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Discussion
Dietary Reference Intakes in Japan ; Estimated Average of Resting Energy Expenditure

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Dietary Reference Intakes in Japan

After two years of discussion and deliberation, the chairperson of the Public Health Council submitted a report on the dietary reference intakes －Recommended Dietary Allowances(RDAs) for the Japanese, 6th Revision－ to the Ministry of Health and Welfare on June 28, 1999. The RDAs, which are to be used for five years from 2000 to 2004, were officially issued on the same day.

It is said that the following categories can be found in the domain of health care : deficiency dissolving, health maintenance, health protection, health promotion, and risk reduction of chronic non-communicable diseases.

Traditionally, the RDAs had been calculated with the purpose of dissolving deficiency, maintaining and protecting the health of a group of people. The 6th revision of the RDAs for the Japanese －the dietary refernce intakes－ has added the idea of health promotion and risk reduction of chronic noncommunicable diseases to the conventional RDA(Fig. 1).

The revised RDAs take the individual into consideration and will be used with the purpose of primary care against diet-induced disease (known as lifestyle-related diseases in Japan).

The RDAs for the Japanese state the standard intake levels of energy ; macronutrients, such as protein, fat, carbohydrates and dietary fiber, and micronutrients, which are the 13 vitamins and 13 minerals(Table 1－4).

With the aim of preventing nutrition deficiency, the "estimatd average requirement(EAR)" is determined from the daily intake level that meets the requirement in 50% of the individuals in a specific life-stage or gen-der group.

The recommended dietary allowance is the daily intake amount that meets the requirement of most individuals(97－98%) in a specific life-stage or gender group. The calculation would be :

$$\text{EAR} + \text{standard deviation(SD)} \times 2$$

If sufficient scientific evidence is not available to calculate the average requirement, it was decided that an adequate amount of recommended allowance to help a defined group of people maintain a given nutritional status can be used. That recommended allowance is called the "adequate intake(AI)".

On the other hand, with the aim of preventing disorders caused by over-intake, the "tolerable upper intake level(UL)" was set. The UL is the maximum level of daily nutrient intake that is unlikely to pose a risk of adverse health effects in almost all individuals in a

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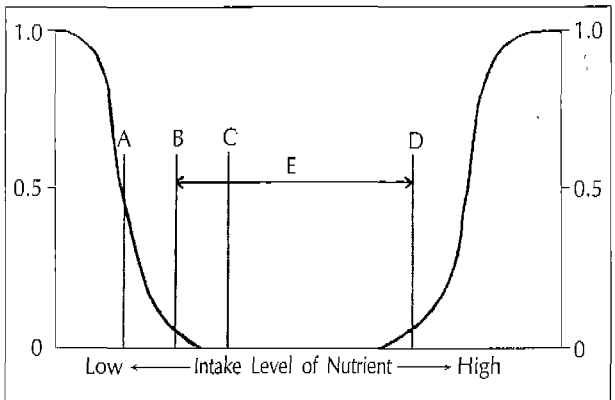

米國・名稱	日本・名稱
食事參考攝取量(DRI : Dietary Reference Intakes, U.S.A.)	食事攝取基準
A : 推定平均必要量(EAR : Estimated Average Requirements)	A ：平均必要量
B : 推奬榮養所要量(個人のための) (RDA : Recommended Dietary Allowances)	B ｝榮養所要量
C : 適正攝取量(AI : Adequate Intakes)	C ｝
D : 許容上限攝取量(レヘル) (UL : Tolerable Upper Intake Level)	D ：許容上限攝取量
E : 攝取安全域(Safe range of intake)	

Fig. 1. Dietary reference intakes.

specified group.

The range of intake between the RDA and UL is set as the "safe range of nutrient intake." Nutritional status of an individual is assessed in this range and nutritional support is provided accordingly.

Taking into consideration the nutrient function and nutrient effects to the structure and function of the body, one must work towards health promotion and risk reduction of chronic non-communicable diseases so that primary care of health can be achieved successfully.

Thus nutrient-based dietary reference intakes(DRI) is the general term used for the values of EAR, RDA, and UL.

Estimated Average of Resting Energy Expenditure

To calculate the recommended energy allowances of the Japanese, I have used the port-

Table 1. Energy and macronutrients(Males)

Age(years)	Height (cm)	Weight (kg)	Energy requirements[1](kcal/day) / quality of daily activity				Fat energy ratio[3](%)	Protein requirements (g)
			Ⅰ. Light (1.3×BM[2])	Ⅱ. Light to moderate (1.5×BM)	Ⅲ. Moderate (1.7×BM)	Ⅳ. Heavy (1.9×BM)		
0 to 6 months	61.7	6.4	110-120kcal/kg				45	2.6/kg
6 months to 1 year	70.7	8.5	100kcal/kg				30-40	2.7/kg
1- 2	83.6	11.5	-	1,050	1,200	-	25-30	35
3- 5	102.3	16.4	-	1,350	1,550	-	25-30	45
6- 8	121.9	24.6	-	1,650	1,900	-	25-30	60
9-11	139.0	34.6	-	1,950	2,250	-	25-30	75
12-14	158.3	47.9	-	2,200	2,550	-	25-30	85
15-17	169.3	59.8	2,100	2,400	2,750	3,050	25-30	80
18-29	171.3	64.7	2,000	2,300	2,650	2,950	20-25	70
30-49	169.1	67.0	1,950	2,250	2,550	2,850	20-25	70
50-69	163.9	62.5	1,750	2,000	2,300	2,550	20-25	65
70 and above	159.4	56.7	1,600	1,850	2,050	-	20-25	65

1. It is desirable that the dietary fiber intake of an adult be 20-25g(10g/1,000kcal) ; the carbohydrate intake ratio to total energy be at least 50% or over.
2. *BM=Basal Metabolism
3. The desirable intake ratio of saturated fatty acid(S), monounsaturated fatty acid(M), and polyunsaturated fatty acid(P) is 3 : 4 : 3. The ratio of n-6 type polyunsaturated fatty acid to n-3 type polyunsaturated fatty acid of a healthy human being is about 4 : 1.

Table 2. Energy and macronutrients(Females)

Age(years)	Height (cm)	Weight (kg)	Energy requirements(kcal/day) / quality of daily activity				Fat energy ratio(%)	Protein requirements (g)
			Ⅰ. Light (1.3×BM[1])	Ⅱ. Light to moderate	Ⅲ. Moderate (1.7×BM)	Ⅳ. Heavy (1.9×BM)		
0 to 6 months	61.7	6.4	110-120kcal/kg				45	2.6/kg
6 months to 1 year	70.7	8.5	100kcal/kg				30-40	2.7/kg
1-2	83.6	11.5	-	1,050	1,200	-	25-30	35
3-5	102.3	16.4	-	1,300	1,500	-	25-30	45
6-8	120.8	23.9		1,500	1,700	-	25-30	55
9-11	138.4	33.8		1,750	2,050	-	25-30	65
12-14	153.4	45.3	-	2,000	2,300	-	25-30	70
15-17	157.8	51.4	1,700	1,950	2,200	2,500	25-30	65
18-29	158.1	51.2	1,550	1,800	2,050	2,300	20-25	55
30-49	156.0	54.2	1,500	1,750	2,000	2,200	20-25	55
50-69	151.4	53.8	1,450	1,650	1,900	2,100	20-25	55
70 and above	145.6	48.7	1,300	1,500	1,700	-	20-25	55
Pregnancy	-	-	+350kcal				20-30	+10g
Lactation	-	-	+600kcal				20-30	+20g

1. BM=Basal Metabolism

able calorimeter "Metavine" to draw the estimated average of the resting energy expenditure according to age and sex.

1. Calculation of energy expenditure of the japanese

The recommended energy alowances of the Japanese have been determined with the purpose of setting energy requirements for health protection and a fulfilling active lifestyle.

An average body size(height and weight) of a Japanese person according to age and sex was hypothetically set, and a group of Japanese people who fall in that category had been gathered to measure the energy requirement. That energy requirement was considered as the recommended energy allowance. The energy requirement, in this case, was calculated on the basis of the basal metabolism.

2. Basal metabolism

Basal metabolism(BM) was an idea first brought about in the 1920s. It is considered as the lowest amount of energy metabolism of a body at physical and mental rest, and a state of chemical process where breathing activity enough to keep one alive, the circulation system, the organs, such as liver and kidneys, and other physical systems, are least active.

In actuality, BM had always been measured under such conditions. It is the amount of energy expenditure at resting state(not asleep) in a 20℃ room after an overnight fast - not having anything to eat for 12 to 15 hours after a light meal at 6 p.m. the day before. One can see that it is not very easy to measure the BM.

BM has been known as the least amount of metabolism necessary to stay alive. When asleep, however, it had been said that the metalbolism becomes 10% below BM. This idea is not rational. One is still alive when asleep. The lowering of BM during sleep(-10%) depends on what one had for meal the night before, what time one went to bed, or one's heart rate.

In compiling the 6th revision of the Recommended Dietary Allowances(RDA) for the Japanese -- the Dietary Reference Intakes - BM was tentatively defined as follows :

"Basal metabolism(BM) is the amount of

Table 3. Dietary reference intakes of minerals

Age(years)	Calcium			Iron			Phosphorus		Magnesium			Potassium[4]		Copper		
	RDA(mg)		UL (mg)	RDA(mg)		UL (mg)	RDA (mg)	UL (mg)	RDA(mg)		UL (mg)	RDA(mg)		RDA(mg)		UL (mg)
	Male	Female		Male	Female				Male	Female		Male	Female	Male	Female	
0 to 6 months	200		–	6		10	130	–	25		–	500		0.3		–
6 months to 1 year	500		–	6		15	280	–	30		–	700		0.7		–
1 – 2	500		–	7		20	600	–	60		130	900		0.8		–
3 – 5	500		–	8		25	700	–	80		200	1,100		1		–
6 – 8	600	600	–	9	9	30	900	–	120	120	250	1,350	1,200	1.3	1.2	–
9 – 11	700	700	–	10	10[1]	35	1,200	–	170	170	500	1,550	1,400	1.4	1.4	–
12 – 14	900	700	–	12	12	35	1,200	–	240	220	600	1,750	1,650	1.8	1.6	–
15 – 17	800	700	–	12	12	40	1,200	–	290	250	650	2,000	2,000	1.8	1.6	–
18 – 29	700	600	2,500	10	12	40	700	4,000	310	250	700	2,000	2,000	1.8	1.6	9
30 – 49	600	600	2,500	10	12[2]	40	700	4,000	320	260	700	2,000	2,000	1.8	1.6	9
50 – 69	600	600	2,500	10	12[2]	40	700	4,000	300	260	650	2,000	2,000	1.8	1.6	9
70 and above	600	600	–	10	10	40	700	–	280	240	650	2,000	2,000	1.6	1.4	–
Pregnancy	–	+300	2,500	–	+ 8	40	+0	4,000	–	+35	700	–	+0	–	+0.4	9
Lactation	–	+500	2,500	–	+ 8[3]	40	+0	4,000	–	+0	700	–	+500	–	+0.6	9

1) 11 years old female=12mg/day 2) Post-menopause=10mg/day 3) During 6 months after parturition

4) To prevent hypertension, it is desirable that the reference intake of salt be less than 150mg/kg/day and for 15 years old and above, less than 10g/day ; the reference intake of potassium be 3,500mg/day for 15 year-olds and above.

Age(years)	Iodine		Manganese			Selenium				Zinc			Chromium			Molybdenum		
	RDA (μg)	UL (mg)	RDA(μg)		UL(μg)	RDA(μg)		UL(μg)		RDA(mg)		UL (mg)	RDA(μg)		UL (μg)	RDA(μg)		UL (μg)
			Male	Female		Male	Female	Male	Female	Male	Female		Male	Female		Male	Female	
0 to 6 months	40	–	0.003		–	15		–		1.2[5]		–	–		–	–		–
6 months to 1 year	50	–	1.2		–	20		–		4		–	–		–	–		–
1 – 2	70	–	1.8		–	25		–		5		–	16		60	6		60
3 – 5	80	–	2.5		–	35		–		6		–	20		80	8		80
6 – 8	100	3	3.0	3.0	–	40	40	–		6	6	–	25	25	120	12	12	120
9 – 11	100	3	3.5	3.0	–	50	45	–		7	7	–	30	30	150	15	15	150
12 – 14	150	3	3.5	3.0	–	55	50	–		8	8	–	35	30	200	20	20	200
15 – 17	150	3	4.0	3.0	–	60	45	250		10		–	35	30	250	30	25	250
18 – 29	150	3	4.0	3.0	10	60	45	250		11	9	30	35	35	250	30	25	250
30 – 49	150	3	4.0	3.5	10	55	45	250		12	10	30	35	30	250	30	25	250
50 – 69	150	3	4.0	3.5	10	50	45	250		11	10	30	35	25	250	30	25	250
70 and above	150	3	3.5	3.0	–	45	40	250		10	9	–	25	20	200	25	25	200
Pregnancy	+25	3	–	+0	10	–	+ 7	250		–	+3	30	–	+0	250	–	+0	250
Lactation	+25	3	–	+0	10	–	+20	250		–	+3	30	–	+0	250	–	+0	250

5) if artificial milk is used=3mg/day

Table 4. Dietary reference intakes of vitamins

Age(years)	Vitamin A			Vitamin D(μg(IU))		Vitamin E			Vitamin K			Vitamin B_1	
	RDA[1](μg RE(IU))		UL[2] (μg RE(IU))	RDA	UL	RDA(mg α-TE)[3]		UL (mg α-TE)	RDA(μg)		UL (μg)	RDA(mg)	
	Male	Female				Male	Female		Male	Female		Male	Female
0 to 6 months	300μg RE[4](1,000IU)		1,200(4,000)	10(400)	25(1,00)	3		200	5		5,000	0.2	
6 months to 1 year	300(1,000)		1,200(4,000)	10(400)	25(1,000)	3		200	10		5,000	0.3	
1 – 2	300(1,000)		1,200(4,000)	10(400)	50(2,000)	5		300	15		10,000	0.5	
3 – 5	300(1,000)		1,200(4,000)	10(400)	50(2,000)	6		400	20		14,000	0.6	
6 – 8	350(1,200)	350(1,200)	1,200(4,000)	2.5(100)	50(2,000)	6	6	400	25	25	17,000	0.8	0.7
9 – 11	450(1,500)	450(1,500)	1,200(4,000)	2.5(100)	50(2,000)	8	8	500	35	35	22,000	1.0	0.8
12 – 14	600(2,000)	540(1,800)	1,500(5,000)	2.5(100)	50(2,000)	10	8	600	50	50	27,000	1.1	1.0
15 – 17	600(2,000)	540(1,800)	1,500(5,000)	2.5(100)	50(2,000)	10	8	600	60	55	28,000	1.2	1.0
18 – 29	600(2,000)	540(1,800)	1,500(5,000)	2.5(100)	50(2,000)	10	8	600	65	55	30,000	1.1	0.8
30 – 49	600(2,000)	540(1,800)	1,500(5,000)	2.5(100)	50(2,000)	10	8	600	65	55	30,000	1.1	0.8
50 – 69	600(2,000)	540(1,800)	1,500(5,000)	2.5(100)	50(2,000)	10	8	600	65	55	30,000	1.1	0.8
70 and above	600(2,000)	540(1,800)	1,500(5,000)	2.5(100)	50(2,000)	10	8	600	55	50	30,000	1.1	0.8
Pregnancy	+60(200)		1,500(5,000)	+5(200)	50(2,000)	–	+2	600	–	+0	30,000	–	+0.1
Lactation	+300(1,000)		1,500(5,000)	+5(200)	50(2,000)	–	+3	600	–	+0	30,000	–	+0.3

Age(years)	Vitamin B_2		Niacin			Vitamin B_6			Folic Acid		Vitamin B_{12}	Bictin	Pantothenic Acid	Vitamin C
	RDA(mg)		RDA(mgNE[5])		UL (mg)	RDA(mg)		UL (mg)	RDA (μg)	UL (μg)	RDA (μg)	RDA (μg)	RDA (mg)	RDA (mg)
	Male	Female	Male	Female		Male	Female							
0 to 6 months	0.2		2		–	0.1		–	40	–	0.2	5	1.8	40
6 months to 1 year	0.3		4		–	0.1		–	50	–	0.2	6	2.0	40
1 – 2	0.6		8		10	0.5		30	70	300	0.8	8	2.4	45
3 – 5	0.8		9		15	0.6		40	80	400	0.9	10	3	50
6 – 8	1.0	0.8	12	10	20	0.8	0.7	50	110	500	1.3	14	3	60
9 – 11	1.1	1.0	14	13	20	1.1	0.8	70	140	600	1.6	18	4	70
12 – 14	1.2	1.1	16	14	30	1.4	1.1	90	180	800	2.1	22	4	80
15 – 17	1.3	1.1	17	14	30	1.6	1.2	90	200	900	2.3	26	4	90
18 – 29	1.2	1.0	17	13	30	1.6	1.2	100	200	1,000	2.4	30	5	100
30 – 49	1.2	1.0	16	13	30	1.6	1.2	100	200	1,000	2.4	30	5	100
50 – 69	1.2	1.0	16	13	30	1.6	1.2	100	200	1,000	2.4	30	5	100
70 and above	1.2	1.0	16	13	30	1.6	1.2	100	200	1,000	2.4	30	5	100
Pregnancy	–	+0.2	–	+2	30	–	+0.5	100	+200	1,000	+0.2	+0	+1	+10
Lactation	–	+0.3	–	+4	30	–	+0.6	100	+80	1,000	+0.2	+5	+2	+40

1) RDA : Recommended Dietary Allowance 2) UL : Tolerable Upper Intake Level 3) α-TE : α-Tocopherol Equivalent
4) RE : Retinol Equivalent 5) NE : Niacin Equivalent

energy expenditure measured at a physically and mentally resting state, and the least amount of energy expenditure necessary to stay alive. This can be observed during the state of sleep."

3. Estimated average of resting energy expenditure

The basal metabolic rate(BMR) used to measure energy expenditure has not been changed since 1969 when the Ministry of Health and Welfare took over the setting of the RDAs. It had been a while that a review of this matter be called for.

Thus Hosoya et al. decided to use "Metavine", an easy-to-use portable calorimeter, developed by Hosoya himself, to observe the resting energy expenditure and calculate the energy requirement from the estimated average(EA).

Metavine was used on subjects in the following situation : 2 or more hours after a meal, in a room with the temperature of 20-25℃, lying down head up or sitting down, after being in such a resting state for 15 minutes. Three or four minutes before the actual measuring begins, the subject puts a mask on the mouth. The energy expenditure is measured from the amount of oxygen intake during 3 minutes.

The resting energy expenditure(REE) by age and sex and the REE average and standard deviation(SD) are shown in Tables 5 and 6. REE distribution is shown in Fig. 2-4. The SD of an individual was 25-30%. It was decided that this deviation can also be seen in the BM.

4. Resting energy expenditure and basal metabolism as calculating standards for energy intake

For an adult person, the basal metabolic rate(BMR) calculated from the estimated average(EA) of resting energy expenditure(REE) is around 0.8 times the REE(-20%). The energy requirement that fulfills 98% of a group of people, or REE+2SD, is, therefore, 1.5BM.

Table 5. Resting energy expenditure by age(males)

		kcal/day		kcal/kg	
Age	N	Mean	SD	Mean	SD
1-5	45	980	238	62.7	14.2
6-8	60	1486	404	62.3	20.2
9-11	78	1559	422	47.8	14.6
12-14	56	1882	531	40.6	11.3
15-17	31	1593	476	29.6	6.5
18-29	303	1871	538	29.2	8.2
30-49	265	1808	497	27.6	7.2
50-69	389	1807	490	29.6	8.0
70-	187	1757	530	30.9	8.8

Total number of people surveyed : 1,414
N=Number of people surveyed, A=average value, SD=standard deviation

Table 6. Resting energy expenditure by age(females)

		kcal/day		kcal/kg	
Age	N	Mean	SD	Mean	SD
1-5	35	815	211	55.8	10.9
6-8	57	1326	314	56.6	16.0
9-11	61	1443	370	44.6	11.3
12-14	23	1583	335	39.2	9.4
15-17	7	1417	638	25.0	7.5
18-29	1179	1468	344	28.6	6.4
30-49	260	1503	421	28.7	8.1
50-69	569	1590	390	29.9	7.5
70-	228	1331	411	28.1	8.2

Total number of people surveyed : 2,419
N=Number of people surveyed,
SD=standard deviation

To use this value as the standard for energy consumption, however, keeping in mind the prevention of obesity, is not a very good idea. It is important that REE of every individual is measured separately and that the amount of energy expenditure is obtained in accordance with the individual's liftstyle.

It is understood that, to calculate the recommended energy allowance, it is more scientifically reasonable to use REE instead of BM. Many people, however, are still used to the word "basal metabolism," and related pub-

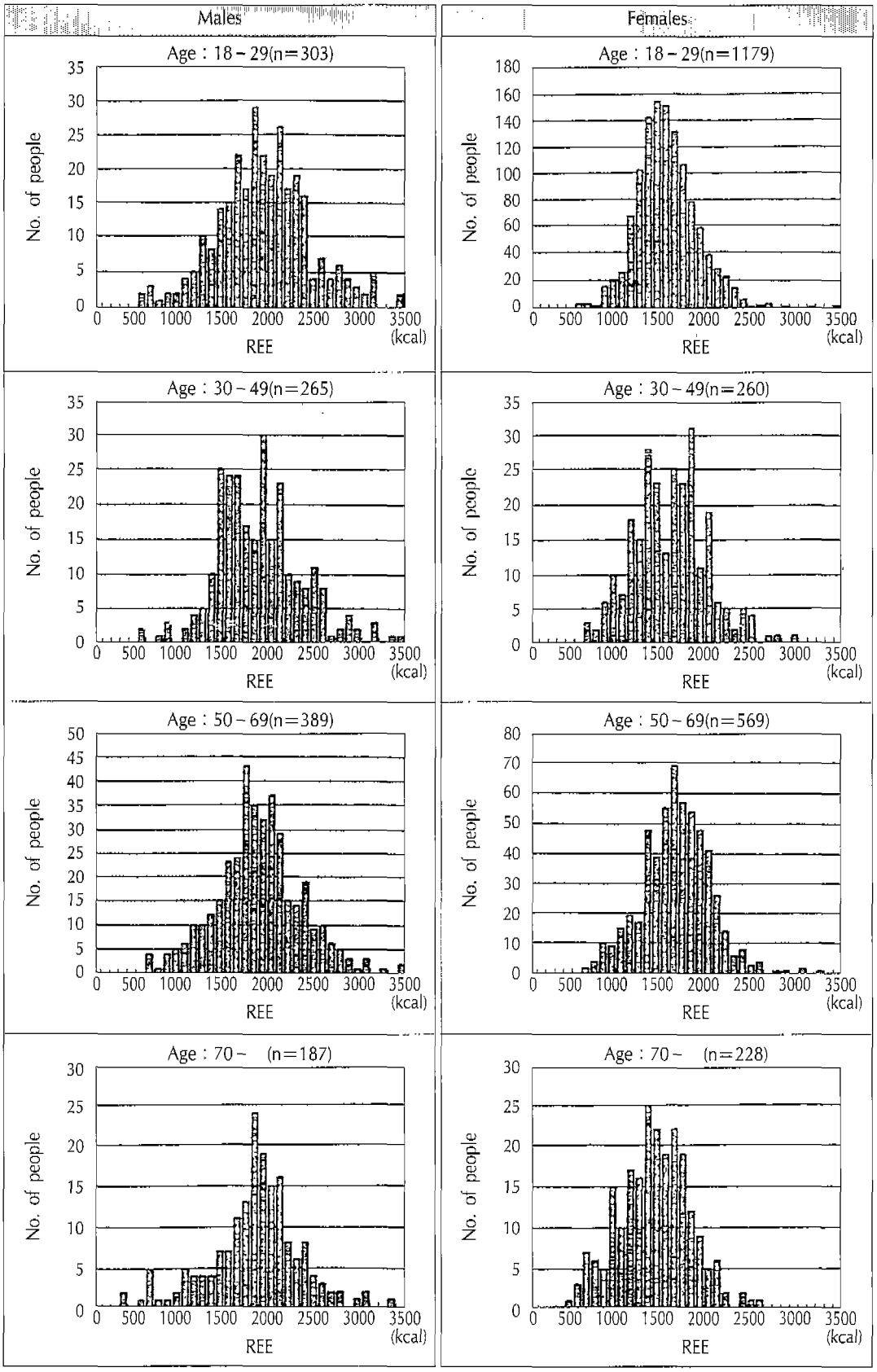

Fig. 2. Resting energy expenditure distribution by age and sex(kcal/day)

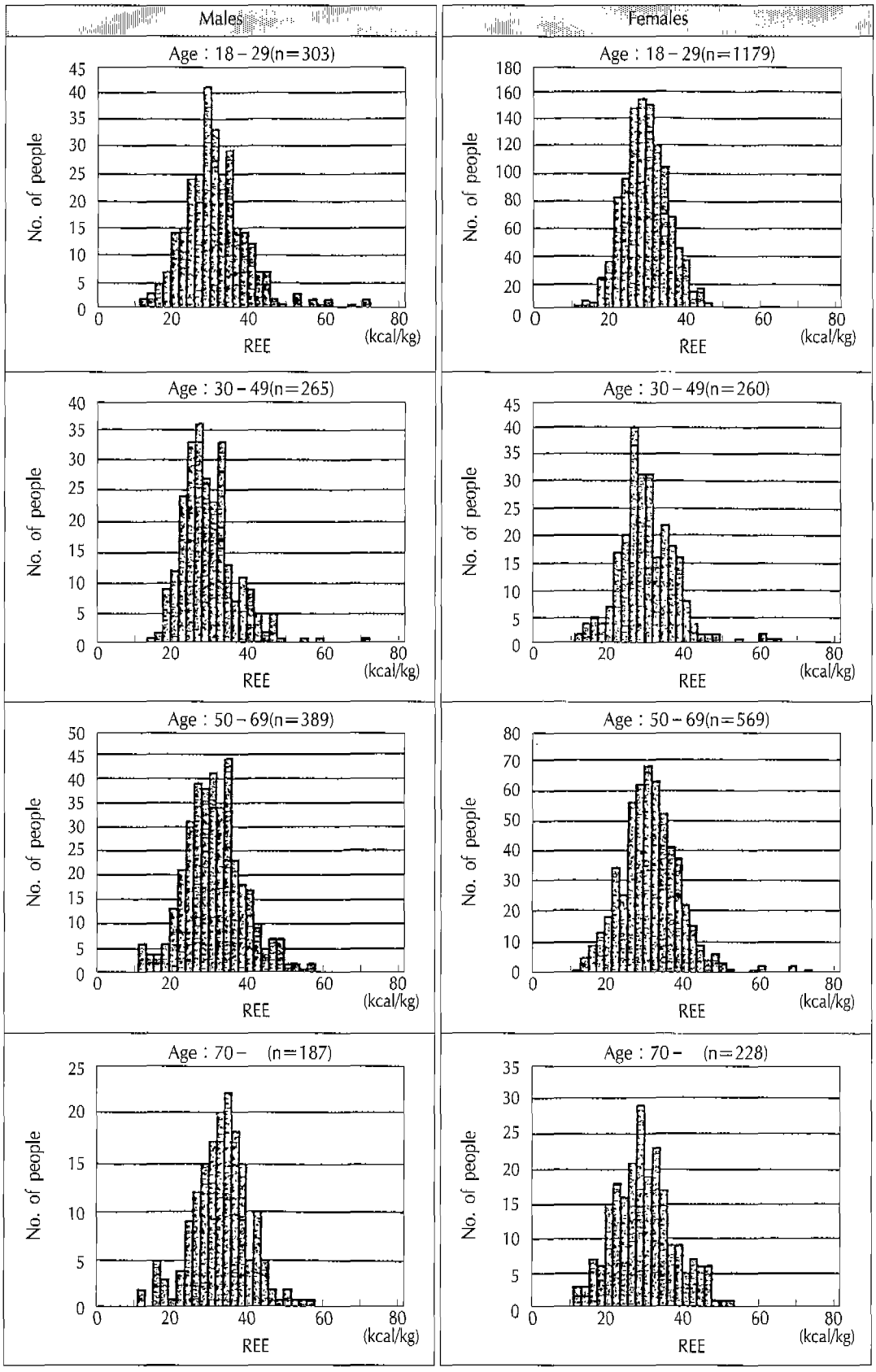

Fig. 3. Resting energy expenditure distribution by age and sex(kcal/kg)

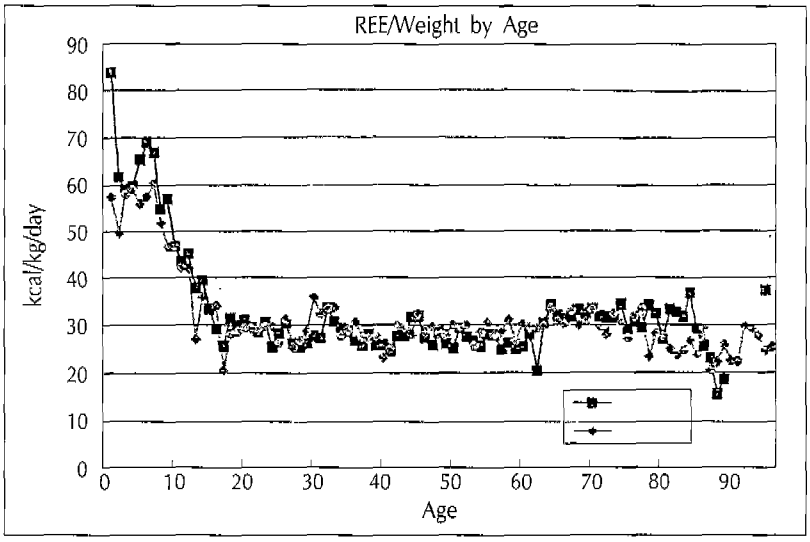

Fig. 4. Resting energy expenditure by age and sex.

lications still state the equation most often used to calculate energy expenditure. So, at this point, to review the standards, make major changes, and use a new method to calculate energy expenditure may cause great confusion.

For the 6th revision of the RDAs, the idea of basal metabolism was reconsidered. Due to the inevitable redirection of opinions of the DRI committee members, however, the energy intake level was calculated by using th existing BM rules.

■ **Memo**

When the survey was first planned, the total number of subjects was supposed to amount to 20,000, more than 100 subjects per age, males and females. The total number of subjects surveyed at this point, however, is 3,833. All data should have been shown by each age and gender group, but the tables and figures were made according to the age groups provided in the Recommended Dietary Allowances(RDAs) for the Japanese, 6th Revision-the dietary reference intakes(DRIs). Therefore, the estimated average of resting energy expenditure is shown by kcal/day and kcal/kg by age/gender group used in the new DRIs.