 ± 9.7          | <0.001 | 65.3 ± 9.7 |
| Body mass index (kg/m²) | 17.7 ± 0.7             | 22.0 ± 1.8             | 27.0 ± 1.8             | 27.0 ± 1.8             | 22.9 ± 3.0          | 0.000  | 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

| BMI Category | (30–39 years) | (40–49 years) | (50–59 years) | (60–69 years) | (70– years) | (Total) |
|--------------|---------------|---------------|---------------|---------------|-------------|--------|
| (n = 103)    | (n = 788)     | (n = 140)     | (n = 103)     | (n = 64)      | (n = 71)    | (n = 1170) |
| Energy (kcal/day) | 1850.1 ± 302.7 | 1872.7 ± 315.5 | 1944.5 ± 308.3 | 0.026 | 1890.2 ± 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 ± 44.6 | 274.5 ± 47.2 | 0.002 | 262.1 ± 47.5 |
| 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 | 56.5 ± 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/m²) | 17.6 ± 0.7   | 21.4 ± 1.7    | 27.3 ± 2.2    | —       | 21.8 ± 3.0   |

| BMI Category | (n = 59) | (n = 867) | (n = 244) | (n = 170) |
|--------------|---------|----------|----------|----------|
| Energy (kcal/day) | 1929.3 ± 303.1 | 1970.6 ± 348.9 | 1953.8 ± 366.2 | 0.578 |
| Protein (g/day) | 76.1 ± 14.2 | 78.4 ± 15.3 | 78.2 ± 15.6 | 0.550 |
| Fat (g/day) | 55.8 ± 13.2 | 56.7 ± 14.4 | 55.2 ± 14.4 | 0.349 |
| Carbohydrate (g/day) | 273.3 ± 49.7 | 280.1 ± 55.2 | 279.6 ± 57.8 | 0.860 |
| Protein energy ratio (%) | 15.8 ± 2.0 | 16.0 ± 1.9 | 16.1 ± 2.0 | 0.549 |
| Fat energy ratio (%) | 26.1 ± 4.8 | 25.9 ± 4.2 | 25.4 ± 4.1 | 0.292 |
| Carbohydrate energy ratio (%) | 55.6 ± 5.2 | 56.9 ± 5.1 | 57.2 ± 5.0 | 0.569 |
| Age (years) | 43.8 ± 3.2    | 44.1 ± 2.9    | 45.1 ± 2.9    | <0.001 |
| Height (cm) | 154.8 ± 5.3   | 153.6 ± 4.8   | 152.6 ± 4.8   | 0.005 |
| Body weight (kg) | 42.3 ± 3.5   | 51.4 ± 5.2    | 64.4 ± 6.9    | <0.001 |
| Body mass index (kg/m²) | 17.6 ± 0.8   | 21.8 ± 1.7   | 27.6 ± 2.4    | —       |

| BMI Category | (n = 40) | (n = 694) | (n = 298) | (n = 403) |
|--------------|---------|----------|----------|----------|
| Energy (kcal/day) | 1918.4 ± 387.7 | 1928.5 ± 351.5 | 1925.6 ± 401.8 | 0.982 |
| Protein (g/day) | 76.5 ± 14.2 | 78.1 ± 15.6 | 78.8 ± 17.4 | 0.714 |
| Fat (g/day) | 51.2 ± 13.4 | 51.7 ± 14.3 | 50.4 ± 15.6 | 0.415 |
| Carbohydrate (g/day) | 281.7 ± 66.0 | 285.4 ± 59.3 | 287.9 ± 63.8 | 0.760 |
| Protein energy ratio (%) | 16.1 ± 2.1 | 16.3 ± 2.0 | 16.5 ± 2.0 | 0.655 |
| Fat energy ratio (%) | 24.0 ± 4.5 | 24.1 ± 4.5 | 23.4 ± 4.7 | 0.137 |
| Carbohydrate energy ratio (%) | 58.7 ± 5.4 | 59.2 ± 5.7 | 60.0 ± 6.2 | 0.114 |
| Age (years) | 54.6 ± 2.9    | 54.5 ± 2.8    | 54.7 ± 2.8    | 0.543 |
| Height (cm) | 151.5 ± 7.2   | 151.4 ± 6.5   | 151.3 ± 5.2   | 0.992 |
| Body weight (kg) | 39.7 ± 4.4   | 50.6 ± 5.0    | 62.3 ± 6.5    | <0.001 |
| Body mass index (kg/m²) | 17.3 ± 1.0   | 22.1 ± 1.7   | 27.2 ± 2.2    | —       |

Values are mean ± S.D.

P value are by analysis of variance.
Lean: BMI < 18.5 (kg/m²), Normal: 18.5 ≤ BMI < 25 (kg/m²), Obese: BMI ≥ 25 (kg/m²)

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 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 other 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”. 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. 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. 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. 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.

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. Since excessive alcohol consumption has a large impact on the customary nutrient intakes and their ratios, 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. 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.

ACKNOWLEDGEMENTS

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

1. Barasi ME. Nutritional principles. In: Nutrition at a Glance. Oxford, UK; 2007. p. 6–25.

2. Gidding SS, Lichtenstein AH, Faith MS, Karpyn A, Mensella JA, Popkin B, et al. Implementing American Heart Association Pediatric and Adult Nutrition Guidelines: a scientific statement from the American Heart Association Nutrition Committee of the Council on Nutrition, Physical Activity and Metabolism, Council on Cardiovascular Disease in the Young, Council on Arteriosclerosis, Thrombosis and Vascular Biology, Council on Cardiovascular Nursing, Council on Epidemiology and Prevention, and Council for High Blood Pressure Research. Circulation. 2009;119:1161–75.

3. Funada S, Shimazu T, Kazikazi M, Kuriyama S, Sato Y, Matsuda-Ohmori K, et al. Body mass index and cardiovascular disease mortality in Japan: the Ohsaki Study. Prev Med. 2008;47:66–70.

4. Japanese Ministry of Health and Welfare. National Survey on Circulatory Disorders (in Japanese). Japan Heart Foundation, Tokyo; 1982.

5. Ueshima H. NIPPON DATA. Nippon Rinsho. 2006;64 Suppl 6:108–11 (in Japanese).

6. Ueshima H, Choudhury SR, Okayama A, Hayakawa T, Kita Y, Kadowaki T, et al. Cigarette smoking as a risk factor for stroke death in Japan: NIPPON DATA80. Stroke. 2004;35:1836–41.

7. Kadota A, Hozawa A, Okamura T, Kadowaki T, Nakamura K, Murakami Y, et al; NIPPON DATA Research Group. Relationship between metabolic risk factor clustering and cardiovascular mortality stratified by high blood glucose and obesity: NIPPON DATA90, 1990–2000. Diabetes Care. 2007;30:1533–8.

8. Ministry of Health and Welfare. The National Nutrition Survey in Japan, 1980. Tokyo: Daichi Shuppan; 1982 (in Japanese).

9. Ministry of Health and Welfare. The National Nutrition Survey in Japan, 1990. Tokyo: Daichi Shuppan; 1992 (in Japanese).

10. Okuda N, Miura K, Yoshita K, Matsumura Y, Nakamura Y, Okayama A, et al. Integration of data from NIPPON DATA80/90 and National Nutrition Survey in Japan: for cohort studies of representative Japanese on nutrition. J Epidemiol. 2010;20 Suppl 3:S506–14.

11. Ministry of Health and Welfare. The National Nutrition Survey in Japan, 1995. Tokyo: Daiichi Shuppan; 1997 (in Japanese).

12. Japan Society for the Study of Obesit. Guidelines for the management of obesity 2006. Journal of Japan Society for the Study of Obesit. 2006;12:10–5 (in Japanese).

13. Ministry of Health. Labour and Welfare. The National Health and Nutrition Survey in Japan, 2007. Tokyo: Daiichi Shuppan; 2009 (in Japanese).

14. Barker DJ, Hales CN, Fall CH, Osmond C, Phipps K, Clark PM. Type 2 (non-insulin-dependent) diabetes mellitus, hypertension and hyperlipidaemia (syndrome X): relation to reduced fetal growth. Diabetologia. 1993;36:62–7.

15. Barker DJ, Osmond C, Simmonds SJ, Wield GA. The relation of small head circumference and thinness at birth to death from cardiovascular disease in adult life. BMJ. 1993;306:422–6.

16. Ministry of Health, Labour and Welfare. Dietary Reference Intakes for Japanese (2010 ed.). Daiichi Shuppan; 2009 (in Japanese).

17. Hayashi F, Takimoto H, Yoshita K, Yoshiike N. Perceived body size and desire for thinness of young Japanese women: a population-based survey. Br J Nutr. 2006;96:1154–62.

18. Yoshita K, Miura K, Morikawa Y, Ishizaki M, Kido T, Naruse Y, et al. Relationship between alcohol consumption to 7-year blood pressure change in Japanese men. J Hypertens. 2005;23:1485–90.

19. Yoshita K. The relationships between alcohol, Food and nutrient intakes and health examination results. Journal of the Japanese Association for Cerebro-cardiovascular Disease Control. 1998;33:186–98 (in Japanese).

20. Yoshita K, Tabata M, Takase E, Kadoshima Y, Ishizaki M, Miura K, et al. The relationships between alcohol intake and contribution ratio of energy intake. Hokuriku Journal of Public Health. 1999;26:34–7 (in Japanese).

21. Ueda H, Higashiyamato A, Okayama A, Okamura T, Okuda N, Yoshita K, et al. Obesity and percentage energy from fat: The intermap study of middle-aged Japanese men. Japanese Journal of Cardiovascular Disease Prevention. 2008;43:123–31 (in Japanese).