Nutritive Values of Energy-control Hospital Menus in the Munakata Area, Fukuoka, Japan

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Abstract

It is important that patients receiving long-term care at medical and welfare institutions receive adequate nutrition in the meals provided for them. To clarify differences in hospital meals from the Dietary Reference Intakes for Japanese (DRIs-J), we evaluated the recipes employed at several institutions in an area of Fukuoka, Japan. Nutritional values of standard and energy-control menus (total 1,260 meals) provided during August 1 - 21, 2011, at two psychiatric hospitals, one geriatric hospital and three non-psychiatric hospitals were estimated using the Standard Tables of Food Composition. The calculated energy values ranged from 1,277 ± 89 to 1,961 ± 123 kcal, all exceeding the set values by up to 5%. In most hospitals, provision of dietary fiber, n-3 unsaturated fatty acids, biotin, calcium, magnesium, iron, zinc, manganese, and vitamin A, E, B_1 and B_6 was suboptimal relative to the DRIs-J, while values for sodium exceeded the reference. These shortfalls in menu nutritional values raise concerns about physical nutritional deficiencies, and suggest that further nutritional surveys are warranted for hospitals providing long-term care. (*Bulletin of Nakamura Gakuen University* 47: 173-181, 2015)

Introduction

It is important that patients receiving long-term care at medical and welfare institutions such as psychiatric hospitals and care houses for the elderly receive adequate nutrition in the meals provided for them. Apart from the meals provided at hospitals, patients have limited opportunities to purchase food, fruit and snacks by themselves.

The Dietary Reference Intakes for Japanese (DRIs-J) is published by the Ministry of Health, Labour and Welfare of Japan (MHLW) and revised every 5 years [1]. DRIs-J 2010 defines the intake levels of energy and 34 nutrients for persons at any given life stage: from 0 months to more than 70 years of age, and those who are pregnant.

In 2006, the MHLW issued official guidance about appropriate usage of the DRIs-J when determining the required levels of energy, fat, protein, vitamins A, B_1, B_2 and C, calcium, iron, sodium and dietary fiber in daily menus offered to patients without any specific dietary restriction. The notification also stated that individual physique, condition, and physical activity should be considered. In Fukuoka city, for example, hospitals, welfare facilities and business offices offering 50 or more meals at any one time or 100 or more meals a day are required to report the values of these 11 nutrition ingredients on 2 days (May 15th and November 15th) every year. Other than this, there are no official or third party systems for checking or surveying the standards of meals provided by hospitals. Only a limited number of studies have investigated meal standards at such hospitals, and in reality, hospitals have been left to supervise themselves.

In the Japanese Universal Healthcare System, 640 JPY per meal (up to three times a day: 1,920 JPY per day) is paid to cover the cost of ingredients, labor, fuel and light when preparing meals. For patients with kidney disease, liver disease, diabetes, gastric ulcer, anemia, pancreatic disease, hyperlipidemia, gout, phenylketonuria, maple syrup urine disease, homocystinuria and galactosemia, an additional 76 JPY per meal is allowed. No specific amount is legally allotted for ingredients. A previous report covering 37 Japanese hospitals in 2004 stated that expenditure for ingredients was 721 ± 54 JPY per day, with approximately 1,208 JPY for labor, lighting and fuel [2]. It has not yet been clarified whether hospital menus can meet the DRIs-J requirements under these circumstances.

We have previously assessed the standard menus (set energy 1,900 kcal/day) of 6 hospitals in Fukuoka Prefecture, Japan [3]. We found that in most hospitals the values of calcium, iron, magnesium, zinc, vitamin A, B_1, B_2 and B_6 in the menus did not reach the recommended dietary allowance

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(RDA). The values of potassium, manganese, vitamin E, pantothenic acid and biotin were less than the adequate intake (AI), and those of n-3 unstaturated fatty acid (USFA) and dietary fiber did not reach the tentative dietary goals for preventing lifestyle-related diseases (DG).

A reduced energy content of meals is necessary for many patients, such as those with obesity, diabetes, or a small physique. Reducing the quantity of all food ingredients evenly may lead to deficiencies of some nutrients. Therefore, more complex meal designs are required in energy control menus.

In the present study, we assessed the existing energy-control recipes (1,200 – 1,600 kcal/day) used at 6 hospitals in the Munakata area of Fukuoka, Japan, and found that n-3 USFA, fiber, calcium, magnesium, iron, zinc, manganese, vitamins A, E, B_1 and B_6, and pantothenic acid were at risk of being deficient.

Methods

Subjects

Energy-control menus for patients with a small build, diabetes or obesity provided at 6 hospitals were examined. These hospitals comprised two psychiatric hospitals (mean stay duration 321 and 582 days), one geriatric hospital (658.7 days) and three non-psychiatric hospitals (17.1, 16.2 and 98.0 days) (Table 1). We examined the energy-control menus for 21 days (882 meals) from August 1 to 21, 2011. The values of standard menus (378 meals) that have been reported previously [3] are also shown in Table 1.

Calculation of nutritive values

Nutritive values of menus at each hospital were calculated using the software package "Excel Eiyo-kun Ver. 6.0" (Kenpaku-sha, Inc.). The program was based on The Standard Tables of Food Composition in Japan 2010 (published by the Ministry of Education, Culture, Sports, Science and Technology) [4]. The loss of nutrients through cooking of boiled vegetables including soy beans, broccoli, spinach and peas, boiled egg, boiled pasta, boiled noodles, and processed food, are already taken into consideration in The Standard Tables of Food Composition in Japan 2010. Cooking loss of heat-labile nutrients was not considered for meat, fish and oil in marinade.

The conversion factor is 60 mg of tryptophan to 1 mg of niacin, which is referred to as 1 niacin equivalent (NE). For vitamin E, α-tocopherol is the only form considered in the Recommended Dietary Allowance (RDA).

As shown in DRIs-J 2010, vitamin B_1, vitamin B_2 and niacin equivalent were set per unit energy. The recommended quantity of vitamin B_6 was calculated based on the daily amount of protein in the hospital menu.

For processed food, the nutritive values printed on the exterior package or those shown on the makers' home pages were used. If the makers' information was not available, the nutritive values were calculated using The Food Composition Tables for Commercial Processed Food [5] and The Table of Trace Element Contents of Japanese Foodstuffs (Daiichi-Shuppan) [6].

Although iodine (EAR, RDA, UL), selenium (EAR, RDA, UL), chromium (EAR, RDA), molybdenum (EAR, RDA, UL) and biotin (AI) are posted on DRIs-J 2010, these nutrients in 1,382 of 1,891 food items are not posted in The Standard Tables of Food Composition in Japan 2010 [4]. Therefore, the values of these 5 elements are not shown here.

DRIs-J 2010 does not define the levels of water, trans-fatty acid, linoleic acid and α-linolenic acid.

Comparison of the nutritive values of hospital menus with DRIs-J 2010

The variety of the menus from day to day is shown as plus and minus 1 standard deviation (SD) of the daily values of the menus for 21 days. The mean daily nutritional values for individual hospital menus were compared with those in the DRIs-J for a 50-69-year-old male, since most of the patients at the hospitals examined fell within this age group [3].

Results

Total energy and macronutrients

The setting of the energy levels among the standard and energy-control menus varied at the 6 hospitals (Table 2). The mean daily energy level for 21 days exceeded the set points by approx. 5%, and at most 9%, at all the hospitals. Daily energy variance (standard deviation) was less than 10% at all hospitals.

Table 1 Profiles of the hospitals that offered meal recipes

Hospital	A	B	C	D	E	F
Clinical Departments	Psychiatry, Internal Medcine (General), Dental	Neurosurgery, Orthopedics	Internal Medicine, Rehabilitation	Internal Medicine, Psychiatry, Geriatrics, Rehabilitation	Internal Medicine, Psychiatry, Dental	Internal Medicine
Number of Beds	500	100	70	236	300	99
Period of Stay (days) in 2011 (mean)	321.0	17.1	16.2	658.7	582.0	98.0

Table 2 Comparison of values of energies and macronutrients in hospital menus with the DRIs-J

	Energy	Protein	Fat	Saturated fatty acids	n-6	n-3	Cholesterol	Carbohydrate	Total Fiber
DRIs-J 2010* Hospital Set Energy	(kcal/d)	RDA：60 (g/d)	20≤DG<25 (%E)	4.5≤DG<7.0 (%E)	DG<10 (%E)	2.4≤DG (g/d)	DG<750 (mg/d)	50≤DG<70 (%E)	19≤DG (g/d)
A (1,900)**	1,950 ± 25	65.2 ± 3.2	20.0 ± 1.8	5.53 ± 0.60	2.9 ± 0.7	1.60 ± 0.68	231.1 ± 82.1	64.3 ± 2.2	13.5 ± 2.8
A (1,600)	1,619 ± 36	61.6 ± 3.7	17.8 ± 1.7	4.25 ± 0.72	2.8 ± 0.8	1.19 ± 0.54	209.8 ± 80.9	65.5 ± 2.2	12.9 ± 2.4
A (1,400)	1,484 ± 29	59.5 ± 3.7	19.4 ± 2.0	4.64 ± 0.82	3.0 ± 0.8	1.21 ± 0.54	210.5 ± 81.9	63.0 ± 2.2	12.5 ± 2.1
A (1,200)***	1,309 ± 38	61.7 ± 4.2	23.4 ± 2.1	5.56 ± 0.93	3.9 ± 0.9	1.21 ± 0.59	221.5 ± 92.8	58.2 ± 2.5	17.6 ± 2.2
B (1,900)**	1,933 ± 93	73.3 ± 6.4	17.7 ± 3.8	3.82 ± 0.77	4.4 ± 1.3	1.70 ± 0.51	265.5 ± 95.2	65.9 ± 3.7	16.6 ± 2.1
B (1,600)	1,635 ± 56	68.8 ± 5.9	17.8 ± 2.7	4.08 ± 0.77	4.2 ± 1.1	1.40 ± 0.40	271.2 ± 94.8	64.2 ± 2.1	15.7 ± 2.4
B (1,400)	1,469 ± 74	65.9 ± 6.0	19.6 ± 2.9	4.50 ± 0.73	4.7 ± 1.1	1.40 ± 0.41	268.4 ± 93.7	61.7 ± 2.3	15.4 ± 2.4
B (1,200)	1,277 ± 89	56.9 ± 6.0	20.5 ± 3.0	4.63 ± 1.02	4.9 ± 1.1	1.27 ± 0.36	215.8 ± 75.5	61.4 ± 2.5	15.2 ± 2.5
C (1,900)**	1,921 ± 69	68.3 ± 3.4	17.7 ± 2.6	5.39 ± 0.98	2.9 ± 0.5	1.51 ± 0.56	253.4 ± 116.6	65.7 ± 2.7	14.3 ± 1.8
C (1,600)	1,699 ± 72	64.4 ± 3.4	19.3 ± 2.8	5.88 ± 0.98	3.2 ± 0.6	1.49 ± 0.57	259.6 ± 116.5	63.3 ± 2.7	13.1 ± 2.0
C (1,400)	1,493 ± 78	60.7 ± 3.2	21.7 ± 3.1	6.61 ± 1.09	3.5 ± 0.6	1.47 ± 0.54	254.2 ± 118.7	60.0 ± 3.2	12.6 ± 2.0
C (1,200)	1,312 ± 96	55.4 ± 3.8	23.6 ± 3.2	7.25 ± 1.15	3.9 ± 0.7	1.38 ± 0.54	241.4 ± 120.2	57.8 ± 3.2	12.3 ± 2.0
D (1,900)**	1,918 ± 69	68.4 ± 3.4	17.6 ± 3.1	5.36 ± 1.14	2.9 ± 0.6	1.51 ± 0.56	252.8 ± 116.6	65.8 ± 2.2	14.4 ± 1.8
D (1,600)	1,645 ± 46	63.7 ± 3.6	19.2 ± 2.2	5.77 ± 0.58	3.0 ± 0.7	1.67 ± 0.78	267.9 ± 108.6	63.7 ± 2.8	12.0 ± 1.1
D (1,400)	1,493 ± 46	61.6 ± 3.6	21.0 ± 2.4	6.31 ± 0.64	3.3 ± 0.8	1.68 ± 0.78	268.5 ± 108.7	61.2 ± 3.1	11.8 ± 1.1
D (1,200)	1,299 ± 42	57.3 ± 3.6	23.1 ± 2.4	6.04 ± 0.98	3.8 ± 0.8	1.70 ± 0.75	248.6 ± 111.0	58.3 ± 3.2	13.2 ± 1.2
E (1,900)**	1,961 ± 123	73.2 ± 8.4	22.0 ± 4.5	6.15 ± 1.40	3.8 ± 0.7	1.70 ± 0.73	342.3 ± 133.9	61.6 ± 2.8	16.7 ± 3.0
E (1,600)	1,750 ± 101	68.2 ± 6.0	22.8 ± 4.1	6.63 ± 1.49	4.1 ± 0.7	1.64 ± 0.76	337.3 ± 133.6	60.1 ± 4.1	14.9 ± 3.0
F (1,800)**	1,851 ± 80	67.5 ± 4.0	20.1 ± 3.4	5.83 ± 0.82	3.7 ± 1.0	2.06 ± 0.78	301.6 ± 121.6	63.9 ± 3.6	15.2 ± 2.4
F (1,200)	1,324 ± 79	57.1 ± 5.1	25.4 ± 3.3	7.37 ± 0.87	4.5 ± 0.8	2.15 ± 0.69	283.0 ± 129.7	56.5 ± 3.6	13.5 ± 1.9

DRIs-J 2010: Dietary Reference Intakes for Japanese 2010. n-6: n-6 polyunsaturated fatty acids. n-3: n-3 polyunsaturated fatty acids. RDA: recommended dietary allowance. DG: tentative dietary goal for preventing lifestyle-related diseases.

* For 50-69 y.o. male ** Standard menu *** For obese patients The values that do not meet DRIs-J are shaded.

Table 3 Comparison of values of macrominerals in hospital menus with DRIs-J

	NaCl	Potassium	Calcium	Magnesium	Phosphorus
DRIs-J 2010 Hospital Set Energy	DG<9.0 - (g/d)	AI：2,500 - (mg/d)	RDA：700 UL：2,300 (mg/d)	RDA：350 - (mg/d)	AI：1,000 UL：3,000 (mg/d)
A (1,900)	7.72 ± 0.78	2,293 ± 225	573 ± 80	207 ± 32	939 ± 66
A (1,600)	7.46 ± 1.02	2,249 ± 197	607 ± 82	208 ± 44	902 ± 101
A (1,400)	7.45 ± 1.00	2,205 ± 184	606 ± 81	193 ± 21	859 ± 71
A (1,200)	7.32 ± 1.18	2,565 ± 227	651 ± 77	334 ± 28	1,182 ± 92
B (1,900)	9.64 ± 1.64	2,782 ± 251	865 ± 130	284 ± 30	1,106 ± 91
B (1,600)	8.94 ± 1.61	2,720 ± 265	847 ± 75	274 ± 28	1,058 ± 88
B (1,400)	8.96 ± 1.56	2,697 ± 243	844 ± 74	267 ± 28	1,027 ± 80
B (1,200)	8.89 ± 1.98	2,548 ± 289	822 ± 73	247 ± 29	909 ± 89
C (1,900)	10.00 ± 1.33	2,956 ± 432	574 ± 61	271 ± 37	1,096 ± 55
C (1,600)	9.43 ± 1.25	2,792 ± 447	553 ± 56	249 ± 36	1,022 ± 57
C (1,400)	9.37 ± 1.22	2,731 ± 436	546 ± 55	239 ± 36	972 ± 54
C (1,200)	9.20 ± 1.13	2,642 ± 452	540 ± 56	227 ± 36	908 ± 62
D (1,900)	10.05 ± 1.34	2,964 ± 432	575 ± 61	272 ± 37	1,099 ± 55
D (1,600)	6.47 ± 0.46	2,240 ± 173	579 ± 92	212 ± 26	993 ± 56
D (1,400)	6.47 ± 0.46	2,217 ± 172	579 ± 91	206 ± 25	965 ± 53
D (1,200)	9.17 ± 0.60	2,159 ± 145	539 ± 87	202 ± 24	876 ± 62
E (1,900)	9.46 ± 1.50	2,558 ± 384	590 ± 68	286 ± 35	1,088 ± 92
E (1,600)	8.30 ± 1.48	2,370 ± 345	559 ± 67	263 ± 33	1,018 ± 70
F (1,800)	9.22 ± 1.18	2,720 ± 241	593 ± 73	277 ± 28	1,063 ± 67
F (1,200)	8.57 ± 1.31	2,358 ± 201	553 ± 59	240 ± 31	904 ± 73

NaCl: sodium chloride equivalent

The values for protein did not reach the RDA for five energy-control menus. The values for fat were below those of the DG (20 - 25% of total energy) in many menus. Saturated fatty acid (SFA) mostly fell within the DG range. The amount of fat did not change to any great extent in most menus, and consequently the ratios of fat and SFA increased in the energy-control menus. At all hospitals, the total calorific value was reduced mainly through carbohydrate (white rice and noodles) in standard menus.

The amounts of n-6 USFA and cholesterol met the DG standard in all of the hospital menus. The values of n-3 USFA did not reach the DG standard in any of the hospital menus (50 - 90% of the minimum requirement stipulated in the DG).

The values of dietary fiber did not reach the DG standard at any of the hospitals: 62 - 93% of the lower limit.

Macro minerals

The values of NaCl in most hospital menus achieved the DG (less than 9 g/day). The value at hospital C exceeded that stipulated by the DG: 10.0 g/day (Table 3).

Achievement of potassium values for AI (2,500 mg/day) differed among the hospitals. All standard and energy-control menus at hospitals B and C reached AI, while all energy-control menus at hospital D had values less than the AI. The minimum value was 2,159 mg/day.

The values of calcium in all menus at hospital B reached the RDA (700 mg). However, those in the other menus at all hospitals were approx. 20% lower than the RDA level.

Regarding magnesium values, none of the hospital menus reached the RDA level (350 mg/day). The values of phosphorus in most hospital menus reached approx. 90% of AI (1,000 mg/day).

Trace minerals

The values of iron in most menus at 3 hospitals were lower than the RDA level (7.5 mg/day). The lowest value was 5.51 mg/day at hospital D (Table 4).

The values of zinc did not reach the RDA level (12.0 mg/day) in any of the menus. The lowest value was 6.43 mg/day at hospital C, which is around half of the RDA, while highest value was 10.14 mg/day at hospital E.

The values of copper in all hospital menus almost met the RDA level (0.9 mg/day). The minimum value among the hospitals was 0.86 mg/day.

Table 4 Comparison of values of trace minerals in hospital menus with the DRIs-J

DRIs-J 2010 Hospital Set Energy		Iron RDA：7.5 UL：50 (mg/d)	Zinc RDA：12.0 UL：45 (mg/d)	Copper RDA：0.9 UL：10 (mg/d)	Manganese AI：4.0 UL：11 (mg/d)
A	(1,900)	5.84 ± 1.49	9.01 ± 1.46	1.12 ± 0.11	3.33 ± 0.58
A	(1,600)	5.84 ± 1.44	8.22 ± 1.38	1.01 ± 0.09	3.05 ± 0.62
A	(1,400)	5.77 ± 1.38	7.83 ± 1.47	0.92 ± 0.09	2.66 ± 0.32
A	(1,200)	7.57 ± 1.35	8.12 ± 1.39	0.86 ± 0.11	4.54 ± 0.48
B	(1,900)	10.29 ± 1.26	9.63 ± 1.15	1.34 ± 0.11	3.52 ± 0.52
B	(1,600)	10.50 ± 2.31	9.01 ± 1.02	1.22 ± 0.09	3.11 ± 0.42
B	(1,400)	10.31 ± 2.34	8.40 ± 1.00	1.12 ± 0.10	2.76 ± 0.41
B	(1,200)	9.79 ± 2.34	7.27 ± 0.89	0.99 ± 0.11	2.44 ± 0.44
C	(1,900)	7.44 ± 0.79	8.73 ± 0.81	1.29 ± 0.07	3.40 ± 0.28
C	(1,600)	6.70 ± 0.87	7.87 ± 0.78	1.14 ± 0.08	2.83 ± 0.27
C	(1,400)	6.82 ± 0.88	7.16 ± 0.76	1.02 ± 0.07	2.39 ± 0.28
C	(1,200)	6.59 ± 0.95	6.43 ± 0.78	0.92 ± 0.07	2.06 ± 0.27
D	(1,900)	7.47 ± 0.79	8.76 ± 0.81	1.29 ± 0.07	3.40 ± 0.28
D	(1,600)	5.56 ± 0.90	7.58 ± 0.79	1.04 ± 0.08	2.89 ± 0.34
D	(1,400)	5.51 ± 0.89	7.06 ± 0.78	0.95 ± 0.08	2.58 ± 0.35
D	(1,200)	6.53 ± 1.74	6.59 ± 1.29	0.86 ± 0.09	2.27 ± 0.34
E	(1,900)	8.26 ± 1.25	10.14 ± 1.38	1.36 ± 0.14	3.42 ± 0.44
E	(1,600)	7.51 ± 1.12	9.28 ± 1.29	1.23 ± 0.13	3.00 ± 0.40
F	(1,800)	8.73 ± 2.26	9.01 ± 0.86	1.26 ± 0.12	3.32 ± 0.32
F	(1,200)	7.23 ± 1.50	6.71 ± 0.85	0.91 ± 0.07	2.27 ± 0.29

The values of manganese in all hospital menus, except for the 1,200 kcal diet at hospital A, were lower than the AI value (4 mg/day). The minimum value was half of the AI value (2.06 mg/day) in the 1,200 kcal menu at hospital C.

Vitamins

Regarding vitamin A, only one menu at hospital F reached the RDA level (850 μgRE/day) (Table 5). The other menus at all hospitals provided less vitamin A; the lowest value was 565 μgRE/day.

The values of vitamin D in all menus except for 4 reached the AI. The minimum value was 4.94 μg/day.

Regarding vitamin E, only one menu met the AI (7.0 mg/day). The other menus contained vitamin E at levels below the AI: the minimum value was 4.29 mg/day in the 1,400 kcal menu at hospital A.

The vitamin K values in all menus met the AI (75 μg/day).

The vitamin B_1 values in most menus did not reach the RDA (0.54 mg per 1,000 kcal of the daily energy intake). The lowest value was 0.434 mg/1,000 kcal at hospital D (Table 6).

The values of vitamin B_2 in most menus achieved the RDA (0.60 mg/1,000 kcal). One menu's vitamin B_2 level was lower than the RDA level, but its value was 0.560 mg/1,000 kcal.

The values of niacin reached the RDA levels (5.8 mgNE/1,000 kcal) in all hospital menus.

The values of vitamin B_6 were lower than that of the RDA (0.023 mg per 1 g of daily protein intake) in all of the hospital menus except for a menu at hospital A.

The values of vitamin B_{12} and folate reached the RDA levels (2.4 μg/day and 240 μg/day, respectively) in all menus.

The values of pantothenic acid in 8 menus did not reach the AI level (6 mg/day). The lowest value was 5.0 mg/day at hospital D.

The values of vitamin C in all menus mostly met the RDA (100 mg/day). The minimum value was 97.5 mg/day at hospital A.

Discussion

In the hospital menus examined, the set energy contents of standard diets were based on each hospital's configurations for patients' ages and diseases [3]. The amounts of energy in the existing menus were acceptable, being equal or up to 5% more than the set levels. Reduction of the energy content of standard menus to create energy-restricted menus was attained mainly by reducing the amount of white rice in all hospitals. Protein and fat were supplied at almost the same

Table 5 Comparison of values of fat-soluble vitamins in hospital menus with DRIs-J

DRIs-J 2010 Hospital	Set Energy	Vitamin A			Vitamin D			Vitamin E			Vitamin K		
		RDA：850 UL：2,700 (μgRE/d)			AI：5.5 UL：50 (μg/d)			AI：7.0 UL：850 (mg/d)			AI：75 - (μg/d)		
A	(1,900)	733	±	255	5.90	±	5.90	5.40	±	1.43	234	±	114
A	(1,600)	673	±	257	5.13	±	6.02	4.34	±	1.33	237	±	112
A	(1,400)	672	±	257	5.08	±	6.01	4.29	±	1.17	236	±	112
A	(1,200)	733	±	267	4.94	±	6.09	6.27	±	1.21	273	±	107
B	(1,900)	565	±	63	9.40	±	7.70	7.90	±	1.69	228	±	49
B	(1,600)	603	±	93	11.60	±	11.34	6.64	±	1.31	251	±	52
B	(1,400)	603	±	91	11.80	±	11.36	6.60	±	1.24	250	±	52
B	(1,200)	583	±	93	10.90	±	10.24	6.22	±	1.25	245	±	52
C	(1,900)	610	±	190	7.13	±	5.64	5.79	±	1.62	195	±	68
C	(1,600)	620	±	197	7.18	±	5.64	5.82	±	1.69	194	±	68
C	(1,400)	613	±	198	6.77	±	5.46	5.82	±	1.69	196	±	70
C	(1,200)	608	±	199	5.85	±	4.75	5.62	±	1.58	196	±	70
D	(1,900)	610	±	190	7.13	±	5.64	5.79	±	1.62	195	±	68
D	(1,600)	568	±	141	6.15	±	2.39	5.35	±	1.62	221	±	139
D	(1,400)	570	±	142	6.18	±	2.37	5.37	±	1.63	222	±	139
D	(1,200)	597	±	121	5.78	±	2.47	5.69	±	1.88	270	±	136
E	(1,900)	592	±	203	5.84	±	5.16	6.07	±	1.44	255	±	112
E	(1,600)	565	±	210	5.42	±	5.23	5.73	±	1.47	235	±	115
F	(1,800)	1,099	±	1,876	6.70	±	4.82	6.68	±	1.60	222	±	84
F	(1,200)	680	±	639	6.76	±	5.01	5.70	±	1.44	225	±	91

Table 6 Comparison of values of water-soluble vitamins in hospital menus with the DRIs-J

	Vitamin B_1	Vitamin B_2	Niacin		Vitamin B_6		Vitamin B_{12}	Folate	Pantothenic Acid	Vitamin C
DRIs-J 2010	RDA：0.54	RDA：0.60	RDA: 5.8 mgNE/1,000 kcal		RDA：0.023 mg/g protein		RDA：2.4	RDA：240	AI：6	RDA：100
Hospital Set	-	-	UL：350 mg/d		UL：55 mg/d		-	UL：1,400	-	-
Energy	(mg/1,000 kcal)	(mg/1,000 kcal)	(mgNE/1,000 kcal)	(mgNE/d)	(mg/g protein)	(mg/d)	(μg/d)	(μg/d)	(mg/d)	(mg/d)
A (1,900)	0.440 ± 0.110	0.560 ± 0.100	5.90 ± 1.32	11.5 ± 2.6	0.0185 ± 0.0031	1.2 ± 0.2	3.66 ± 2.05	286 ± 65	6.0 ± 0.6	97.5 ± 28.3
A (1,600)	0.509 ± 0.135	0.683 ± 0.105	7.10 ± 2.08	11.5 ± 3.3	0.0184 ± 0.0028	1.1 ± 0.2	3.80 ± 2.18	275 ± 64	5.6 ± 0.7	103.9 ± 33.3
A (1,400)	0.515 ± 0.124	0.739 ± 0.119	7.18 ± 1.84	10.7 ± 2.6	0.0182 ± 0.0023	1.1 ± 0.1	3.99 ± 2.51	271 ± 62	5.3 ± 0.5	105.3 ± 32.2
A (1,200)	0.994 ± 0.175	0.906 ± 0.117	14.76 ± 2.69	19.3 ± 3.3	0.0280 ± 0.0034	1.7 ± 0.2	3.99 ± 2.53	342 ± 70	6.6 ± 0.6	125.1 ± 30.7
B (1,900)	0.503 ± 0.081	0.636 ± 0.099	6.67 ± 1.02	12.9 ± 2.1	0.0171 ± 0.0029	1.3 ± 0.2	5.95 ± 4.87	382 ± 68	6.5 ± 0.7	130.3 ± 29.2
B (1,600)	0.570 ± 0.104	0.758 ± 0.107	7.65 ± 1.15	12.5 ± 1.8	0.0175 ± 0.0030	1.2 ± 0.2	6.24 ± 4.93	406 ± 53	6.1 ± 0.6	127.5 ± 23.6
B (1,400)	0.619 ± 0.121	0.844 ± 0.093	8.29 ± 1.40	12.2 ± 2.0	0.0178 ± 0.0031	1.2 ± 0.2	6.26 ± 4.91	402 ± 54	5.8 ± 0.6	127.8 ± 23.8
B (1,200)	0.628 ± 0.101	0.883 ± 0.128	8.42 ± 1.37	10.8 ± 1.7	0.0191 ± 0.0035	1.1 ± 0.2	5.20 ± 3.85	389 ± 53	5.2 ± 0.6	127.5 ± 24.4
C (1,900)	0.475 ± 0.087	0.612 ± 0.073	8.29 ± 1.62	15.9 ± 3.2	0.0190 ± 0.0018	1.3 ± 0.1	4.99 ± 1.67	308 ± 48	7.3 ± 0.9	112.4 ± 29.2
C (1,600)	0.496 ± 0.097	0.677 ± 0.065	8.87 ± 1.79	15.1 ± 3.3	0.0189 ± 0.0020	1.2 ± 0.2	4.92 ± 1.64	297 ± 49	6.8 ± 0.8	108.5 ± 29.3
C (1,400)	0.541 ± 0.107	0.759 ± 0.078	9.72 ± 2.04	14.5 ± 3.3	0.0192 ± 0.0022	1.2 ± 0.2	4.86 ± 1.58	294 ± 50	6.4 ± 0.8	109.0 ± 29.9
C (1,200)	0.579 ± 0.114	0.829 ± 0.079	10.29 ± 2.07	13.5 ± 3.1	0.0199 ± 0.0024	1.1 ± 0.2	4.41 ± 1.43	290 ± 51	6.0 ± 0.8	108.8 ± 30.1
D (1,900)	0.474 ± 0.083	0.615 ± 0.083	7.07 ± 1.20	11.7 ± 2.1	0.0190 ± 0.0020	1.3 ± 0.1	4.99 ± 1.67	309 ± 48	7.3 ± 0.9	112.4 ± 29.2
D (1,600)	0.434 ± 0.091	0.605 ± 0.056	6.85 ± 1.18	11.3 ± 2.0	0.0178 ± 0.0026	1.1 ± 0.2	2.80 ± 1.11	266 ± 46	5.8 ± 0.5	99.5 ± 27.3
D (1,400)	0.468 ± 0.099	0.663 ± 0.061	7.44 ± 1.29	11.1 ± 2.0	0.0182 ± 0.0027	1.1 ± 0.2	2.84 ± 1.09	265 ± 46	5.6 ± 0.5	99.7 ± 27.2
D (1,200)	0.536 ± 0.123	0.697 ± 0.085	8.63 ± 1.51	11.2 ± 2.1	0.0193 ± 0.0033	1.1 ± 0.2	2.63 ± 1.15	274 ± 45	5.0 ± 0.7	107.9 ± 25.5
E (1,900)	0.519 ± 0.129	0.610 ± 0.094	6.53 ± 1.89	12.8 ± 3.7	0.0171 ± 0.0034	1.2 ± 0.2	4.25 ± 2.74	371 ± 102	6.6 ± 1.0	125.1 ± 47.9
E (1,600)	0.521 ± 0.141	0.654 ± 0.095	6.73 ± 1.93	11.8 ± 3.4	0.0168 ± 0.0032	1.1 ± 0.2	4.02 ± 2.56	345 ± 99	6.1 ± 0.8	110.9 ± 36.4
F (1,800)	0.523 ± 0.135	0.661 ± 0.135	7.90 ± 1.82	14.6 ± 3.6	0.0203 ± 0.0037	1.4 ± 0.3	7.59 ± 5.88	347 ± 177	6.7 ± 1.4	113.0 ± 33.5
F (1,200)	0.534 ± 0.092	0.808 ± 0.140	10.40 ± 3.08	13.8 ± 4.1	0.0197 ± 0.0034	1.1 ± 0.2	5.66 ± 2.55	294 ± 72	5.5 ± 0.7	103.9 ± 36.4

levels in individual hospitals.

In most of the energy-restricted menus, levels of minerals and vitamins were the same as, or lower than, those of standard menus. n-3 USFA, fiber, calcium, magnesium, iron, zinc, manganese, vitamins A, E, B_1 and B_6, and pantothenic acid were found to be at risk of being deficient in the standard and energy-restricted menus for a 50-69-year-old male. Even when the nutritive values of all 6 hospitals' menus were compared with the DRIs-J for women aged ≥70 years (physical activity level 2, estimated energy requirement 1700 kcal), magnesium in 10 of the 20 menus did not reach the RDA. The levels of iron in 5 of the 20 menus, zinc in 14, and vitamin A in 14 did not reach the RDA level (data not shown).

One of the factors responsible for insufficient nutrition in menus is thought to be restricted expenditure on cooking ingredients. As stated in the Introduction, it has been reported that 721 ± 54 JPY per day is actually spent on ingredients [2]. Interviews with dieticians at the surveyed hospitals revealed that the cost allocated for ingredients was 740-780 JPY a day.

We have previously examined the nutritive values of diets for patients with liver disease and energy-restricted diets in commercially available family cookbooks [7,8]. Although the levels of many nutrients fell below the DRIs-J requirements, the severity of the deficiencies was lower in the cookbook menus than in the hospital menus. For meals prepared following a cookbook, there is no economic restriction and the menus may contain a variety of expensive ingredients, with a total cost of 1,400-1,600 JPY/day.

Blue-skinned fish, containing a relatively high amount of n-3 USFA, is more expensive than larger-sized fish. Blue fish was used 8 - 10 times during three weeks at 5 hospitals, where the amounts of n-3 USFA were lower than the DRIs-J recommendation (Table 2). At hospital A, blue fish was provided once during three weeks, and thus the n-3 USFA level supplied was extraordinary low. The hospital used no, or only low amounts of perilla seed oil and rape seed oil, which contain more n-3 USFA than other types of cooking oil.

Only at hospital B did the amounts of iron and calcium meet the DRIs-J requirement. Calcium was supplied at all hospitals with mainly in the form of milk. Hospital B, which specialized in neurosurgery and orthopedics, used milk fortified with iron (230% of that in standard milk) and calcium (209%). The price of such fortified milk is the same as that of standard milk. If a hospital intends to avoid supplements, then cheese, small dried sardines and Japanese mustard spinach, which are relatively expensive, could be considered as alternative sources of calcium.

Beef, pork and chicken are superior to eggs in supplying zinc, and cost approx. >300 JPY/100 g, 200 JPY/100 g, 150 JPY/100 g and 60 JPY/120 g (2 medium eggs), respectively. Beef, pork, chicken and eggs were used at 8.5 g/day, 24.0 g/day, 20.6 g/day and 32.7 g/day on average in all menus at the 6 hospitals. Oysters, sardines and mackerel contain more zinc per wet weight, but they cost much more than beef.

There are several alternative foods that do not cost so much [9]. Many trace minerals and vitamins can be compensated for by increasing the intake of whole beans. White rice was provided almost 3 times a day at all hospitals. By substituting white rice for breakfast with brown rice, the amounts of magnesium were estimated to meet the DRIs-J' levels in all of the menus at 4 hospitals, and to account for more than 80% of the DRIs-J' levels at the other 2 hospitals (data not shown). Potassium, manganese, vitamins E, B_1 and B_6, pantothenic acid and dietary fiber can also be increased by intake of brown rice. Substituting one third the volume of tofu with whole-grain soy would also supply such minerals and vitamins.

Supplying energy for individuals can be controlled by monitoring of a patient's weight, activity and stress level. On the other hand, no physical indicator is available for adequate supply of minerals and vitamins until an individual develops deficiency illness.

Evaluation of overall nutrition loss through food processing is important: meal design > cooking (cooking loss) > ingestion (wastage) > absorption (interference due to a combination of foods and medicine) [10]. Cooking loss of iron, zinc, copper and manganese has been reported to be more than 25% [11]. The amounts of food intake, and conversely those of food wastage, are not negligible, especially in hospitals with many elderly patients [12,13]. Since the nutritive values listed in the DRIs-J are net amounts of ingested nutrients, patients are considered likely to be at risk of deficiencies, especially at hospitals A, D and E, where many patients stay for more than 1 year and the only nutrition source is the daily hospital meals. Serum examinations to determine the levels of these nutrients are required, and moreover supplements may be considered [14,15].

The undernutrition resulting from hospital menus found in this study also suggests that the current system for reporting to local governments (shown in the Introduction) is not working well. Nutritional items including magnesium, iron, zinc, manganese, vitamin E, B_6 and pantothenic acid should be added to the items that need to be reported, which currently include energy, protein, fat, vitamins A, B_1, B_2 and C, calcium, iron, and fiber. More importantly, the number of reporting days should be increased from one (3 meals) every 6 months to, for example, several weeks in every season.

More positively, the government should not only publish the DRIs-J but also suggest ideal model menus, which would be suitable for areas receiving supplies of readily available regional foods, in order to improve the nutritive values of hospital menus while maintaining a reasonable level of expense.

Conflict of Interest

None.

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