The 1975 Type Japanese Diet Improves Lipid Metabolic Parameters in Younger Adults: A Randomized Controlled Trial

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Abstract: In our previous study, the health benefits of the 1975 Japanese diet were shown to be the highest, since the diet suppressed visceral and liver fat accumulation, and hyperglycemia. In addition, the 1975 Japanese diet promoted maintenance of learning memory ability and a lengthened life span. However, the effect of the 1975 Japanese diet has not been ascertained in humans. In the current study, a diet with the characteristics of the 1975 Japanese diet was prepared to examine if this diet is beneficial for human health. The purpose of this randomized controlled trial was to determine effects of the 1975 Japanese diet (JD) in comparison with a modern Japanese diet (MD). Subjects aged 20~29 years old were randomly assigned to the MD (n=16) and JD (n=16) groups. Each subject consumed the diet three times a day for 28 days. Changes in physical conditions, including body composition and blood biochemistry, from before to after the study period were evaluated. As a result, body weight (p < 0.05), body fat percentage (p < 0.05), body fat mass (p < 0.05), serum triglyceride level (p < 0.05), and serum low-density lipoprotein cholesterol level (p < 0.05) were significantly decreased and serum high-density lipoprotein cholesterol (p < 0.05) and serum magnesium levels (p < 0.05) were significantly increased in JD group. These results showed that a diet with the characteristics of the 1975 Japanese diet has a beneficial effect on lipid metabolic parameters.

Key words: Japanese diet, lipid metabolism, 1975 Japanese diet, LDL - cholesterol, HDL - cholesterol

1 INTRODUCTION

The average life expectancy in Japan has steadily increased and Japan is known for its longevity worldwide. In comparison with other countries, the Japanese population has a long life-span and a long healthy life expectancy. The primary reasons for these observations are progress of medical care, improvement in living standards, and the Japanese diet. In particular, the unique Japanese diet is thought to have a significant impact on life span, and there is growing interest in this diet because of its health benefits. Over the years, a number of studies have examined the characteristic components of the Japanese diet. However, these studies have investigated the effects of single components only, and there have been few reports on the effects of the entire diet. Thus, the effects of the Japanese diet as a whole ensemble of ingredients remain unclear.

Many ingredients are consumed in a diet, and it is therefore important to evaluate how the whole diet affects the body. Accordingly, we have conducted a series of studies to examine the effects of ingestion of the Japanese diet as a whole. We first showed that the Japanese diet has greater health benefits than the American diet; the Japanese diet had a lower risk of causing stress, resulting in accelerated metabolism, and was less likely to lead to obesity. However, as the Japanese diet has become more Westernized in the past 50 years, the prevalence of lifestyle disease has increased, and there is some question as to whether the modern Japanese diet has any health benefits. Therefore, we also examined the contents of Japanese diets from different years to determine which diet was most effective in maintaining good health. The Japanese
diet from 2005 was defined as the modern Japanese diet. Moving back in 15-year increments, weekly menus from 2005, 1990, 1975, and 1960 were reproduced and prepared as powdered foods. Effects on lipid and glucose metabolic pathways were examined using normal (ICR) mice and senescence-accelerated mouse prone 8 (SAMP8) mice fed the diets from the respective years ad libitum. The health benefits of the 1975 Japanese diet were shown to be the highest, since the diet suppressed visceral and liver fat accumulation, and hyperglycemia. In addition, the 1975 Japanese diet promoted maintenance of learning memory ability and a lengthened life span.

In the current study, a diet with the characteristics of the 1975 Japanese diet was prepared to examine if this diet is beneficial for human health. Effects on healthy subjects were compared for a diet similar to the 1975 Japanese diet (JD) and a modern Japanese diet (MD) based on the 2015 Japan National Health and Nutrition Survey (NHNS). We analyzed blood lipid metabolic parameters and body composition related to it as the main result.

2 MATERIALS & METHODS

2.1 Study design

The study was a double-blind, parallel-group, randomized trial (Fig. 1). This study was conducted in accordance with the Declaration of Helsinki, in compliance with the ethical guidelines of the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Health, Labor and Welfare concerning medical research on humans, and with the approval of the Tohoku University Ethics Committee (registration ID No. 15-A-05). This study was registered at the University Hospital Medical Information Network (UMIN) (registration ID No. UMIN20449).

2.2 Subjects

Subjects recruited publicly students from universities in Sendai city ranged in age from 20-30 years by poster. Thirty-two voluntary students signed an informed consent form for participation of this trial. Exclusion criteria were pregnancy (possibility of, or desire for pregnancy) or lactation, any disease that prevented participation in the study, diseases related to poorly controlled metabolic syndrome by drug or diet therapy, severe food allergies, current participation in other clinical trials, and judgment by the clinical trial doctor as unsuitable for participation (Two people were excluded).

2.3 Intervention

We randomly assigned 16 subjects to the MD as the control group (11 men, 5 women) and 16 subjects to the JD as the intervention group (10 men, 6 women). The intervention period was 4 weeks from January 25, 2016 to February 21, 2016. Subjects performed moderate exercise (running, badminton, etc.) for more than 1 hour a day, 3 times a week during the intervention period. Measurement of body composition and blood biochemical examination were conducted before and after the test period, and the change in the physical condition was evaluated.

The MD was based on the 2015 NHNS. The JD incorporated features of the 1975 Japanese diet into the MD. MD menus were created for 4 weeks (84 diets) based on the NHNS under the guidance of a registered dietitian, with reference to a previously reported method. The JD was prepared based on the ingredients and cooking methods used for the MD, but with incorporation of five characteristics of the 1975 Japanese diet, which were based on our previous study (Fig. 2): variety, indicating that more types of foodstuffs are used in the JD; cookery, indicating that more dishes were prepared using simmering; steaming, and as raw food in the JD; foodstuff, indicating a higher frequency of soy products, fish (shellfish), vegetables (pickles), fruit, green tea, seaweed, and mushrooms in the JD; condiment, indicating more frequent use of soup stock “Dashi” and fermented seasoning (soy sauce, miso, vinegar, mirin, and sake) in the JD; and form, indicating more use of...
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The characteristics of the 1975 Japanese diet were divided into 5 elements, based on our previous study. The first one is "Variety". This characteristic means that there are many types of foodstuffs used. The second one is "Cookery". This characteristic means that many dishes were prepared using simmering, steaming and raw among the various cooking methods. The third one is "Foodstuff". This characteristic means that the use frequency of soy products, fish (shellfish), vegetables (pickles), fruit, green tea, seaweed, and mushrooms are high. The fourth one is "Condiment". This characteristic means that the use frequency of soup stock "Dashi" and fermented seasoning (soy sauce, miso, vinegar, mirin, and sake) are high. The final one is "Form". This characteristic means that the form of rice and soup is prepared per meal.

A form of rice and soup per meal in the JD (Table 1). In addition, for general health, both diets were adjusted to maintain minimum amount required of nutritional ingredients such as minerals and vitamins in the 2015 Dietary Reference Intakes for Japanese (DRI). The amount of diet provided to subjects was based on the 2015 DRI under the menu planning of a registered dietitian. The energy of the diet was adjusted to 1,800 kcal per day. The test diets were made at Miyagi Central Kitchen. When rice was the staple food, packaged ready cooked rice was used. Main dishes and side dishes were processed in retort pouches individually after cooking and the soup ration was freeze-dried. Subjects received pre-prepared diets once daily (three servings) and were supplied these diets for 4 weeks (28 days). An excess or shortage was adjusted by the amount of staple food such as cooked rice. Eating out, drinking, snacking, and supplements were allowed freely during the study, and subjects recorded their dietary intake and intake of food other than the test diet. Each diet was freeze-dried in a vacuum freeze dryer (FD-550 R; Tokyo Rikakikai, Tokyo, Japan) and homogenized by grinding and stirring. The nutritional composition (fat, protein, moisture, ash, carbohydrate and energy) was determined to confirm the actual values (11). Fat was determined by acid digestion; protein by a modified Dumas method (Sumigraph NC analyzer NC-220 F; Sumika Chemical Analysis Service, Tokyo, Japan); moisture by vacuum oven drying; ash by direct ashing; and carbohydrate by subtracting the fat, protein, moisture and ash contents from the total amount (8, 11). Energy content was calculated using modified Atwater factors (4, 9 and 4 kcal/g for protein, fat and carbohydrate, respectively).

### Table 1 Characteristic value of two test diets.

|                | JD      | MD      | JD / MD |
|----------------|---------|---------|---------|
| Variety        | 22.0    | 19.2    | 1.14    |
| Cookery        | 2.13    | 1.69    | 1.26    |
| Foodstuff      | 9.02    | 6.94    | 1.30    |
| Condiment      | 5.51    | 3.84    | 1.43    |
| Form           | 0.64    | 0.45    | 1.42    |

The 1975 type Japanese diet (JD) and modern diet (MD) were prepared according to the menu.
1) Number of ingredients per dish.
2) Number of dish using "simmer", "steamed", and "raw" per dish.
3) Intake frequency of soy products, fish (shellfish), vegetables (pickles), fruit, green tea, seaweed, and mushrooms per dish.
4) Number of use of soup stock "Dashi" and fermented seasoning (soy sauce, miso, vinegar, mirin, and sake) per dish.
5) Frequency of form of rice and soup per dish.

Fig. 2 Beneficial Characteristics of the 1975 Japanese diet.

The characteristics of the 1975 Japanese diet were divided into 5 elements, based on our previous study. The first one is "Variety". This characteristic means that there are many types of foodstuffs used. The second one is "Cookery". This characteristic means that many dishes were prepared using simmering, steaming and raw among the various cooking methods. The third one is "Foodstuff". This characteristic means that the use frequency of soy products, fish (shellfish), vegetables (pickles), fruit, green tea, seaweed, and mushrooms are high. The fourth one is "Condiment". This characteristic means that the use frequency of soup stock "Dashi" and fermented seasoning (soy sauce, miso, vinegar, mirin, and sake) are high. The final one is "Form". This characteristic means that the form of rice and soup is prepared per meal.

of staple food such as cooked rice. Eating out, drinking, snacking, and supplements were allowed freely during the study, and subjects recorded their dietary intake and intake of food other than the test diet. Each diet was freeze-dried in a vacuum freeze dryer (FD-550 R; Tokyo Rikakikai, Tokyo, Japan) and homogenized by grinding and stirring. The nutritional composition (fat, protein, moisture, ash, carbohydrate and energy) was determined to confirm the actual values (11). Fat was determined by acid digestion; protein by a modified Dumas method (Sumigraph NC analyzer NC-220 F; Sumika Chemical Analysis Service, Tokyo, Japan); moisture by vacuum oven drying; ash by direct ashing; and carbohydrate by subtracting the fat, protein, moisture and ash contents from the total amount (8, 11). Energy content was calculated using modified Atwater factors (4, 9 and 4 kcal/g for protein, fat and carbohydrate, respectively).

2.4 Outcome

Blood lipid metabolic parameters and body composition as the main outcome were analyzed. Other parameters were checked for adverse events. Height measured using a height meter (HM 200 P, Navis), and body weight, %body fat, body fat mass, muscle mass, and bone mass measured using a body composition meter (MC-980, Tanita) were recorded. Triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), glucose (GLU), immune reactive insulin (IRI), glycylated hemoglobin (HbA1c), aspartate aminotransferase (AST), alanine aminotransferase (ALT), γ-glutamyl transferase (γ-GTP), uric acid (UA), blood urea

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The number of foodstuffs was 1.14 times higher; cookery, the characteristics compared to the MD size by one person and aimed to include 16 persons. To account for potential dropouts during the study, we increased the sample size of 0.8 and an \( \alpha \) ratio of LDL-cholesterol and HDL-cholesterol between groups with a \( \beta \) of 0.8 and an \( \alpha \) of 0.05. To account for potential dropouts during the study, we increased the sample size by one person and aimed to include 16 persons. Results are expressed as the mean ± standard error (SE).

### 2.5 Statistical analysis

Based on data from previous preliminary studies at our laboratory, we calculated a sample size of 15 subjects to be sufficient to detect a difference of 10% in change in the ratio of LDL-cholesterol and HDL-cholesterol between groups with a \( \beta \) of 0.8 and an \( \alpha \) of 0.05. To account for potential dropouts during the study, we increased the sample size by one person and aimed to include 16 persons. Results are expressed as the mean ± standard error (SE).

Data were analyzed by a two-way repeated measures ANOVA with a Tukey post hoc test. A difference between the control and intervention groups or before and after the study period, HDL-C of the JD group was significantly higher than that of the MD group \( (p<0.05) \) (Table 4). On the other hand, the body composition of the MD group did not differ significantly before and after the study period. After the study period, body fat mass of the JD group was significantly lower than that of the MD group \( (p<0.05) \). Difference of mean between before and after the study period of body weight, % body fat, body fat mass, body muscle mass and body mass index (BMI) in the JD group decreased significantly after the study period compared to before the study period \( (p<0.05) \) (Table 5). TG and LDL-C in the JD group decreased significantly after the study period compared to before the study period \( (p<0.05) \), and HDL-C increased significantly \( (p<0.05) \). On the other hand, lipid metabolic parameters of the MD group did not differ significantly before and after the study period. After the study period, HDL-C of the JD group was significantly higher than that of the MD group \( (p<0.05) \). Difference of mean between before and after the study period of TG and LDL-C in the JD group were significantly decreased \( (p = 0.004 \) and 0.015, respectively \) compared with the MD group, and HDL-C was significantly increased \( (p = 0.050) \). Before the study period, IRI, GPT, \( \gamma \)-GTP, TP and MCV of the JD group were significantly lower than that of the MD group \( (p<0.05) \) (Table 6). Other items did not differ significantly in either group. HbA1c, GOT, GPT, UA, CRE, TP, times higher; foodstuff, intake of soy products, fish (shellfish), vegetables (pickles), fruit, green tea, seaweed, and mushrooms was 1.30 times higher; condiment, use of soup stock “Dashi” and fermented seasoning (soy sauce, miso, vinegar, mirin, and sake) was 1.43 times higher; and form, the form of rice and soup was 1.42 times higher in the JD (Table 1). The general compositions and energy quantities of the MD and JD are shown in Table 2. The JD had less lipid per weight compared to the MD.

### 3.2 Body composition and blood biochemistry

All 32 subjects completed the study without problems and with compliance rate to intake of diets and time and frequency of exercise of \( \geq 90\% \), with no significant difference in these items between the JD and MD groups (Supplemental Table 3). In addition, energy intake from snack, drinking and the test diet were showed in Supplemental Table 3. As a result, there was no difference in energy intake between the groups. Body composition and blood lipid metabolic parameters as the main outcome were analyzed. Other parameters were checked for adverse events. Baseline data for body composition did not differ significantly between the groups (Table 3 and 4). Body weight, % body fat, body fat mass, body muscle mass and body mass index (BMI) in the JD group decreased significantly after the study period compared to before the study period \( (p<0.05) \) (Table 4). On the other hand, the body composition of the MD group did not differ significantly before and after the study period. After the study period, body fat mass of the JD group was significantly lower than that of the MD group \( (p<0.05) \). Difference of mean between before and after the study period of body weight, % body fat, body fat mass, body muscle mass and body mass index (BMI) in the JD group decreased significantly after the study period compared to before the study period \( (p<0.05) \), and HDL-C increased significantly \( (p<0.05) \). On the other hand, lipid metabolic parameters of the MD group did not differ significantly before and after the study period. After the study period, HDL-C of the JD group was significantly higher than that of the MD group \( (p<0.05) \). Difference of mean between before and after the study period of TG and LDL-C in the JD group were significantly decreased \( (p = 0.004 \) and 0.015, respectively \) compared with the MD group, and HDL-C was significantly increased \( (p = 0.050) \). Before the study period, IRI, GPT, \( \gamma \)-GTP, TP and MCV of the JD group were significantly lower than that of the MD group \( (p<0.05) \) (Table 6). Other items did not differ significantly in either group. HbA1c, GOT, GPT, UA, CRE, TP, and measured. The measured value was obtained by measuring the whole diet after cooking used in this study.

#### Table 2: Nutritional composition of test diet (g/100 g).

|          | JD  | MD  |
|----------|-----|-----|
| Protein  | 17.8| 16.7|
| Fat      | 8.6 | 12.2|
| Carbohydrate | 69.7| 67.3|
| Sodium chloride equivalent | 2.5 | 2.6|
| Ash      | 3.9 | 3.9|
| Energy (kcal/100 g) | 407 | 412|

The modern diet (MD) and 1975 type Japanese diet (JD) prepared according to the menu was freeze-dried, powdered and measured. The measured value was obtained by measuring the whole diet after cooking used in this study.
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Table 3  Baseline data of Intervention (JD) vs Control (MD).

|            | JD (n=16)    | MD (n=16)    | P-value $^{\dagger}$ |
|------------|--------------|--------------|----------------------|
| Age        | 23.0 ± 0.32  | 22.9 ± 0.64  | 0.921                |
| Gender     |              |              |                      |
| Male       | 10 (62.5% of group) | 11 (68.8% of group) |            |
| Female     | 6 (37.5% of group)  | 5 (31.3% of group)  |            |
| Height (cm)| 164 ± 2      | 167 ± 3      | 0.419                |

$^{\dagger}$ P-value (JD vs MD) (Mann-Whitney U test).
Mean ± standard error.

Table 4  Body composition measurement data in Intervention (JD) vs Control (MD).

|            | JD (n=16)     | MD (n=16)     | P-value $^{\ddagger}$ |
|------------|---------------|---------------|-----------------------|
| Weight (kg)| 58.4 ± 2.2    | 57.3 ± 2.11$^{*}$ | -1.02 ± 0.27          |
| Body fat (%)| 20.4 ± 1.6    | 18.9 ± 1.7$^{**}$ | -1.49 ± 0.41          |
| Fat mass (kg)| 11.8 ± 0.97  | 10.7 ± 1.0$^{*}$ | -1.04 ± 0.27          |
| Muscle mass (kg)| 43.6 ± 1.9  | 44.3 ± 1.9$^{**}$ | 0.71 ± 0.25           |
| Bone mass (kg)| 2.48 ± 0.08  | 2.51 ± 0.09   | 0.03 ± 0.02           |
| Body mass index (kg/m$^2$)| 21.6 ± 0.63 | 21.4 ± 0.6$^{*}$ | -0.17 ± 0.10          |

$^{\ddagger}$ Mean ± standard error.
1) Difference of mean between before and after.
2) P-value for Difference (Mann-Whitney U test).

Table 5  Lipid metabolic parameters in Intervention (JD) vs Control (MD).

|            | JD (n=16)     | MD (n=16)     | P-value $^{\S}$ |
|------------|---------------|---------------|-----------------|
| TG (mg/dL)| 61.8 ± 6.5    | 48.8 ± 4.8$^{**}$ | -13.0 ± 4.7     |
| TC (mg/dL)| 178 ± 6      | 176 ± 6      | -2.24 ± 3.38    |
| LDL-C (mg/dL)| 98.0 ± 6.9  | 90.9 ± 7.0$^{**}$ | -7.13 ± 3.48    |
| HDL-C (mg/dL)| 67.2 ± 4.4  | 72.8 ± 4.9$^{**}$ | 5.54 ± 2.13     |

$^{\S}$ P-value for Difference (Mann-Whitney U test).
1) Mean ± standard error.
2) Difference of mean between before and after.

WBC and PLT in the JD group decreased significantly after the study period compared to before the study period ($p < 0.05$). On the other hand, HbA1c, WBC, Ca and Mg in the MD group decreased significantly after the study period compared to before the study period ($p < 0.05$), and IRI increased significantly ($p < 0.05$). After the study period, UA and Fe of the JD group were significantly lower than that of the MD group ($p < 0.05$), and MCV, Ca and Mg were significantly higher ($p < 0.05$). The decrease in difference of mean between before and after the study period of Mg was significantly suppressed ($p = 0.028$) and insulin tended to decrease in the JD group ($p = 0.080$). Difference of mean between before and after the study period of other items did not differ significantly in either group.

4 DISCUSSION
In this study, the JD decreased body weight, % body fat, body fat mass, triacylglycerol, and LDL-C, and increased HDL-C, compared to the MD. These results are similar to those in our earlier study in mice. Visceral fat in mice of various ages fed the 1975 Japanese diet decreased, liver TG and TC decreased, and glucose metabolism improved. The effect on glucose metabolism in the current study was relatively weak (insulin showed a tendency to decrease in
### Table 6  Blood biochemical examination data in Intervention (JD) vs Control (MD).

|                | JD (n=16) | MD (n=16) | Difference | P-value $^b$ |
|----------------|-----------|-----------|------------|--------------|
|                | Before$^a$ | After$^a$ |            |              |
| Glu (mg/dL)    | 81.5 ±1.2 | 80.2 ±1.3 | -1.25 ±1.47|              |
| IRI (μU/mL)    | 5.17 ±0.71| 5.39 ±0.61| 0.23 ±0.55 |              |
| HbA1c (%)      | 5.28 ±0.06| 5.18 ±0.06$^*$| -0.09 ±0.02|              |
| GOT (IU/L)     | 23.5 ±1.1 | 21.4 ±0.7$^*$| -2.06 ±0.83|              |
| GPT (IU/L)     | 20.7 ±3.2 | 16.8 ±1.5$^*$| -3.94 ±2.32|              |
| UA (mg/dL)     | 5.83 ±0.45| 5.03 ±0.23$^*$| -0.79 ±0.33|              |
| UN (mg/dL)     | 13.0 ±0.7 | 12.3 ±0.6 | -0.71 ±0.58 |              |
| CRE (mg/dL)    | 0.756 ±0.04| 0.732 ±0.029 | -0.02 ±0.02 |              |
| CPK (IU/L)     | 158 ±20   | 124 ±15   | -34.6 ±15.9 |              |
| TP (g/dL)      | 7.68 ±0.10| 7.53 ±0.08$^*$| -0.14 ±0.07|              |
| ALB (g/dL)     | 4.88 ±0.05| 4.81 ±0.04 | -0.06 ±0.05 |              |
| WBC (10$^3$/μL)| 6268 ±450 | 5187 ±298$^*$| -1081 ±330 |              |
| RBC (10$^6$/μL)| 490 ±11   | 486 ±13   | -3.50 ±4.59 |              |
| Hb (g/dL)      | 14.8 ±0.3 | 14.7 ±0.4 | -0.12 ±0.14 |              |
| Ht (%)         | 43.8 ±1.0 | 43.6 ±1.0 | -0.24 ±0.39 |              |
| PLT (10$^3$/μL)| 25.8 ±1.2 | 24.6 ±1.2$^*$| -1.19 ±0.64 |              |
| MCV (fL)       | 89.6 ±0.6 | 89.7 ±0.8 | 0.13 ±0.26 |              |
| MCH (pg)       | 30.3 ±0.2 | 30.3 ±0.3 | 0.01 ±0.09 |              |
| MCHC (%)       | 33.8 ±0.1 | 33.7 ±0.2 | -0.07 ±0.14 |              |
| Fe (μg/dL)     | 120 ±13   | 107 ±8    | -12.5 ±13.6 |              |
| K (mEq/L)      | 4.22 ±0.08| 4.11 ±0.07| -0.11 ±0.09 |              |
| Ca (mEq/L)     | 9.65 ±0.09| 9.50 ±0.05| -0.15 ±0.07 |              |
| Cl (mEq/L)     | 101 ±0    | 101 ±0    | -0.13 ±0.30 |              |
| Na (mEq/L)     | 140 ±0    | 141 ±0    | 0.25 ±0.37 |              |
| Mg (mEq/L)     | 2.19 ±0.04| 2.15 ±0.03| -0.04 ±0.04 |              |

$^a$Mean ± standard error.
$^b$Difference of mean between before and after.
$^c$P-value for Difference (Mann-Whitney U test).

* $p < 0.05$, ** $p < 0.01$ (Before vs After) and *$p < 0.05$, **$p < 0.01$ (JD vs MD) (Two-way repeated measures ANOVA).

The reason for setting 1800 kcal/day in this study is because the average dietary intake energy of Japanese aged 20-29 years old is 1800 to 1900 kcal/day (2015 NHNS). When the amount of meal was insufficient, we asked subjects to adjust by the amount of staple food (rice, bread etc.) or snack. In Table 4, since body bone mass and body muscle mass were not decreased in both groups, it was considered that the subjects were not undernourished. In these regard, we showed energy intake from snack, drinking and test diet and dietary compliance in Supplemental Table 3. As a result, there was no difference between these data among the groups. Therefore, we believe that the results of this study are based on the contents of meals.

The average total intake energy of Japanese aged 20-29 years old is 1953 kcal/day (2015 NHNS). In this study, it was about 2,000 kcal/day, so it was almost equal (Supplemental Table 3). However, it is thought that this energy intake is not sufficient when exercise is added (2015 NHNS). In Table 4 and Table 6, since body bone mass, body muscle mass and blood albumin level were not decreased in both groups, it was considered that the subjects were not undernourished. Though quantitative values of physical activity could not be shown since the accurate ex-
exercise time is not recorded in this study, it was thought that energy consumption was suppressed because exercise intensity was probably weak (for example, it ran slower than general running). The body composition and total intake energy of each male and female are shown in **Supplemental Table 4**. There was no difference in the total intake energy between both groups, and the same tendency as that of the combined data of male and female was shown in each body composition. The average total intake energy of male and female Japanese aged 20-29 years old is 2222 kcal/day and 1706 kcal/day (2015 NHNS). In this study, it was about 2,150 kcal/day and 1,700 kcal/day, so it was almost equal (**Supplemental Table 4**). Therefore, it was considered that the subjects were not undernourished and the results of this study are based on the contents of meals. Although male received the effect of JD more strongly than female, this was thought to be due to the difference in n numbers.

In this study, comparison of a modern Japanese diet (MD) and the same diet strengthened with five characteristics (variet, cookery, foodstuff, condiment, form) of the 1975 Japanese diet (JD) showed that these characteristics had beneficial effects on human health. Variety reflects intake of various food little by little and eating well in balance, and has been suggested to have a high health benefit in epidemiological studies. Form refers to a diet of rice and soup, and the number of items per dish in this form was higher in the JD menu in this study (the form of rice and soup was 1.42 times higher in the JD). Therefore, to ensure variety, it is important to incorporate foods such as rice and miso soup. Cookery refers to use of boiling, steaming, and raw as cooking methods that cause little change in active components in the food, and this is thought to promote health. Regarding foodstuff and condiment, in our recent study using mass spectrometry and PCA of Japanese diets from 1960, 1975, 1990, and 2005, the characteristic components in the 1975 Japanese diet were identified as histidine, naringin, pyridoxamine, catechin, chromium, boron, isoleucine, arachidonic acid, glycine, stearidonic acid, daidzein, tyramine and leucine. The health effects of these components were reviewed in our previous study. Histidine is converted to histamine, histamine naturally reduces appetite and visceral fat. Naringin is promotes lipid metabolism in the liver. Pyridoxamine is improves obesity-related diseases such as metabolic dysfunction, insulin resistance, and adipose tissue inflammation. Catechin is promotes weight loss, alleviates metabolic syndrome, and prevents diabetes and cardiovascular disease. Chromium improves lipid homoeostasis. Isoleucine suppresses lipid accumulation in tissues. Glycine and daidzein are aglycones, in a comparative study of aglycones and glycosides, aglycones had better absorption than glycosides and improved lipid metabolism in liver. Leucine improves mitochondrial dysfunction and metabolic abnormalities. Foodstuffs containing many of these components include fish, fruits, vegetables, seaweed, soybean foods, soup stock “dashi”, and fermented seasoning, and a diet with enhanced levels of these foodstuffs had high health benefits. Therefore, ingesting these foodstuffs is likely to lead to health promotion, as supported by the results of this study. The amounts of vitamins and minerals and n-6/n-3 fatty acids ratio in the test diet calculated from Standard Tables of Food Composition in Japan -2015- (Seventh Edition) are shown in **Supplemental Table 5**. It was considered that the levels of vitamins and minerals and n-3 fatty acid ratio in JD were higher than that in MD and these ingredients were also involved in health function of JD. In addition, it is also important to efficiently absorb these active ingredients. There is a difference in the digestion and absorption rate of nutrients due to the difference in the cookery. Therefore, it was also important which foodstuffs the active ingredient was contained in and how it was cooked, and considered the style of the Japanese diet was important.

Two recent publications have clearly indicated that two characteristics of Japanese diets are soy foods and fish, based on analysis of biomarkers of these components in 24-hour urine samples collected worldwide or by classification of dietary patterns based on data obtained from food intakes of over 80,000 Japanese people. In addition, subjects who consumed a large amount of soy foods and fish had significantly higher serum HDL-C and folate acid. In this study, the change in serum LDL-C was significantly lower and the change in serum HDL-C was significantly higher in the JD group compared to the MD group, and the LDL-C/HDL-C ratio, an indicator of arteriosclerotic progression, was significantly lower in the JD group. These results suggest that the JD decreases the risk of arteriosclerosis onset, and intake of fish and soy foods may be an important factor that led to these results.

In this study, magnesium in the JD group was not decreased compared with the MD group. Magnesium has various beneficial effects and is an essential mineral for maintaining life. More magnesium than usual may have leaked out in sweat because of the exercise load and the JD was able to supply the lost amount. In fact, it was considered that the amount of Mg contained in JD is higher than that in MD (**Supplemental Table 5**). There was almost no difference in salt content between the JD and MD. Therefore, it seems that salinity content did not affect the results of the study. Japanese people have more salt intake than other people worldwide because a great amount of salt is included in the Japanese diet. This is one of the major disadvantages of the diet. Increased ingestion of salt is a concern because this increases the incidence of cardiovascular diseases and stomach cancer. This concern needs to be addressed in future work. The current study...
showed that the JD improves lipid metabolic parameters in humans, compared to the MD. We plan to conduct further studies in humans to obtain more detailed findings.

This study distributed all meals to the subjects. If the test period is long, stress is exerted on the subject (stress due to not being able to eat out or being unable to choose a meal). This stress probably causes a large decrease in dietary compliance. Therefore, in this study, the test period was designed to be as short as possible. So, there is a possibility that parameters with big difference might be hidden. In the future, we would like to observe changes in the physical condition over the long term by letting subjects adhere to the five characteristics (Fig. 2) of healthy Japanese diet.

5 CONCLUSION

In this study, the JD decreased body weight, % body fat, body fat mass, triacylglycerol, and LDL-C, and increased HDL-C, compared to the MD. These results showed that a diet with the characteristics of the 1975 Japanese diet has a beneficial effect on lipid metabolic parameters. These results are similar to those in our earlier study in mice. Visceral fat in mice of various ages fed the 1975 Japanese diet decreased, liver TG and TC decreased, and glucose metabolism improved. The effect on glucose metabolism in the current study was relatively weak (insulin showed a tendency to decrease in the JD group), but the benefit of the 1975 Japanese diet was also proven in humans.

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Supporting Information

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