The Origin of Dietary Reference Intakes in Japan

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ABSTRACT

Objective: To describe the nutritional issues faced during the search for the “optimal diet” in modern Japan, how it evolved into the development of the current Dietary Reference Intakes, and its future perspectives for further health promotion.

Methods: We investigated and summarized the history of the Dietary Reference Intakes in Japan, by reviewing articles, books, official reports, and the publications of the National Institute of Nutrition.

Results: Thiamin deficiency has long been reported in the Japanese people due to their diet based mainly on polished rice. Medical doctors and nutritional scientists made efforts to determine the cause and to set dietary standards for people to maintain health. The first “Health Diet for the Japanese” (Nihonjin no Hoken Shokuryo) was made public in 1877. Furthermore, the State Institute of the Study of Nutrition was founded in 1920, which conducted studies on nutritional requirements and collaborated with the League of Nations. During and soon after World War 2, the mission of “Dietary Allowances” was the prevention of nutritional deficiencies. With accumulating knowledge, this evolved into the development of the “Dietary Reference Intakes,” published since 2000.

Conclusions: The current Dietary Reference Intakes is the fruit of the historical pursuit for determining the optimal nutrition for the overall health of the general population. They provide a standard for nutritional assessment, school lunches, and hospital meals, and support the development of nutrition policies, such as food-based dietary guidelines. Further accumulation of evidence, such as the life-course approach to nutrition, may be needed to ensure the future health of the coming generations.

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Key words: Dietary Reference Intakes, dietary allowances, nutrients, Japan

I. Introduction

Long before the age of modern nutritional science, people had known from their experience that diet is an essential component of health. A famous Confucianist in the Edo era, Kaibara Ekken, dedicated two out of eight volumes of his 1713 “Yojo-Kun” (a guide to healthy life and longevity) to drinking and eating1). He wrote that drinking and eating are essential for human life, and controlling the digestion within the body is important. He suggested moderation when drinking and eating, gave advice on how to balance breakfast and dinner, and promoted cessation of smoking, all of which are still applicable now. However, these recommendations had little effect on the general population due to serious famines and food shortage occurring intermittently due to crop failure.

Another serious health problem which became prevalent in the Edo era was beriberi2). Consuming polished rice as a staple food became popular among the ruling class (the Bushi class) and gradually spread to the whole
population. Beriberi, called “Kakke” in Japanese, is characterized by leg edema, peripheral neuropathy, weakness, congestive heart failure, and even death. However, the etiology of beriberi as thiamine deficiency was unknown. Modern nutrition science in Japan began only after Japan opened its borders to foreign countries, and scientific approaches to combat disease were introduced. In this review, we describe the nutritional issues faced during the search for the “optimal diet” for Japanese people in modern Japan, how it evolved into the development of the current Dietary Reference Intakes, and its future perspective for further health promotion.

II. Methods

We investigated and summarized the history of the Dietary Reference Intakes in Japan (DRIs-J), by reviewing articles, books, official reports, and the publications of the National Institute of Nutrition (the current National Institutes of Biomedical Innovation, Health, and Nutrition).

III. Results

1. Combating nutritional deficiencies during modernization and the birth of dietary standards in Japan

After the rule of the Tokugawa Shogun ended, and Japan opened its borders to foreign countries, the Meiji government opened the first medical school in Tokyo in 1869, which taught Western medicine. This is now the Graduate School of Medicine and Faculty of Medicine, University of Tokyo. The Japanese government invited professors from overseas, and Dr. Leopold Müller was among the first to teach. Dr. Müller and his colleagues petitioned the Ministry of Education in 1871 to reform the school building because of its poor sanitary state. Half of the medical students had dropped out due to illness, nearly half of them from “Kakke.” At this time, the cause of “Kakke” was thought to be unhealthy environment, toxicants, infectious disease, or poor diet. Dr. Hoffman, another professor at the medical school, blamed the poor diet of the students as the cause of “Kakke,” and costly eggs, meat, and fish were served at dormitory meals to improve the health of the students.

Another problem the Japanese government was facing was that “Kakke” was causing a heavy burden among the military troops. In 1878, 1,485 men out of 4,528 (32.8%) navy personnel had “Kakke,” and 32 men had died. The status in the army was similar, with 13,570 out of 36,098 men (37.6%) having “Kakke.” Military rations were based on the calculations during the Edo period, the standard amount of food per day for army personnel was 900 g uncooked polished rice, with meat and other side dishes, which costed a total of 6 sen (approximately 1,200 yen). However, due to rises in food prices, this led to meals mainly comprising rice, with only small amounts of side dishes. The army surgeons were aware of the poor quality of military rations. In 1882, Koike Masanao, who later became the army surgeon general, published his suggestions to reform the military rations, citing examples from the United Kingdom, France, Germany, Austria, and the United States. He proposed per capita intakes 120~160 g/day of protein and 420 g/day nitrogen-free component (carbohydrates and fat). Koike’s proposals were consistent with the works of the German physiologist Karl von Voit, who estimated a minimum daily intake of 118 g of protein in 1877.

The arguments whether “Kakke” was caused by protein deficiency or by polished rice persisted in Japan. In 1881, the government revised the “Code of Meals for Prisoners,” and the staple food served in prison meals were rice mixed with 60% barley, with meager side dishes. This change in prison meals lead to drastic decrease in “Kakke” among the prisoners, and the army surgeon Horiuchi Toshikuni, who observed this phenomenon, introduced barley to be added to rice in military rations at the Osaka garrison, in 1884. As a result, dramatic decreases in “Kakke” in the army was observed, decreasing from 42.82% in 1883 to 1.32% in 1885. However, the surgeon general of the army headquarters was still suspicious of the effect of barley added rice to “Kakke” improvement because the exact dietary component that produced such an effect was still unknown.

In the meantime, in accordance with the early energy balance studies of Max Rubner, measurements of protein, fat, and carbohydrate contents of frequently eaten Japanese foods were conducted by the Institute of Hygiene (the present National Institute of Health Sciences) in 1886~1887. By using these data and adapting the nutrient requirement estimation by von Voit, the first “Health
Diet for the Japanese” (Nihonjin no Hoken Shokuryo) was made public9, 10. The recommended amount of per capita protein, fat, and carbohydrate per day were 94 g, 20 g, and 450 g, respectively.

However, these values were not based on actual feeding study results in humans. The army surgeon general Ishiguro Tadanori petitioned the Minister of the Army to conduct human trials using soldiers as study subjects4. Between August and December 1889, the famous novelist and later army surgeon general Mori Rintaro conducted the first controlled dietary study in Japan. Six study subjects were fed rice meals, rice mixed with barley meals, and Western meals (bread and meat) for 8 days each. Mori analyzed the dietary intakes of the subjects, examining their intakes of protein, fat, and carbohydrates. Urine and feces of the study subjects were also collected to measure their nitrogen balance. The study results were published the following year, and Mori concluded that rice meals showed the highest positive nitrogen balance, and was the best meal for Japanese4, 11). Mori’s training in Germany supported his strictly controlled human study.

In contrast, the navy surgeon Takaki Kanehiro, conducted his famous intervention study in 1884 using two navy ships12, where one was serving bread meals and the other serving rice meals. The cases of “Kakke” among navy personnel on the ship serving bread were significantly lower than the cases on the ship serving rice meal. However, his study hypothesis was that the cause of “Kakke” was an imbalance of protein and carbohydrates13), which was refuted by Mori. He had to wait until 1911 when Casimir Funk introduced the idea of “vitamins”14) for curing beriberi, and Christiaan Eijkman confirmed the effect of thiamine by conducting deficiency studies using chickens15). In 1926, Barend Jansen and Willem Donath isolated thiamine16), although they were preceded in 1911 by Suzuki Umetaro in Japan17).

As described above, the research tools, which are still in use in modern nutritional science, were developed in the late 19th century. Nutritional scientists were aware of the importance of observing symptoms of deficiency, chemical analyses of nutrients in food, measuring dietary intakes, and conducting epidemiological studies.

2. The establishment of the State Institute of the Study of Nutrition and its contribution to the development of dietary standards

Saiki Tadasu (1876-1959) had studied medicine at Kyoto Imperial University18). One of his research interests in Kyoto was “Can people live only on rice and salt?”. He worked at the Infectious Disease Institute of the Interior Ministry, and later studied physiology and biochemistry at Yale University. He had worked at the United States Department of Agriculture before returning home to Japan in 1912. In 1914, he started a private Institute of Nutrition. In 1916, the Institute had four laboratories (physiology, pathology, bacteriology, and metabolism) with a clinic, where animal experiments were conducted, and lectures were held. Research on rice consumption and its effect on health status was conducted, and Saiki was eager to apply his research evidence to the public. Saiki lobbied the Lower House of the Imperial Congress to the foundation of the first national research institute of Nutrition. Thus, the State Institute of the Study of Nutrition was founded in 1920 in Tokyo, which is the current National Institute of Health and Nutrition celebrating its centennial anniversary19). The research missions of the Institute were 1) research on major food items, 2) research on the nutritional status of the Japanese, and 3) research on foods under famine conditions. There was special emphasis on the development of “national standard meals” that are nutritious and inexpensive, to solve the various public health problems related to malnutrition among the Japanese20).

The consequences of World War 1 (1914-1918) and the Spanish flu pandemic (1918-1920) had devastated people’s health globally. The League of the Nations was founded in 1920, and in 1922, the League of Nations Health Committee and Health Section were established21). Saiki contributed to the Institute’s research works to the League of Nations through his report, “The Progress of the Science of Nutrition in Japan”22). His view was that the problem of nutrition should have the following three objectives: “1) to determine what natural products can satisfy food requirements, and select those the consumption of which would be most advantageous from a purely physiological point of view; 2) to select from the latter group the substances which best meet the requirements of the national economy; and 3) proceed, in this last group, by selection based
on social considerations, to draw up a “food code” which, though perhaps not be perfect, would, under the existing social conditions, be the closest approach to perfection we can attain.” Interestingly, Saiki and his colleagues were already aware that children need additional nutritional requirements, and from interventions on malnourished children, they proposed the treatment diet shown in Figure 1.

The Institute’s works, together with the contributions of the United Kingdom, United States, Denmark, Sweden, Norway, and the Union of Soviet Socialist Republics, the League of Nations published three volumes of the “Problem of Nutrition,” and the average requirements of calories and protein were shown for adults, children, pregnant and lactating women. The report states, “An adult, male or female, living an ordinary everyday life in a temperate climate and not engaged in manual work is taken as the basis on which the needs of other age-groups are reckoned. An allowance of 2,400 calories net per day is considered adequate to meet the requirements of such an individual.” This was probably the earliest attempt to harmonize the nutritional requirements of different populations.

3. The minimum nutrition standard during the World War 2

After the Manchurian Incident of 1931, Imperial Japan was at war with China, and the improvement of the physical status of the population became one of the key concerns of the government. In 1938, the Ministry of Health and Welfare was founded to “promote the physical strength and welfare of the people.” In 1941, the Department of National Nutrition at the Health Science Institute (formerly the State Institute of the Study of Nutrition) proposed a “Standard Nutrition Requirement for Japanese” as shown in Table 1. According to Fujimoto and Tsuyuki, the estimated energy requirement for infants (under 1 year of age) was 130–90 cal/kg weight. For children and adolescents, they developed standard height and weight growth curves, and by using the estimated surface area, the energy requirement values were calculated. Protein requirements were estimated as 17% of energy requirements. For adults, the estimated standard height and weight was also applied for calculating energy requirements. Protein requirements were estimated as 14% of energy requirements for individuals aged 21–50 years and 11% for individuals aged 51 years and older. Requirements for pregnant and lactating women were also shown. How-

| Age        | Poids Body-weight (Kilog.) | Quantité de nourriture par jour Amount of food per day | Quantité de nourriture par kilog. de poids Amount of food per 1 kilog. of body-weight |
|------------|-----------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------|
|            |                             | Protein (gr.) Calories | Protein (gr.) Calories |
| (a) Garçons — Boys. |                             |                          |                          |
| 8 ans — years | 19,500                      | 65.0                     | 1800                     | 3.4                                      | 92.8                                      |
| 9          | 20,500                      | 65.0                     | 1850                     | 3.1                                      | 89.3                                      |
| 10         | 21,500                      | 65.0                     | 1880                     | 2.0                                      | 85.5                                      |
| 11         | 22,500                      | 70.0                     | 1940                     | 2.7                                      | 82.6                                      |
| 12         | 23,500                      | 70.0                     | 1980                     | 2.6                                      | 78.0                                      |
| 13         | 24,500                      | 75.0                     | 2120                     | 2.5                                      | 75.7                                      |
| 14         | 25,000                      | 75.0                     | 2200                     | 2.3                                      | 73.3                                      |

| (b) Filles — Girls. |                             |                          |                          |
| 8 ans — years | 18,500                      | 63.0                     | 1650                     | 3.4                                      | 89.2                                      |
| 9          | 20,000                      | 65.0                     | 1700                     | 3.1                                      | 87.0                                      |
| 10         | 21,000                      | 65.0                     | 1750                     | 3.0                                      | 82.9                                      |
| 11         | 22,500                      | 65.0                     | 1800                     | 2.7                                      | 78.3                                      |
| 12         | 23,500                      | 70.0                     | 1850                     | 2.6                                      | 74.5                                      |
| 13         | 24,500                      | 70.0                     | 1900                     | 2.5                                      | 72.3                                      |
| 14         | 25,000                      | 70.0                     | 2100                     | 2.3                                      | 70.1                                      |

Figure 1 Standard diet for malnourished and weak Japanese children.
ever, because food shortages became even more serious during World War 2, in 1944 the “Chosa-Kenkyu-Donin-Honbu” (The Headquarter of Survey and Research) issued the minimum nutrition standard (Table 2), so that the food distributed to households could be cut down to maintain the minimum requirements of each individual household.

Table 1  Standard Nutrition Requirements for Japanese, 194124)

| Age category | Energy cal | Protein g | Energy cal | Protein g |
|--------------|------------|-----------|------------|-----------|
| 1 year       | 850        | 30        | 850        | 35        |
| 2 years      | 1,200      | 50        | 1,200      | 50        |
| 3 years      | 1,320      | 55        | 1,320      | 50        |
| 4 years      | 1,430      | 60        | 1,430      | 60        |
| 5 years      | 1,490      | 60        | 1,490      | 60        |
| 6 years      | 1,610      | 65        | 1,500      | 60        |
| 7 years      | 1,690      | 70        | 1,570      | 65        |

Table 2  Minimum nutrition standard for Japanese Nationals, 194420)

| Age category | Workload | Males | Females |
|--------------|----------|-------|---------|
|              | Energy cal | Protein g | Energy cal | Protein g |
| 0–1 year     | 600       | 30    | 600      | 30        |
| 1–3 years    | 1,250     | 40    | 1,250    | 40        |
| 4–5 years    | 1,450     | 45    | 1,450    | 45        |
| 6–8 years    | 1,700     | 50    | 1,700    | 50        |
| 9–11 years   | 1,900     | 65    | 1,900    | 65        |
| 12–14 years  | Light     | 2,200 | 75       | 2,200     | 75        |
|              | Moderate  | 2,600 | 90       | 2,100     | 70        |
|              | Heavy     | 3,100 | 100      | 2,100     | 78        |
| 15–20 years  | Light     | 2,100 | 75       | 1,700     | 70        |
|              | Moderate  | 2,600 | 90       | 2,100     | 70        |
|              | Heavy     | 3,100 | 100      | 2,100     | 78        |
| 21–64 years  | Light     | 2,100 | 75       | 1,700     | 60        |
|              | Moderate  | 2,600 | 80       | 2,100     | 68        |
|              | Heavy     | 3,100 | 90       | 2,500     | 75        |
| 65 years and older | Light | 1,900 | 55       | 1,600     | 45        |
|              | Medium    | 2,100 | 60       | 1,700     | 50        |

Increment for pregnancy – – – 440 20
member\(^{29}\). However, this standard was still idealistic compared with the actual intake status of the general population. These values seem to be satisfactory even in current views, although we need to consider that the major source of protein was from grains, not animal products.

4. From dietary allowances to Dietary Reference Intakes

In 1945, Imperial Japan surrendered to the Allied Forces, and the General Head Quarters took control of public health issues. Food shortages were serious, and to receive food aids from the United States, the first Nutrition Survey was conducted in December\(^{25}\). In 1947, the government Food and Nutrition Countermeasures Council proposed the “Desirable Allowance” for per capita intake/day, as follows: energy; 2,150 cal, protein; 75 g, fat; 25 g, calcium; 1 g, iron; 10 mg, vitamin A; 3,000 IU, vitamin B\(_1\); 1 mg, vitamin B\(_2\); 1 mg vitamin C; 40 mg, and salt; 15 g\(^{26}\).

In 1954, the Council on Resources of the Prime Minister’s Office issued the “Standard Nutrition Values for Japanese”\(^{27}\). In this report, the standard values for energy and nutrients intakes per capita/day were shown, adding niacin and vitamin D, which were lacking in the 1947 version. The objectives of the Standard were 1) to provide a standard to identify the adequacy of dietary intakes of the current population, 2) to serve as a basic document presenting food and diet patterns for the nutrition of the people, and 3) to serve as a standard for current and future food, and nutrition policies. The term “Dietary Allowance” was used to describe the adequate dietary intake of energy and nutrients according to sex, age group, and workload, and these values were shown in a separate handbook\(^{28}\). In 1959, the term “Dietary Allowance” became the official title of the revised report\(^{29}\). The reason for the revision was the rapid change in height and weight of children due to improved diet, development of new scientific evidence on nutrition, and to comply with international standards. Phosphorus was added to the list of nutrients. At last, “Kakke” cases were nearly eliminated\(^{30}\). As already reported by Tsuboyama-Kasaoka et al.\(^{31}\), the Ministry of Health and Welfare became in charge of revising the Dietary Allowances in 1969.

As Japan recovered from the devastation of World War 2, improved dietary intakes, hygiene, and access to medical care brought changes to people’s health. This was apparent in the changes in the causes of death among the Japanese. According to the Vital Statistics of Japan, the age-adjusted death rate per 100,000 due to tuberculosis was high (192.5 in men, 141.6 in women) in 1950, but declined to 32.3 in men and 11.7 in women in 1970. Instead, deaths from cancer (148.2 to 199.2 in men, 121.4 to 126.9 in women), heart disease (126.2 to 161.7 in men, 105.4 to 114.5 in women), and cerebrovascular disease (297.9 to 361.0 in men, 236.3 to 243.8 in women) increased during the same period\(^{32}\). The transition from undernutrition to over-nutrition or excess food intake were suspected as the underlying cause of these changes. These changes were not only observed in Japan, but also in the United States, where the McGovern report\(^{33}\) was published by the Senate Committee, to improve health through informed diet selection in every American. In this report, Dietary Goals extended the concept of the Recommended Dietary Allowances (RDA) to include macronutrients, sodium and cholesterol (Table 3). The Committee stated

| Table 3 | United States Dietary Goals, 1977\(^{33}\) |
|---|---|
| 1. | To avoid overweight, consume only as much energy (calories) as are expended; if overweight, decrease energy intake and increase energy expenditure. |
| 2. | Increase the consumption of complex carbohydrates and “naturally occurring” sugars from about 28 percent of energy intake to about 48 percent of energy intake. |
| 3. | Reduce the consumption of refined and processed sugars by about 45 percent to account for about 10 percent of energy intake. |
| 4. | Reduce overall fat consumption from approximately 40 percent to about 30 percent of energy intake. |
| 5. | Reduce saturated fat consumption to account for about 10 percent of total energy intake; and balance this with poly-unsaturated and mono-unsaturated fats, which should account for about 10 percent of energy intake each day. |
| 6. | Reduce cholesterol consumption to about 300 mg a day. |
| 7. | Limit the intake of sodium by reducing the intake of salt to about 5 grams a day. |
Table 4  DRIs-J 2020\(^{39}\) for children and adults aged 1 years and older\(^1\)

| Nutrients                          | EAR   | RDA   | AI    | UL    | DG    |
|-----------------------------------|-------|-------|-------|-------|-------|
| Protein\(^2\)                     | –     | –     | –     | –     | ○\(^3\) |
| Fat                               | –     | –     | –     | –     | ○\(^3\) |
| Saturated fat\(^4\)              | –     | –     | –     | –     | ○\(^3\) |
| n-6 Fatty Acids                   | –     | –     | –     | –     | –     |
| n-3 Fatty Acids                   | –     | –     | –     | –     | –     |
| Cholesterol\(^3\)                 | –     | –     | –     | –     | –     |
| Carbohydrates                     | –     | –     | –     | –     | ○\(^3\) |
| Carbohydrate                      | –     | –     | –     | –     | –     |
| Dietary fiber                     | –     | –     | –     | –     | ○     |
| Sugars                            | –     | –     | –     | –     | –     |
| Energy Providing Nutrients’ Balance\(^2\) | –     | –     | –     | –     | ○\(^4\) |
| Vitamin A                         | ○\(^a\) | ○\(^a\) | –     | –     | –     |
| Vitamin D\(^2\)                   | –     | –     | ○     | ○     | –     |
| Vitamin E                         | –     | –     | ○     | ○     | –     |
| Vitamin K                         | –     | –     | ○     | –     | –     |
| Water soluble                      |       |       |       |       |       |
| Vitamin B1                        | ○\(^c\) | ○\(^c\) | –     | –     | –     |
| Vitamin B2                        | ○\(^c\) | ○\(^c\) | –     | –     | –     |
| Niacin                            | ○\(^a\) | ○\(^a\) | –     | –     | ○     |
| Vitamin B6                        | ○\(^b\) | ○\(^b\) | –     | ○     | –     |
| Vitamin B12                       | ○\(^a\) | ○\(^a\) | –     | –     | –     |
| Folate                            | ○\(^a\) | ○\(^a\) | –     | ○\(^7\) | –     |
| Pantotene acid                     | –     | –     | ○     | –     | –     |
| Biotin                            | –     | –     | ○     | –     | –     |
| Vitamin C                         | ○\(^x\) | ○\(^x\) | –     | –     | –     |
| Minerals                           |       |       |       |       |       |
| Macro                             |       |       |       |       |       |
| Sodium\(^6\)                      | ○\(^a\) | –     | –     | –     | ○     |
| Potassium                         | –     | –     | ○     | –     | ○     |
| Calcium                           | ○\(^b\) | ○\(^b\) | –     | –     | ○     |
| Magnesium                         | ○\(^b\) | ○\(^b\) | –     | ○\(^7\) | –     |
| Phosphorus                        | –     | –     | ○     | –     | ○     |
| Micro                             |       |       |       |       |       |
| Iron                              | ○\(^x\) | ○\(^x\) | –     | ○     | –     |
| Zinc                              | ○\(^b\) | ○\(^b\) | –     | ○     | –     |
| Copper                            | ○\(^b\) | ○\(^b\) | –     | –     | ○     |
| Manganese                         | –     | –     | ○     | ○     | –     |
| Iodine                            | ○\(^a\) | ○\(^a\) | –     | –     | ○     |
| Selenium                          | ○\(^a\) | ○\(^a\) | –     | –     | –     |
| Chromium                          | –     | –     | ○     | –     | –     |
| Molybdenum                        | ○\(^b\) | ○\(^b\) | –     | ○     | –     |

\(^{-}\): values not shown, EAR: Estimated Average Requirement, RDA: Recommended Dietary Allowance, AI: Adequate Intake, UL: Tolerable Upper Intake Level, DG: Tentative dietary goals for preventing life-style related diseases
1 Includes indices shown for limited age groups.
2 Additional information for prevention of frailty is provided as footnotes
3 As % Energy
4 Cholesterol indices for the prevention of progression of dyslipidemia, and additional information regarding trans-fatty acid intake is provided as footnotes
5 Indices for the prevention of progression of dyslipidemia are provided as footnotes for the table on saturated fatty acids.
6 Indices for the prevention of progression of hypertension and chronic kidney disease are provided as footnotes
7 Intakes from fortified foods or dietary supplements
a Intake levels where half of the population show signs of insufficiency or deficiency
b Intake levels where half of the population can maintain adequate status in the body
c Intake levels where half of the population show signs of saturation in the body
x other than a-c
that “the over-consumption of food in general, combined with our more sedentary lifestyle, has become a major health problem,” and “heart disease, some cancers, stroke and hypertension, diabetes, arteriosclerosis, and cirrhosis of the liver” were shown to be leading causes of death associated with diet33). In 1978, the first national health promotion policy in Japan began, aiming at the primary prevention of adult disease (the current lifestyle-related disease)34). Nutrition, exercise, and rest were the three basic components of the policy, and dissemination of the Dietary Allowances was also included.

With accumulation of scientific knowledge regarding the association of diet and health, the pressure for revising the criteria for nutrient adequacy and what constitutes a “requirement” mounted35). The concept of using statistical approaches to determine the requirement of the individual and groups was introduced in the joint Food and Agriculture Organization of the United Nations/World Health Organization/United Nations University report 36). This approach was followed by the United Kingdom 37) and the United States38).

The concept of “Dietary Reference Intakes” was first introduced in 2000 (the 6th revision), and the latest version was published in January 202039), to include energy and 34 nutrients (plus water, though values not shown). Up to the 1995 version (the 5th revision), there was only one index (the dietary allowance) shown according to sex and age categories for each nutrient31). From the 2000 version, the DRIs-J introduced three indices to be applied for avoiding inadequate nutrient intakes: the Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), and in 11 nutrients where EAR could not be determined, Adequate Intake. To avoid health risks due to excess intake of nutrients, the Tolerable Upper Intake Level was introduced. Tentative dietary goals for preventing lifestyle related diseases (DGs) were introduced as desirable intake levels, by achieving either higher or lower consumption, depending on the nutrient, to prevent the onset and progression of lifestyle related disease, such as hypertension, dyslipidemia, diabetes mellitus, and chronic kidney disease39). The indices for each nutrient are shown in Table 4.

The latest version includes the “prevention of malnutrition and/or frailty in the elderly” as one of its objectives (Figure 2)39). Frailty was defined as a state between healthy and requiring nursing care, and middle-aged and elderly age group categories were revised accordingly. Furthermore, systematic reviews were conducted in the process of revision, and graded evidence levels (D1-D5) were shown for selected nutrients (protein, fat, carbohydrates, saturated fat, dietary fiber, sodium, and potassium)39).

IV. Discussion

The Dietary Reference Intakes evolved in accordance
with the changes in nutritional issues of the society. Nutritional deficiencies, such as “Kakke,” have long been reported in Japan, and efforts by the government and the academia focused on conquering this. In recent years, a rise in chronic non-communicable diseases (life-style related diseases in Japan) has led to the development of DGs. The diseases in concern were limited to hypertension, dyslipidemia, diabetes, and chronic kidney disease, while frailty was added due to the increase in the elderly population. The current legal basis of the DRIs-J is the Health Promotion Act (Act No. 103 of 2002)\(^\text{39}\), and the DRIs-J is the official reference intakes of energy and nutrients for the health promotion and primary prevention of life-style related diseases; it is also a standard for nutritional assessment, school lunches, hospital meals, and supporting the development of nutrition policies, such as food-based dietary guidelines.

Currently, knowledge is accumulating regarding the effect of nutrition at the start of life and during early childhood to overall health throughout the lifetime. A life-course approach\(^\text{40}\) could be considered in the development of Dietary Reference Intakes in the future.

V. Conclusions

The current DRIs-J is the fruit of the historical pursuit to determine the optimal nutrition for health of the Japanese population. It provides a standard for nutritional assessment, school lunches, hospital meals, and supports the development of nutrition policies, such as food-based dietary guidelines. Further accumulation of evidence, such as the life-course approach to nutrition, may be considered for further improvement of the health of coming generations.

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Conflicts of Interest Statement

There are no conflicts of interest to declare.

References

1) Itoh, C.: The View of “Health” in Kaibara Ekken’s “Yojo-kun”, Nihon Daigaku Daigakuin SogoShakaigaku Kenkyuka Kiyou, 6, 128–137 (2005)
2) Bay, A.R.: Beriberi in Modern Japan: The Making of a National Disease (2012) Rochester University Press, NY, USA
3) Koseki, T.: Notes on Leopold Müller and Theodor E. Hoffmann, founders of the Medical School of Tokyo in the early Meiji era (2), Nihon Ishigaku Zasshi, 34, 585–600 (1988)
4) 下山政三：閣外森林太郎と脚気紛争（2008）日本評論社，東京 [Yamashita, S.: Ohgai-Mori Kintaro and Kakke Arguments (2008) Nihon-Hyoronsha, Tokyo]
5) 小池正直：大日本兵卒食料改正意見草案，東京医事新誌, 230, 22–41 (1882) [Koike, M.: A draft revision for Imperial military rations, Tokyo-Iji-Shinshi, 230, 22–41 (1882)]
6) Heyll, U.: [The “Fight Over the Protein Minimum”, The Conflict Between Scientific Nutrition Teaching and Food Reform in 19th and 20th Century Germany], Dtsch. Med. Wochenschr., 132, 2768–2773 (2007) [Article in German]
7) No authors listed: Max Rubner (1854–1932) Energy Physiologist, JAMA., 194, 86–87 (1965)
8) 内務省衛局：衛生試験彙報，第１號（1886）[Bureau of Hygiene, Ministry of Internal Affairs: Eisei-Shiken Iho, Vol 1 (1886)]
9) 内務省衛局：衛生試験彙報，第２號（1887）[Bureau of Hygiene, Ministry of Internal Affairs: Eisei-Shiken Iho, Vol 2 (1887)]
10) Kaneko, S., Marui, E.: Establishment for proper diets for health and recommended dietary allowances in 1887, Minzoku-Eisei, 51, 147–151 (1985)
11) 石黑忠直：陸軍兵食試験報告，中日医事新誌, (261), 51–53 (1891) [Ishiguro, T.: Report of the Imperial Army Ration Trial, Chugai-Iji-Shinpo, (261), 51–53 (1891)]
12) Takaki, K.: Three lectures on the preservation of health and recommended dietary allowances in 1887, Minzoku-Eisei, 51, 147–151 (1985)
13) Sugiyama, Y., Seita, A.: Kanehiro Takaki and the control of beriberi in the Japanese Navy, J. R. Soc. Med., 106, 332–334 (2013)
14) Cooper, E.A., Funk, C.: Experiments on the causation of Beri-beri: (preliminary communication.), Lancet, 178, 1266–1267 (1911)
15) Eijkman, C.: Antineuritic Vitamin and Beriberi. Nobel Lecture, 1929, https://www.nobelprize.org/prizes/medicine/1929/eijkman/lecture/ (Accessed May, 26, 2020)
16) Jansen, B.C.P., Donath, W.F.: Over de isoleering van het anti-beriberi vitamine, Geneeskundig Tijdschrift voor Nederlandsche-Indie, 66, 810–827 (1926)
17) 鈴木梅太郎，島村虎猪: 糠中の一有効成分に就て, 東京化學會誌, 32, 4–17 (1911) [Suzuki, U., Shimamura, T.: A vital component in rice bran, Tokyo-KagakukaiShi, 32, 4–17 (1911)]
18) Namatsu, N.: The Formation of Nutrition Science and Tadasu Saeki, Kyoto-Sangyo-Daigaku Ronshu Shakai-kagaku-Keiretsu, 34, 25–53 (2017)
19) 栄養研究所編：栄養研究所彙報（1924）内務省栄養研究所、東京 [State Institute of the Study of Nutrition ed.: Eiyo-Kenkyusho Iho (1924) Interior Ministry Institute of the Study of Nutrition, Tokyo]

20) 有本邦太郎：日本栄養学史、（財団法人栄養協会編）(1981) 秀潤社、東京 [Arimoto, K.: Nihon-Eiyou-gakushi, (Kokumin Eiyo Kyokai ed.) (1981) Shujunsha, Tokyo]

21) Archives of the League of Nations, Health Section Files, https://www.who.int/archives/fonds_Collections/bytitle/fonds_3/en/ (Accessed on May, 26, 2020)

22) Saiki, T.: Progress of the Science of Nutrition in Japan, (Health Organization, ed.) (1926) League of Nations, Geneva

23) League of Nations ed.: The Problem of Nutrition (1936) League of Nations, Geneva

24) 藤本薰喜、森木貞文: 日本人栄養要求量標準の算定並に其の根據. 栄養学雑誌, 1, 22–28 (1941) [Fujimoto, S., Tsuyuki, S.: Estimation of nutrition requirement standards for Japanese and its evidence, Jpn. J. Nutr. Diet., 1, 22–28 (1941)]

25) 大塚敏雄: 日本人栄養所要量改訂のことなど. 栄養学雑誌, 27, 249–250 (1969) [Oiso, T.: About the revision on Dietary Allowances for Japanese, Jpn. J. Nutr. Diet., 27, 249–250 (1969)]

26) Ministry of Health and Welfare ed. Current Nutritional Status of the Japanese -Report of the 1950 National Nutrition Survey (1946) Ministry of Health and Welfare, Tokyo

27) Council on Resources, the Prime Minister’s Office ed.: Standard Nutrition Values for Japanese (1954) the Prime Minister’s Office, Tokyo

28) Council on Resources, the Prime Minister’s Office ed.: A Handbook on Dietary Allowances for Japanese (1954) the Prime Minister’s Office, Tokyo

29) Council on Resources, the Prime Minister’s Office ed.: 1959 revision, Dietary Allowances for Japanese (1959) the Prime Minister’s Office, Tokyo

30) Abe, T.: The recent trends in “Kakke”, Vitamin, 51, 228–233 (1977)

31) Tsuboya-Kasaya, N., Tsuboi-Utsugi, M., Imai, E., et al.: Historical Overview of the Establishment of Dietary Reference Intakes for Japanese, J. Nutr. Sci. Vitaminol (Tokyo), 59(Supplement), S6–S8 (2012)

32) Ministry of Health, Labour and Welfare ed.: Vital Statistics of Japan 2018 Vol.I, Death (2019), Ministry of Health, Labour and and Welfare, Tokyo

33) Select Committee on Nutrition and Human Needs, United States Senate ed.: Dietary Goals for the United States 2nd Edition (1977) U.S. Government Printing Office, Washington, D.C.

34) Sectional Meeting on Regional Health, Health Promotion, and Nutrition, Council on Health and Welfare Science, Technical Committee for Development of Next Health Promotion Action Plan, Reference material for the promotion of The Healthy Japan 21 (second term), http://www.kenkounippon21.gr.jp/kenkounippon21/about/pdf/kenkounippon21_suisin_siryou.pdf (accessed on May, 18, 2020)

35) Beaton, G.H.: Recommended dietary intakes: Individuals and populations. In Shils ME, Olson JA, Shike M, et al., eds. Modern Nutrition in Health and Disease, 9th ed. pp. 1705–1725 (1999) Williams & Wilkins, Baltimore

36) FAO/WHO/UNU: Energy and protein requirements. Report of a joint FAO/WHO/UNU expert consultation. WHO technical report series 724 (1985) WHO, Geneva

37) Committee on Medical Aspects of Food Policy Panel on Dietary Reference Values. Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. Department of Health Report on Health and Social Subjects 41 (1991) Published for the Department of Health under licence from the Controller of Her Majesty’s Stationery Office, London

38) Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes: Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride (1997) National Academies Press (US), Washington, D.C.

39) Ministry of Health, Labour, and Welfare ed.: Dietary Reference Intakes for the Japanese 2020, https://www.mhlw.go.jp/stf/newpage_08517.html (Accessed on May, 27, 2020)

40) Kuruvilla, S., Sadana, R., Montesinos, E.V., et al.: A life-course approach to health: synergy with sustainable development goals, Bull. World. Health Organ., 96, 42–50 (2018)

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日本における「食事摂取基準」の起源

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【目的】日本の近代化において、「適切な食事摂取」を求める背景にどのような栄養学的課題が存在したのかを明らかにし、それが現在の「食事摂取基準」に至るまでの歴史と、今後のさらなる健康増進に向けての展望を記述すること。

【方法】日本の食事摂取基準に関する論文、書籍、国の報告書、国立栄養研究所の出版物などを通じ、歴史的背景を整理した。

【結果】日本人の食生活は長らく白米中心であったため、ビタミン B1欠乏症である脚気が蔓延していた。多くの医師や栄養学者らはその原因究明に腐心し、人々の健康維持に必要な食事の基準を設定することを目指した。1877年には「日本人の保健食料」が策定された。1920年には国立栄養研究所が設立され、そこで栄養必要量の研究が進められ、さらに国際連盟とも研究協力を行った。第二次世界大戦中や終戦後早期では、国民の低栄養の予防が「栄養所要量」の主たる目的であった。その後多くの研究成果の積み重ねをもとに、2000年に「食事摂取基準」が策定された。

【結論】現在の「食事摂取基準」は、人々の健康維持のための適切な栄養摂取量を追求した数々の歴史的研究成果の賜物である。人々の栄養評価、学校給食や病院給食の献立、そして食生活指針などの栄養政策の策定など、幅広く用いられるものである。今後は、「生涯を通じた栄養」の視点からの研究成果の蓄積により、次世代の健康維持へのさらなる発展が望まれる。

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