Dietary Fiber Intake of Japanese Younger Generations and the Recommended Daily Allowance

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Summary A method was introduced for the estimation of total dietary fiber (TDF) intake of a population using a menu-oriented questionnaire and a menu-based calculation table. TDF intake correlated well with age in a population investigated, and in younger generations TDF consumption was very low (less than 11.5 g/day in teenagers). The similar results were obtained from the calculation using data of National Nutrition Survey (10.7 g/day). The foodstuffs they consumed were more processed and refined. This fact suggested that in younger generations a future resumption of their present eating habits might produce a serious lack of TDF intake in later years. To clarify the optimal level of TDF intake for the upper limit of recommended daily allowance (RDA) of an average Japanese, the following were measured and calculated. (I) Estimation of recent TDF intake (1990) and of 30 and 50 years ago (1955, 1935), based on TDF data of foodstuffs by the enzymatic-gravimetric method. (II) Measurement of the TDF of model duplicate meals and model composite diets for the average Japanese in 1985 using the same assay method. (III) Conversion of a recommendation of 20–35 g/day for American into RDA for Japanese considering energy consumption and lower fat intake. (IV) Re-estimation of the literature data on the adverse effects of DF on the human mineral balance considering the insufficient calcium intake of Japanese. The results indicated an RDA of 10–12 g TDF/1,000 kcal fit better for an average Japanese.

Key Words dietary fiber, RDA, intake, dietary questionnaire, age
Numerous studies have indicated various health-improving effects of dietary fiber (DF). The average DF intake of the general population, however, has never been calculated on a single DF database. For example, reports from the United States (1), Japan (2), and European countries (3) used combined data obtained from more than three different principles of measurement. Some of the authors have admitted discrepancies obtained from each method. In this study we aimed at the calculation of DF intake of Japanese on a single DF table and the confirmation of the decreasing trend in the latest decades. On the other hand, in a preliminary study on the DF intake from daily meals using a dietary questionnaire, we obtained a very low result for younger generations (e.g. 11.3 g/day in the age of 20) in an urban population. This result indicated that the eating habits of younger Japanese might be drifting away from the traditional foods. We investigated, therefore, the eating trend of average younger Japanese using the National Nutrition Survey (NNS).

No recommendation for the amount of daily intake (RDA) of DF has been proposed by a dose-controlled administration study. A criterion has been proposed just for the lower limit of RDA based on the DF required for the daily fecal output of 140–150 g (4). In light of our preliminary result described above, it seemed to be of urgent need to obtain the RDA for Japanese after appropriate considerations for the necessary specific allowances for Japanese. Together with analyses of past and present TDF consumption, a proposed RDA for Americans was consulted in this study because of the extensive literature background. We re-calculated the recommended amount by Federation of American Societies for Experimental Biology (FASEB) of 20–35 g/day (5), making allowance for the total energy consumption of Japanese. This consideration may be important for maintaining a balanced nutrient supply, and also for preventing a negative mineral balance putatively caused by excess TDF. The detrimental effect may be augmented by an irregular and inconsistent intake of artificial DF products, since the adaptation of microflora and the resulting degradation of soluble DF might be minimal.

Those several lines of considerations indicated nearly the same desirable DF intake as described below, and the value was compared with the proposed intake of 10–13 g (5, 6) or 10–12 g (7–9) per 1,000 kcal. The minimum points to be considered for the RDA were also indicated in Discussion.

MATERIALS AND METHODS

Basic data for the estimation of TDF intake. The National Nutrition Survey (NNS) data (10) were consulted for the daily intake per capita of each food or food group from 1956 to the present. This was based on weighing every food item consumed for 3 days in 7,000 randomly selected families (about 20,000 people) throughout Japan. The unit of statistical analysis is for a household and the families are categorized into groups, e.g. by the age of the head of household, or by the location of residence, etc. These categorized food intake data were used for the
estimation of TDF intake in each group of household. The results of NNS have been published as intake data of 63 or 89 (1971–present) foods or food groups. In groups of plural food components, the TDF of a group was calculated with a proportional allowance for the amount of consumption (weighted mean TDF table of 97 food groups) (11). In a few groups, no detailed consumption data for each food component was available in the earlier years, and the 1985 value was substituted. The 89 items on the NNS list were then placed into 10 food groups in this study. Each group was composed of the following foods: 1, rice; 2, wheat, barley, potatoes, nuts, and seeds; 3, confectioneries; 4, pulses; 5, fruits; 6, colored vegetables; 7, non-colored vegetables, algae, mushrooms, pickles; 8, seasonings, spices, beverages, prepared foods; 9, meats, fishes, shellfishes, eggs, milks; 10, fats and oils.

The National Food Supply and Demand Tables (FSDT) that reported after the FAO food classification standard (the food balance sheet) were also consulted for the food consumption from 1935 to the present (12). The TDF content of rice eaten was regarded as half-milled (2.27% TDF) in 1935, 100% under-milled (1.73%) in 1950–1955, 25% under-milled and 75% well-milled (0.92%) in 1960–1965, 20% under-milled and 80% well-milled (0.82%) in 1970–1975, and well-milled (0.72%) in 1980–present. From 1980 to the present, the TDF of soybean was taken as 70% of that calculated with the total soybean consumption (15.03% × 0.7) because of the general practice of discarding the fiber fraction called “okara.”

Sample preparation for the measurements by enzymatic-gravimetric method. Model duplicate meals were cooked in 4 different cities according to menus constructed for 3 days so as to comply with the 1985 NNS results in terms of the total carbohydrate, lipid, protein, and energy in each district. Three meals were combined for each day giving a total sum of 12 samples in 4 locations (shown in Table 7) and were analyzed using the enzymatic-gravimetric method (13). Composite diets from shopping-basket samples were prepared by purchasing 96–171 food items in retail stores in 6 different locations (shown in Table 6). The selection was based on the 1985 NNS results for each food item in each location. When the component food(s) was unavailable, a substitute within the same group was used. Foods of similar kinds were gathered into 10 food groups that contained primarily the same food items as described above for the calculation study using NNS. The foods were cooked appropriately before mixing. For each of the 9 groups other than the fat and oil (fiber of this group was assumed to be 0), mixed samples were prepared at 6 locations, and they were freeze-dried, and powdered according to the DF analysis method (13). More than 2 institutions analyzed each sample repeatedly to obtain 4 to 6 data.

Dietary questionnaire for the estimation of TDF intake. To expedite the calculation of nutrients for a large number of participants, a pamphlet was handed out that described 164 representative recipes including the amount of foodstuffs and TDF data (14). The questionnaire form for each day carried approximately 50
representative names of sample menu with a space for notes and more detailed records. Participants were asked to choose the foods (dishes) they consumed, and to note any major changes, addition or deletion of the recipe, or major deviation from the usual amounts served per person.

For the calculation of TDF intake two tables were used: the table of TDF content for the 164 representative menus (14) and a table of TDF of each food item for a standard amount used in typical recipes (per dish size) (14). The TDF value found in these tables was substituted for the menus and food names described in the questionnaire considering the notes of the participants that indicated, in some cases, a half or a third of the amount per dish size. For the evaluation of this method, the results were compared with the estimation through an interview by experienced dietitians. Twenty-six participants who answered the above questionnaire were interviewed first. The difference was 9.0% overestimation in the questionnaire method. When the number of participants interviewed was increased to 64, the two methods gave practically the same results.

Statistical analysis. In the data analyses, extreme values were detected and rejected by Smirnov test. An equation of simple linear regression line together with the residual variance ($s^2$) and the expected residual ($s$) were calculated by the least squares method. The test for significance of the regression was achieved by the $t$-test. All the above calculations were accomplished and the sample correlation coefficient was obtained by the use of a personal computer program “Stat Flex” by Viewflex Co. Ltd.

RESULTS

Chronological change of TDF intake of Japanese from 1935–1990

1. Decreasing trend of TDF intake estimated by the National Nutrition Survey. The average intake of TDF for Japanese (Fig. 1) decreased 22% during the 30 years from 1955 to 1985 (g/day or g/kcal). It was confirmed that the decreasing trend continued in 1990. There was practically no decrease in the energy intake during the same period (Table 1). The tendency was clearer when fiber fraction of animal origin was excluded (25% down in the same period, the definition of DF extended to animal foods in this study) and much clearer when the fiber content per 1 kg food was calculated (36% decrease), indicating that more refined foods were consumed as time passed (Table 1). The rate of decrease was relatively high between 1955–1975 and declined in later decades. The sources of TDF in Japan were distributed among wider food groups than in the United States (Fig. 2). Japanese eat higher amounts of rice (group 1), seaweeds, mushrooms, and pickles of various vegetables (group 7b) than Americans. This feature has a long history originating from traditional Japanese dishes (Fig. 3). The most typical example of an alteration of dietary style resides in the groups of major and minor grains (groups 1 and 2) and pulses (group 4). The consumption of barley increased temporarily because of the lack of rice during and after World War II, and the high
Fig. 1. Chronological change of dietary fiber intake in Japanese. TDF intake for an average Japanese was calculated from the food consumption data of two statistical tables (10, 12) and the TDF table of enzymatic-gravimetric measurements (13). In the case of data obtained from National Nutrition Survey, the values of 1966 and 1972 were substituted for 1965 and 1970, respectively.

Table 1. Chronological change of dietary fiber intake in Japanese.

| Year   | TDF intake (g/day) | TDF intake without animal foods (g/day) | TDF intake (g/kg food) | TDF intake (g/1,000 kcal) | Energy intake (kcal/day) |
|--------|--------------------|---------------------------------------|------------------------|----------------------------|--------------------------|
| 1934–1938 | 21.9¹             | 24.3¹                                 | 20.8                   | 10.7                       | 2,125                    |
| 1951    | 22.7               | 22.3                                  | 21.7                   | 20.2                       | 10.6                     | 2,104                    |
| 1955    | 22.2               | 21.7                                  | 17.8                   | 18.5                       | 9.1                      | 2,096                    |
| 1960    | 19.1               | 18.5                                  | 15.2                   | 17.8                       | 8.6                      | 2,096                    |
| 1966    | 18.9               | 18.2                                  | 15.2                   | 17.8                       | 8.6                      | 2,096                    |
| 1972    | 18.8               | 17.8                                  | 13.2                   | 17.8                       | 8.2                      | 2,279                    |
| 1975    | 18.3               | 17.4                                  | 13.0                   | 17.4                       | 8.2                      | 2,226                    |
| 1980    | 17.4               | 16.4                                  | 12.9                   | 16.4                       | 8.2                      | 2,119                    |
| 1985    | 17.3               | 16.3                                  | 12.9                   | 16.3                       | 8.3                      | 2,088                    |
| 1990    | 17.0               | 15.9                                  | 12.8                   | 15.9                       | 8.4                      | 2,026                    |

Calculated from the National Nutrition Survey data (10). ¹Calculated from the National Foods Supply and Demand Table.
Fig. 2. Food groups as a dietary fiber supplier in Americans and Japanese. Americans: calculated from the data of Block and Lanza (15), and the total intake was 13.14 g/day for white male American of age 19–74 years. Japanese: calculated from the data of National Nutrition Survey in 1985, and the total intake was 17.34 g/day. The constitution of each food group was 1, rice; 2, wheat, barley, potatoes, nuts, and seeds; 3, confectioneries; 4, pulses; 5, fruits; 6, colored vegetables; 7a, non-colored vegetables, 7b, algae, mushrooms, and pickles; 8, seasonings, spices, beverages, and prepared foods; and 9, meats, fishes, shellfishes, eggs, and milks.

Fig. 3. Changes of TDF intake in each food group. Calculated from the intake data of National Nutrition Survey for each food group and TDF data of enzymatic-gravimetric method (13). The food groups are the same as in Fig. 2. In the case of data obtained from National Nutrition Survey, the values of 1966 and 1972 were substituted for 1965 and 1970, respectively.

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Table 2. Size of household and dietary fiber intake.

| Household members | TDF intake (g/day) | Total food (g/day) | TDF/food (g/kg) |
|-------------------|-------------------|-------------------|----------------|
| 1                 | 16.1              | 1,263             | 12.7           |
| 2                 | 19.3              | 1,434             | 13.5           |
| 3                 | 18.5              | 1,396             | 13.3           |
| 4                 | 17.4              | 1,347             | 12.9           |
| 5                 | 17.0              | 1,317             | 12.9           |
| 6 or more         | 16.5              | 1,260             | 13.1           |
| Average\(^1\)    | 17.5              | 1,336             | 13.1           |

Calculated from the National Nutrition Survey data (1986). \(^1\)Average TDF intake of households of all kinds.

DF content contributed to the TDF intake (Fig. 3, group 2). Those minor grains were first substituted with rice, and a slow drift followed away from rice after around 1970 (group 1). Soybeans had been eaten in the form of tofu, okara, miso, and natto and were all good sources of TDF. Pulses are still consumed in approximately the same amount as a food item, but in a more refined form in recent years (Fig. 3, group 4). The residue of soybean processing called “okara” is discarded nowadays as an industrial waste. A characteristic feature in TDF intake was observed in the increased consumption as a foodstuff of algae (from 5.6 to 6.1 g) and mushrooms (from 9.7 to 10.3 g) during the latest half decade (group 7).

In this study, the DF included resistant components, against human digestive enzymes, of animal and bacterial origin, e.g. chitin and chitoacids, protein like keratin, peptidoglycans, etc. The total amount of those resistant residues of animal origin used to be less than 5% of the total DF intake (Fig. 3, group 9), but is increasing steadily.

(2) DF intake in various types of household. Results of NNS in 1986 and 1990 were analyzed to see whether any type of family retained problems in nutritional status of TDF. As shown in Tables 2 and 3, the size and age of a family affected the TDF intake. Both the total food consumption and the TDF content of the meal per capita were the highest in a 2-person family and the lowest in persons living alone. In the one-person household, where the effect of the age of head of household is not diluted by other family members, the younger the age the lower the intake of TDF tended to be (Table 3). During the twenties TDF intake was 13.5 g/day per capita and in the teenagers it was 10.7 g/day. The most noticeable result was the more purified foods consumed by younger generations (Table 3, the column of TDF intake/g/kg food) which might affect their future goal of returning to a previous eating style. A decreasing trend of TDF intake in the teenagers and the twenties was also confirmed in our investigation against various family sizes mixed. It is widely accepted that when one gets older one becomes more fond of traditional Japanese dishes and consumes less greasy foods. It is not clear whether this results
Table 3. Age and dietary fiber intake in one-person household.

| Age   | Year | TDF intake (g/day) | Total food (g/day) | TDF intake (g/kg food) | TDF intake from (g/day) |
|-------|------|--------------------|--------------------|------------------------|------------------------|
|       |      |                    |                    |                        | Potatoes | Pulses | Fruits | Seaweeds | Nuts and seeds |
| ≤19   | 1990 | 10.7               | 944                | 11.3                   | 0.65     | 0.61   | 1.30    | 0.53      | 0               |
| ≤19♀  | 1990 | 9.3                | 802                | 11.6                   | 0.47     | 0.62   | 0.53    | 0.40      | 0               |
| ≤19♂  | 1990 | 11.6               | 1,033              | 11.2                   | 0.77     | 0.60   | 1.78    | 0.63      | 0               |
| 20–29 | 1990 | 13.5               | 1,183              | 11.4                   | 0.83     | 1.07   | 1.02    | 0.93      | 0.07            |
| 20–29♀| 1990 | 13.3               | 1,114              | 12.0                   | 1.01     | 1.05   | 1.32    | 0.70      | 0.03            |
| 20–29♂| 1990 | 13.6               | 1,228              | 11.1                   | 0.72     | 1.08   | 0.83    | 1.08      | 0.09            |
| 20–29 | 1986 | 12.8               | 1,105              | 11.6                   | 0.46     | 0.80   | 0.92    | 0.63      | 0.07            |
| 30–39 | 1986 | 15.6               | 1,314              | 11.8                   | 0.52     | 1.25   | 1.16    | 1.20      | 0.17            |
| 40–49 | 1986 | 15.9               | 1,352              | 11.8                   | 0.66     | 1.04   | 1.85    | 0.88      | 0.10            |
| 50–59 | 1986 | 18.3               | 1,427              | 12.8                   | 0.91     | 2.21   | 2.27    | 1.40      | 0.19            |
| 60–69 | 1986 | 19.0               | 1,374              | 13.8                   | 1.11     | 2.46   | 2.50    | 1.70      | 0.23            |
| ≥70   | 1986 | 17.4               | 1,210              | 14.4                   | 1.00     | 2.44   | 2.47    | 1.78      | 0.16            |

Calculated from the National Nutrition Survey data. "TDF intake in households of all kinds averaged. In 1990, consumption data for 19 food groups in one-person household were used for the TDF intake, and converted into the data of households of all kinds on the energy consumptions."
Fig. 4. Relationship between age and TDF intake from daily meals. The TDF intake is a 7 days average for 235 healthy city dwellers of the average age of 38.1 ± 11.8 years old. The regression equation was \( Y(\text{TDF}) = 9.433 + 0.11X \) (age), \( r = 0.373, p < 0.0001, s = 3.386 \) (SD from the regressed value or the expected residual).

from scanty diets in their early years when they grew up or from physiological requirements. In any event, this trend was reinvestigated in city dwellers, because of the possible significance of TDF in preventing elderly people from noninfectious chronic diseases. Our study using a dietary questionnaire clearly indicated that age and TDF intake had a statistically significant positive correlation \( (p < 0.0001) \) (Fig. 4). There would certainly be no direct causal relation between the two parameters, and the correlation would be a result of some causal chain. The low correlation coefficient and the high expected residual indicated the influences of other factors than age on TDF intake. The average TDF intake for the population investigated was 13.81 g/day for the average age of 38.1 ± 11.8 and composed mainly of office workers and students living in big cities. The difference between young and elderly generations was analyzed as follows. A one-person household in the twenties and thirties was compared with the sixties and seventies (Table 3). The TDF intake from potatoes, pulses, and fruits was double in elderly populations, and the intake from seaweeds increased clearly. The same was the case in households with more than one member (data not shown).

In Table 4, it is indicated that families living in bigger cities consume less TDF-containing foods than in rural districts. In Table 5, it is clear that the total amount of food intake directly governs the TDF, and the component foods are similar in dietary styles except for the difference between generations. Thus, the selection of foodstuffs is crucial for increased intake of TDF.

(3) The trend analysis by food supply and demand table. To study the TDF intake in Japan around 1935, the FSDT was consulted. Results of the analysis from 1951 to 1990 were compared with the results of the NNS. The two figures were
Table 4. Residence and dietary fiber intake (1985).

| Site of residence       | TDF intake (g/day) | Total food (g/capita) | TDF (g/kg food) |
|-------------------------|--------------------|-----------------------|-----------------|
| 11 big cities           | 16.9               | 1,325                 | 12.8            |
| Population > 150,000    | 17.4               | 1,343                 | 13.0            |
| Population 150,000-50,000 | 17.8             | 1,354                 | 13.1            |
| Population < 50,000     | 17.4               | 1,314                 | 13.3            |
| Non-city area           | 17.8               | 1,343                 | 13.3            |
| Throughout Japan        | 17.5               | 1,340                 | 13.1            |

Calculated from the National Nutrition Survey data.

Table 5. TDF intake in households of different protein consumption (1985).

| Protein intake (g/day) | < 40 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-99 | > 100 |
|-----------------------|------|-------|-------|-------|-------|-------|-------|-------|
| TDF intake (g/day)    | 8.1  | 10.8  | 13.0  | 14.9  | 17.0  | 18.7  | 20.7  | 23.7  |
| Total food (g)        | 613  | 830   | 991   | 1,143 | 1,295 | 1,432 | 1,582 | 1,797 |
| TDF (g/kg food)       | 13.2 | 13.0  | 13.1  | 13.0  | 13.1  | 13.0  | 13.1  | 13.2  |

Calculated from the National Nutrition Survey data.

similar and comparable (Fig. 1). The amount of TDF intake of Japanese before World War II was shown to be approximately 22 g/day. The major source of nutrients had been half-milled-type rice at the time. A similar amount of TDF intake, before and after World War II, had been indicated using data obtained with other assay methods (2, 18). From the results described above, 22-23 g/day (10.5–11.0 g/1,000 kcal) TDF was inferred to be contained in the diet of an average Japanese 30 to 50 years ago.

Measurement of TDF intake by shopping-basket method and model duplicate menu

To confirm the above calculations, sample diets were assayed for TDF by two different methods. The results of measuring the composite diets are shown in Table 6. Average total intake from the composite diets was 17.64±2.39 g/day. From the list of the foods used for the composite diets and from the TDF content in each food (13), the amount of TDF was calculated and shown at the bottom of the table with a reasonable parallel relationship. The sources of TDF were scattered among food groups as described above when compared with the United States.

The TDF of 12 sample meals (model duplicate menu) is shown in Table 7. The standard values of the NNS for 1985 were 2,088 kcal, 79.0 g protein, 56.9 g lipid, and 298 g carbohydrate for an average Japanese. The calculations of the actual menus prepared were 2,070±73 kcal, 76.7±5.0, 58.3±6.2, and 302±26 g, respectively. The average value obtained, after excluding the 1% outlier, was similar to the other 3 estimations. They were 16.86 (FSDT), 17.33 (NNS), 17.64
Table 6. Measurement of total dietary fiber intake by composite diets (1985).

| Location       | Food group<sup>2</sup> | TDF intake (g/1,000 kcal) |
|----------------|------------------------|---------------------------|
|                | 1  2  3  4  5  6  7  8  9 |
| Tohoku district| 1.77 4.85 0.75 2.83 1.22 1.38 6.20 0.75 1.04 | 20.8 |
| Kanto district | 1.88 5.49 0.77 1.87 1.55 1.27 5.80 0.62 0.40 | 19.7 |
| Kinki 1 district| — — 0.43 1.03 2.10 1.49 3.64 — 2.36 | — |
| Kinki 2 district| 1.90 3.31 0.57 1.37 1.04 1.16 4.98 0.46 1.03 | 15.8 |
| Chugoku district| 1.75 4.29 0.39 1.64 0.69 1.12 4.02 0.76 1.30 | 16.0 |
| Shikoku district| 2.27 9.3<sup>3</sup> 0.36 1.61 1.24 1.56 3.42 0.25 0.79 | 16.0 |
| Average        | 1.91 4.49 0.57 1.86 1.15 1.30 4.88 0.57 0.91 | 17.6 ± 2.39<sup>3</sup> |
| Calculated     | 1.56 3.57 0.68 2.69 1.93 1.87 4.30 0.34 0.84 | 17.8 |

Four to six analyses in 2 laboratories were carried out. —, single analysis data reported and excluded. <sup>1</sup>11% outlier excluded, and the average (4.49) substituted for the total (16.0). <sup>2</sup>The foodstuffs in each group are mentioned in MATERIALS AND METHODS. <sup>3</sup>M ± SD of TDF intake for all districts.

Table 7. Measurement of total dietary fiber intake by model duplicate meals (1985).

| Location       | Exp day | TDF intake (g/day) |
|----------------|---------|--------------------|
| Tohoku district| 1st     | 19.2               |
|                | 2nd     | 16.8               |
|                | 3rd     | 31.8<sup>1</sup>   |
| Kanto district | 1st     | 20.9               |
|                | 2nd     | 19.5               |
|                | 3rd     | 19.5               |
| Kinki district | 1st     | 17.1               |
|                | 2nd     | 19.3               |
|                | 3rd     | 15.7               |
| Kyushu district| 1st     | 18.3               |
|                | 2nd     | 20.3               |
|                | 3rd     | 16.9               |

M ± SD 18.5 ± 1.66

<sup>1</sup>11% outlier excluded.

A proposal for the recommended daily allowance of TDF for Japanese

We propose a TDF intake of 10–12 g/1,000 kcal for Japanese from the following reasons.

1) We prefer supplement of not more than 10% to the 1955 value (10.6 g/1,000 kcal in NNS) for the RDA. More than 10% addition was avoided because...
Table 8. Some nutritional status in 1955, 1985, and 1990.

| Year | Age | TDF intake (g/1,000 kcal) | Fat intake (g/1,000 kcal) | Ca intake (mg/1,000 kcal) | IHD mortality (/100,000) |
|------|-----|--------------------------|--------------------------|--------------------------|-------------------------|
| 1955 | all | 10.6                     | 9.7                      | 161                      | approx. 20              |
| 1985 | all | 8.3                      | 27.3                     | 265                      | 41.2                    |
| 1990 | all | 8.4                      | 28.1                     | 262                      | 41.6                    |
| 1990 | 20–29 | 6.8                      | 29.3                     | 199                      |                         |
| 1990 | ≤19  | 6.0                      | 29.9                     | 171                      |                         |

Calculated from the National Nutrition Survey data (10) and the vital statistics Japan. IHD, ischemic and arteriosclerotic heart disease.

FASEB indicated that the administration of more than 25 g/day neutral detergent fiber for less than 4 weeks sometimes resulted in negative mineral balance of Ca, Fe, Mg, Zn, and Cu in human intervention trials (5). The addition of soy soluble fiber to the enteric nutrition fluid at a concentration of more than 40 g/day TDF also caused a negative mineral balance of Fe and Cu in some cases (16, 17). Increased mortalities, on the other hand, of fiber-related diseases such as ischemic heart disease (Table 8) cannot be explained only by the decreased DF intake; they have more direct nutritional reasons such as increased fat intake. Therefore, an increased amount of DF intake alone would not settle recent nutritional situation.

2) Although FASEB indicated that there was an adaptation to high-dose TDF intake in approximately 8 weeks, continuous increase of TDF intake cannot necessarily be expected in present-day Japan. In young generations the intake frequently varies each day from less than 10 g to over 30 g, often by consuming artificial fiber drinks. It is not certain to what extent the intermittently ingested artificial soluble DF can be utilized by the enteric microflora for proliferation.

3) The estimated 22 g/day (average) intake of a Japanese in 1934–1938 (Fig. 1) and the reported high TDF intake in developing countries are probably accompanied by some level of malnutrition in at least some part of the population.

4) The intake of fats is not so high in Japanese as in Americans. For example, 104.6 (male)–71.6 g (female) total fat intake for an American (U.S. Department of Agriculture Nationwide Food Consumption Survey 1977–1978) contrasts with 56.9 g for an average Japanese (1985), including only 27.6 g fat from animal origin (NNS 1985) (10), while a much higher percentage of animal fat would be expected for Americans. Thus, the present study proposes a TDF intake of 10–12 g/1,000 kcal in Japanese. This indicates the recommended ranges of TDF for energy levels as 20–25 g for 2,088 kcal (average intake in 1985) and 25–30 g for 2,500 kcal.

DISCUSSION

The average intake of TDF by Japanese was estimated to be 19.4 g (in 1979)
(18), 22.6 g (in 1980) (2), or 15–19 g (in 1982) (19) by Japanese authors using various fiber assay methods. Earlier sources have cited 25 and 34.1 g (20), and 31.9 g from 1972 to 1974 (20). The value of 31.9 g for Japanese was clearly high when compared with 26.5–17.2 g (in 1970–1977) for the Netherlands, Denmark, and England (3). We tried to confirm the chronological decrease and geographical difference using a single TDF table. The results indicated that there was a decreasing trend of TDF intake in Japanese (Fig. 1) that still continued in 1990, but the amount was calculated to be 18.8 g in 1972 and 18.3 g in 1975; this was in the same range as in other European countries (Table 1). Furthermore, the TDF intake in 1985 was 17.3 g/day, and this was between the recently recalculated values for the French (16 g/day) (21) and Dutch (24 g/day) (22).

It is presently being established that different kinds of DF exert various specific physiological effects in human digestive tract. To improve the intake of wholesome foods, therefore, it is recommended that the fiber components should be from natural foods containing mixed DF types. This implies that the total amount of TDF, together with the fractional amount of soluble or insoluble DF, is preferable as information to the people’s reference. The enzymatic-gravimetric method provides the most appropriate ground for such information. However, a recent trend in Japan is to be taken into consideration when the RDA is represented by the TDF: a fad of drinking artificial soluble oligosaccharides. General consumers have easy access to several kinds of DF drinks containing 5 g/bottle or more of artificial soluble DF. Thus, recommending a higher total DF intake may cause an immediate increase in the consumption of these convenient commercial products. The possible adverse effects of excess of soluble DF over insoluble DF have not been well studies. Three to one seems to be tentatively suggested as to the intake ratio of insoluble to soluble DF (5, 6). A preliminary measurement of the two DF types in Japanese duplicate meals indicated, on the other hand, much higher percentage of soluble DF (T. Sumimoto et al., unpublished results).

It is well known that the amount of fat intake and mortality rate of colon cancer correlate well. The role of insoluble DF may be emphasized to facilitate defeation of secondary or free bile acids that may act as colon tumor promoters (23). At this time, however, mineral imbalance seems to concern Japanese more than insufficient TDF intake, because a deficiency in calcium intake, which has been pointed out officially, seems to be more serious. The negative correlation between colon cancer and TDF intake has not been established unequivocally. Thus, the RDA of TDF seemed to need some adjustments depending on the composition of the basal meal. To deduce the upper limit of RDA of TDF, we (a) studied the intake in the past and present, (b) confirmed the estimation by measuring the TDF of recent meals, and (c) evaluated the result in connection with the mortality rate of the relevant diseases in the vital statistics of the past and present. Thus the decreasing tendency of TDF intake in Japanese was compared with the crude mortality rate of diabetes mellitus or ischemic heart disease. The increase of mortality rates has approached a plateau in recent years in those cases, and
inversely corresponds to the trend shown in Fig 1. We also confirmed the same trend in diverticulosis (2) (data not shown). Thus, these mortalities in 30 and 50 years ago suggested a criteria of TDF intake. The supplementary points we propose are, (d) sufficiency of minerals, (e) fat consumption rate in the meals, and (f) an appropriate ratio of insoluble to soluble DF. (g) Another factor to be considered was a predictable future trend of eating habits. Although the real reason(s) for positive correlation between TDF intake and the age (Fig. 4) remains to be elucidated, the possible recurrence of eating habits through aging of younger generations may become a serious problem in the future. A preference for more purified foods over fiber-containing foods is becoming increasingly apparent (Table 3, TDF intake (g/kg food)).

If we adopt a DF intake of 13 g/1,000 kcal, 2,088 kcal (average intake in 1985) will provide 27.1 g TDF, which is more than 5 g above the intake of 50 years ago. Putting aside whether this amount is an over-recommendation for Japanese, we would like to recall the discussion by Kritchevsky (6) that DF is not a nutritional panacea but a necessary component of a normal diet. In addition, DF deficiency or excess will show itself in a non-direct manner. Thus, it is tempting to prescribe an excess of DF, but it may be accompanied by inevitable side effects in the deficiency of other indispensable, intracellularly acting nutrients. Compared with the discussion for upper limit of RDA, it seems to be of immediate need to improve the TDF intake (g/1,000 kcal) values of younger generations (Table 8), e.g. through an introduction of some high-fiber foodstuffs of acceptable taste for them.

The content of water-soluble DF and insoluble DF in foods has been published recently as a supplement to the 4th edition of Standard Nutrition Table of Japanese Foods (24). Using this table, the results of our study in this report are now being re-analyzed from the standpoint of imbalance in the intake of soluble and insoluble DF. It would be more desirable to use data in the supplement as a common ground of discussion, although it is highly probable that no major change occurs from the results we obtained here.

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REFERENCES

1) Lanza, E., Jones, D. Y., Block, G., and Kessler, L. (1987): Dietary fiber intake in the

J. Nutr. Sci. Vitaminol.
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US population. Am. J. Clin. Nutr., 46, 790–797.

2) Ohi, G., Minowa, K., Oyama, T., Nagahashi, M., Yamazaki, N., Yamamoto, S., Nagasako, K., Hayakawa, K., Kimura, K., and Mori, B. (1983): Changes in dietary fiber intake among Japanese in the 20th century. Am. J. Clin. Nutr., 38, 115–121.

3) Kromhout, D. (1983): Changes in energy and macronutrients in 871 middle aged men during 10 years of followup (the Zutphen Study). Am. J. Clin. Nutr., 37, 287–294.

4) Spiller, G. A., Chernoff, M. C., Shipley, E. A., Beigler, M. A., and Briggs, G. M. (1977): Can fecal weight be used to establish a recommended intake of dietary fiber? Am. J. Clin. Nutr., 30, 659–660.

5) Pilch, S. M. (ed.) (1987): Physiological Effects and Health Consequences of Dietary Fiber, Life Sciences Research Office, Federation of American Societies for Experimental Biology, Bethesda, MD.

6) Kritchevsky, D. (1988): Dietary fiber. Annu. Rev. Nutr., 8, 301–328.

7) Prosky, L., and Devries, J., (1992): Controlling Dietary Fiber in Food Products, Van Nostrand Reinhold, N.Y., pp. 37–40.

8) Nordisk Ministerrad Standing Nordic Committee on Food (1989): Nordic Nutrition Recommendation, 2nd ed., Report 2.

9) Butrum, R. R., Clifford, C. K., and Lanza, E. (1988): NCI dietary guidelines: Rationale. Am. J. Clin. Nutr., 48, 888–895.

10) Health Promotion and Nutrition Division, Health Service Bureau, Ministry of Health and Welfare (1951–1990): Current Nutritional Status of the Nation: Results of National Nutrition Survey, Daiichi Publishing Co., Tokyo.

11) Nishimune, T., Yakushiji, T., Sumimoto, T., Ichikawa, T., Kunita, N., and Nakahara, S. (1990): Study on dietary fiber content of foods. J. Health Welfare Stat. (Jpn.), 37, 39–41.

12) Statistical and Survey Division, Ministry of Agriculture and Forestry (1961, 1956–1991): Statistical Yearbook of Ministry of Agriculture and Forestry Japan.

13) Nishimune, T., Sumimoto, T., Yakushiji, T., Kunita, N., Ichikawa, T., Doguchi, M., and Nakahara, S. (1991): Determination of total dietary fiber in Japanese foods. J. Assoc. Off. Anal. Chem., 74, 350–359.

14) Japan Association of Prefectural and Municipal Public Health Institutes (1992): Dietary Fiber Table, Daiichi Publishing Co., Tokyo.

15) Block, G., and Lanza, E. (1987): Dietary fiber sources in the United States by demographic group. J. Natl. Cancer Inst., 79, 83–91.

16) Taper, L. J., Milam, R. S., McCallister, M. S., Bowen, P. E., and Thye, F. W. (1988): Mineral retention in young men consuming soy-fiber-augmented liquid formula diets. Am. J. Clin. Nutr., 48, 305–311.

17) Scheppach, W., Burghardt, W., Bartram, P., and Kasper, H. (1990): Addition of dietary fiber to liquid formula diets: The pros and cons. J. Parent. Ent. Nutr., 14, 204–209.

18) Minowa, M., Bingham, S., and Cummings, J. H. (1983): Dietary fibre intake in Japan. Human Nutr.: Appl. Nutr., 37A, 113–119.

19) Mori, B. (1982): Contents of dietary fiber in some Japanese foods and the amount ingested through Japanese meals. Nutr. Rep. Int., 26, 159–166.

20) Bright-See, E., and McKeown-Eyssen, G. E. (1984): Estimation of per capita crude and dietary fiber supply in 38 countries. Am. J. Clin. Nutr., 39, 821–829.

Vol. 39, No. 3, 1993
21) Bagheri, S. M., and Debry, G. (1990): Estimation de la Consommation moyenne de fibres alimentaires en France. *Ann. Nutr. Metab.*, 34, 69–75.

22) Van Dokkum, W., De Vos, R. H., Dukel, F., and Hilwig, G. N. G. (1990): Analysis of macrocomponents and fatty acids in the market basket of male adolescents in the Netherlands. *J. Am. Diet. Assoc.*, 90, 77–81.

23) Reddy, B. S. (1981): Diet and bile acids. *Cancer Res.*, 41, 3766–3768.

24) Resources Council, Science and Technology Agency, Japan (1992): Standard Tables of Food Composition in Japan—Dietary Fiber—.

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