are done for the same individual, a comparison should be done between nutrients assessed by same index (e.g. EAR). Meanwhile, when assessing a certain nutrient among individuals, the results are comparable between individuals. However, in such cases, results must be delivered by the same dietary survey method and carried out with same degree of standardization and accuracy management.

4-3. Planning and implementation of dietary improvements (Table 17)

The basics of planning and implementation of dietary improvement are to assess dietary intakes and plan and implement them based on the results of dietary assessment. When that is difficult, dietary improvement should be planned and implemented by referring to the result of individuals or groups with similar characteristics to the subject. For this it is important to comprehend the characteristics of the subject. The term "characteristics" refers to gender, age, PAL, and other key life environment and lifestyle habits. In addition, clinical symptoms and laboratory data should be positively used as needed.

For assessment and implementation of inadequate or excessive intake of energy, BMI or body weight change is used. Plans should be focused on maintaining a normal range of BMI. Measurement should be done twice or more over several months (at least twice a year), and reviewed using changes in body weight as indices.

For nutrients with RDA, this should be used for assessment. If the intake is near or above the RDA, the plan should aim to maintain this. If the intake is below RDA, the plan should approach the RDA. However, evaluation should be comprehensive, considering feasibility and intake of other nutrients. For nutrients which have AI, this should be used for assessment. If intake is near or above AI, plans should maintain the intake. If the intake is below AI, plans should come closer to the AI. If the intake is above the UL, plans should aim to reduce the intake below UL. Intake above UL should be avoided. The plain should be promptly made and implemented to solve the problem when it has become evident. If intake is out of the range of the DG, plans should aim to come within the range. However, it is recommended to comprehensively consider other nutrition- and non-nutrition-related factors associated with lifestyle-related diseases, aiming to prevent them before determining improvement plans for target nutrients. In addition, with regard to characteristics of lifestyle-related diseases, planning and implementation which is sustainable in the long term is desirable.

5. Dietary improvement (groups)

5-1. Basic concepts

Basic concepts of applying DRIs-J for dietary improvement for groups are shown in Table 18. The table concepts are based on DRIs of the United States and Canada[13,14,51] and application patterns of DRIs-J. Important points are to assess nutritional intake and plan and practice the result of the assessment in advance of planning and practising dietary improvement. However,

when it is difficult to assess nutritional intake, it should be omitted and the minimum nutritional status measured, dietary improvements planned and implemented. Measurement of nutritional status may also be omitted and replaced by information based on obtainable references.

5-2. Assessment of dietary intake (Table 18)

For assessment of inadequate or excessive intake of energy, distribution of BMI is used. For energy, the percentage of individuals with a normal BMI (and those outside the normal range) is calculated from the distribution. Following the definition of the Japan Society for the Study of Obesity (JASSO), the normal range of BMI is 18.5 - 25.0.[50] For nutrients, distribution of intake obtained from dietary surveys is used. However, assessments need to be done with through understanding of measurement errors (especially under-reporting, over-reporting, and day-to-day variation), inference from results and its influence from dietary survey methods. Considerations to under- and over-reporting are needed which can have great influence especially in a group. Refer to the section on issues due to methods of dietary survey (3-1) for details.

For nutrients with EAR, the percentage of individuals whose intake is below EAR should be calculated, using a probability method to obtain the correct percentage. However it is rare to have conditions where this method can be used.[13] Therefore, the cut-point method is used as a compendium method. Concepts behind the Probability and cut-point methods are shown in Figures 4 and 5.[13] However, it is theoretically known that when distribution of intake is wide, a value based on cut-point methods is far from the true percentage. Iron is a representative nutrient affected by this issue.[13] Also, when mean intake and its distribution is far from EAR, a value based on cut-point methods can also be far from the true percentage.

When using AI, calculate percentage of individuals whose intake is below AI. The percentage of those below AI and percentage of those with true inadequate intake do not match theoretically. However, no other indices exist when AI is established and in fact AI must be used. For UL, the percentage of those with possibility of excessive intake should be calculated from the intake distribution and UL. For DG, the percentage of those whose intake is out of range of DG should be calculated from intake distribution and DG. When assessments of several nutrients are within a group, comparison should be done between nutrients assessed by the same index (e.g. EAR). Meanwhile, when assessing a certain nutrient among groups, the results are comparable between groups. However, in that case, the results must be taken from the same dietary survey method and the survey carried with the same degree of standardization and accuracy management.

5-3. Planning and Implementation of Dietary Improvement (Table 18)

For assessment and implementation of inadequate or excessive intake of energy, BMI or body weight changes are used. Plans should focus on increasing the percentage of individuals with BMI within the normal range. Measurement should be done twice or more in a period of several months(at least twice a year), and changes in body weight as indices used to make the plan.

Table 18 Basic concept of applying DRIs-J for the purpose of dietary improvement (for groups)

Purpose	Indices	Dietary assessment	Planning and application of dietary improvement
Assessment of excessive intake of energy	Change in BMI and body weight	Calculate the percentage of individuals with normal range of BMI from distribution of BMI	Plans should aim to increase percentage of individuals keeping normal range of BMI
		To assess the difference, measure body weight difference	Note: Measurement should be done twice or more in a certain period of time and review plan based on the results and put in practice.
Assessment of inadequate intake of nutrients	EAR, RDA, AI	Calculate the percentage of individuals whose intake is below EAR from distribution of measured intake.	When using EAR, plans should aim to reduce percentage of individuals whose intake is below EAR.
		When using AI, Calculate the percentage of individuals whose intake is below AI from distribution of measured intake.	When using AI, plans should aim to increase groups' mean intake near AI
			Note: It is difficult to compare percentage of individuals with intake below EAR and that of AI because the meanings of the percentages are different.
Assessment of excessive intake of nutrients	UL	Calculate the percentage of individuals with potential risk of excessive intake from distribution of measured intake and UL.	Plans should aim to reduce intake of all individuals below UL.
			Note: intake above UL should be avoided and when excessive intake is reported, review the plan and put in practice promptly to solve the problem
Assessment of primary prevention of lifestyle-related disease	DG	Calculate the percentage of individuals whose intake is beyond the range of DG from measured intake and DG. However, assessment should be done with comprehensive consideration of existence and degree of other nutrition-related and non-nutrition-related factors of target lifestyle-related disease	Plans should aim to increase number of individuals whose intake is within or near the range of DG.
			Note: Assessment of target nutrient should be done considering other nutrition- and non-nutrition-related factors associated with the particular lifestyle-related disease. In addition, with regard to characteristics of lifestyle-related diseases, planning and implementation which is practicable long term is desirable

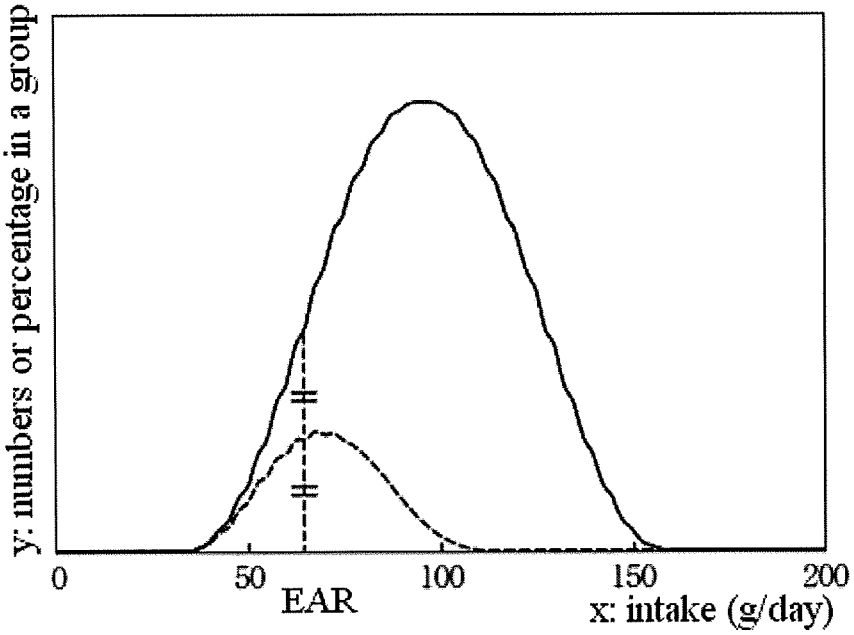

Figure 4 Concept of method (probability method) to assess dietary intake for a group
Solid line shows the intake distribution of a subject group; dotted line shows intake distribution of individual subjects with inadequate intake in the group. Percentage of inadequate intake individuals is calculated from (area surrounded by dotted line and x-axis) / (area surrounded by solid line and x-axis).
Individuals with inadequate intake exist with some probability at each intake. The probability is 50% when intake matches the EAR; it is above 50% when intake is below EAR, and below 50% when intake is above EAR with 2 - 3 % when intake is near RDA. This figure shows the condition when intake distribution is assumed to be a normal distribution setting a mean intake of 96 g/day, EAR of 65 g/day and RDA as 101 g/day.

For assessment and implementation for purpose of preventing inadequate intake, EAR or AI is used. When using EAR, plans should aim to decrease of percentage of individuals with intake below EAR. When using AI, plans should aim to improve mean intake of the group close to AI. However, it is difficult to compare the percentage of individuals with intake below EAR and that of AI since meanings of those percentage are different.

For assessment and implementation for purpose of preventing excessive intake, UL is used. Plans should aim to reduce every individual's intake below UL. Intake above UL should be avoided. Promptly plan and implement to solve the problem when existence of individual's excessive intake has become evident.

For assessment and implementation to prevent lifestyle-related diseases, DG is used. Plans should aim to increase the percentage of individuals whose intake is within or near the range of DG. It is recommended to comprehensively consider other nutrition- and non-nutrition-related factors of lifestyle-related diseases aiming to prevent them before deciding an improvement plan for the particular nutrient. In addition, regarding characteristics of lifestyle-related diseases, planning and implementation which is practicable in the long term is desirable.

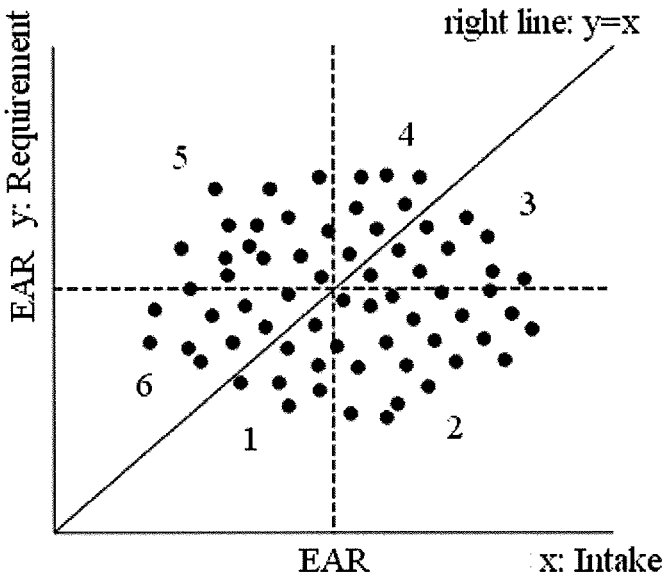

Figure 5 Concept to assess dietary intake of a group (cut-point method)

If an individual is unable to know his/her requirement, there is no relation between intake and requirement in a group. This hypothesis is thought to be true except for energy. Next, suppose distributions of intake and requirement are both normal distributions with mean intake near EAR; individuals with inadequacy are in the area of right line y = x and y axis, and those with no inadequacy (fulfilled) are in the area of right line y = x and x axis. Furthermore, adding lines x = EAR and y = EAR, areas are divided into 6 areas (1 to 6). Individuals with inadequacy exist in areas 4, 5, and 6. Meanwhile, it is assumed that the number of individuals in area 1 and 4 are the same; individuals with inadequacy equal to the sum of areas 1, 5, and 6. This is the number of individuals with intakes below EAR. Now, note that it is impossible to know which individual has fulfilled his/her requirement or not with cut-point method.

6. Food service

6-1. Basic concept

The term "food service" here refers to making dietary plans for particular groups and on-going provision of meals with appropriate quality control based on the plans. Maintenance and improvement of health (including healthy development of children) and primary prevention of lifestyle-related diseases are key purposes of the food service. Therefore, it is necessary to create and manage menus referring to DRIs-J.

Concepts for applying DRIs-J for the purpose of food services are shown on Table 19 in order of work procedure. Important points are to understand the characteristics of the group, decide an appropriate plan, create menus, serve quality-controlled meals, resurvey intakes and group characteristics, use the information from the survey and other information obtained, review the plan, and strive to improve created menus and other sets of work contents. Subsequently, concepts of applying the DRIs-J for the purposes of food service are shown in Table 20 on energy and nutrient bases, and assessment and planning bases.

Table 19 Basic concept of applying DRIs-J for work procedure of food service

Basic points	Basis of work procedure
1. Selection of subject group to serve meals and identify characteristics of the group	• Selecting subject group to serve meals. Identifying or estimating the distribution of genders, age groups, physical characteristics(mainly heights and weights), and PALs of the group.
2. Assessment of dietary intake	• Assessing dietary intake. Not only food service meals but every meal and snack are included. It is also desirable to obtain data on the contribution of food service to the total. When it is difficult to obtain data, assess a part of the meals (e.g. food service meals only) or only a few of the groups. Furthermore, when it is difficult to assess subject groups, substitute data obtained from other groups with similar characteristics.
3. Deciding dietary plan	• Make a dietary plan (type of meals, numbers, and serving nutritional values) based on data obtained from #1 and 2 Consideration is needed on whether serving every meal or some of the meals that subjects eat
4. Making menu plan	•Make a specific menu plan based on #3
5. Quality control and serving meals	• Serve meals prepared under appropriate quality control based on #4.
6. Understanding intake volume	•Obtain intake data on subjects (subject groups)
7. Review of dietary plan	Check and review #3 based on results of #6 and review #1.

For the purposes of maintenance and improvement of health(including healthy development of children) and primary prevention of lifestyle-related diseases, it is desirable that mean intake of nutrients over each month meets the DRIs-J. It is not overly necessary to consider DRIs-J regarding intake for each individual meal, day, or period of several days. When serving on-going meals each day to a certain group, planning should aim daily meals to satisfy average intakes over the whole month period.

However, it is currently difficult to find sufficient reliable studies on this topic. It is imperative to increase the level of research and number of high quality studies in this field.

6-2. Understanding the characteristics of subject groups

It is necessary to identify the distribution of gender, age, body height, body weight and PAL. BMI is calculated from height and weight; from its distribution, the percentage of individuals with a BMI outside the range 18.5 - 25.0 can be calculated.[46)]

It is recommended to use references already available such as student health records rather than conducting new research. Where such reference data is unavailable, those of other groups presumed to have similar characteristics can initially be referred to.

It is desirable to repeat research of subjects' characteristics periodically and aim to improve management and context. There are two purposes to such repeat studies. Firstly, when subjects change sequentially, the purpose is to understand the latest subjects' characteristics as much as possible and to apply the information to review plans or create menus. When subjects are children or otherwise subject to physical changes such as mild obesity, subjects can change in their individual characteristics. Secondly, research is conducted to improve plans and menus based on newly obtained data. Biochemical data from clinical laboratory tests should be also used where needed.

6-3. Assessment of dietary intake

Not only the intake from food services but all meals are subject to assessment. It is preferable to obtain the contribution ratio of food service from total intake. If it is difficult to obtain such data, assessment based on single meals(e.g. food services) or particular subject groups may be conducted. Assessment of subject groups is being increasingly omitted and replaced with data obtained from other similar groups.

For nutrients with the purpose of ensuring adequate intake, the percentage of individuals with intake below EAR is estimated from the measured intake distribution and EAR. When using AI, the percentage of individuals with intake below AI is estimated. For nutrients for preventing excessive intake, the percentage of individuals with intake above UL is estimated from the measured intake distribution and UL. For primary prevention of lifestyle-related diseases, the percentage of individuals with intake out of the DG range is calculated from measured intake distribution and the DG. In addition, data is gathered on other nutrition and non-nutrition-related factors influencing lifestyle-related diseases to be prevented.

It is thus desirable to repeat research on subjects' characteristics periodically. The adequacy of values obtained is to be assessed relative to the DRIs-J, points for improvement are to be identified and plans for how to deal any issues implemented.

The accuracy of dietary intake surveys depends on methods involved, but it is recommended to sample at least a minimum number of subjects receiving food services, research the amount of waste left on plates depending on dish type(staple, main dish, side dish etc.) and estimate the energy intake and major nutrients. If it is difficult to research plate waste volume on an individual basis, there are cases where group data can be substituted for an initial approximation. Usable information is also obtainable from plate waste surveys regarding dishes rather than food.

Table 20 Basic concepts of applying DRIs-J for food service work procedures on energy/nutrient and assessment/planning basis

Purpose	Assessment (corresponding to #1 and 2 of Table 19)		Planning (corresponding to #3 of Table 19)	
	Indices	Basis	Indices	Basis
Avoiding inadequate or excessive intake of energy	Changes in BMI, body weight, PAL	Understanding distribution of gender, age group, height, weight, PAL. Calculate the percentage of individuals whose BMI less than 18.5 above 25.0 from distribution Measure body weight difference	EER	Calculate EER based on genders, age groups, and PALs. Decide serving energy value considering changes in BMI and weight.
Avoiding inadequate intake of nutrients	EAR, AI	Calculate the percentage of individuals whose intake is below EAR from distribution. When using AI, calculate the percentage of individuals whose intake is below AI from distribution.	EAR, RDA, AI	Referring to assessment results, determine serving nutrient values such that nearly no individuals' intake falls below ERA or AI. More specifically, make a menu such that intakes are near to EAR or AI. When intake is below these, make menus aiming at RDA or AI. Use a menu near to or above RDA or AI where possible Even it is difficult to fulfill RDA, avoid dropping below EAR. Note: Not all subjects need to fulfill RDA. This would increase percentage of individuals with excessive intake. It is desirable to use "approach to a high risk groups as well as "approach to a group"[1]
Avoiding excessive intake of nutrients	UL	Calculate the percentage of individuals with potential risk of excessive intake from distribution of measured intake and UL.	UL	Make menus such that no individuals' intake exceeds the UL.
Primary prevention of lifestyle-related diseases	DG	Calculate the percentage of individuals whose intake is outside the range of DG from measured intake and DG. Assessment should also consider other nutrition- and non-nutrition-related factors affecting the target lifestyle-related disease	DG	Referencing assessment results, plan a menu to reduce intake of individuals from beyond the range of DG as much as possible. More specifically, make menus such that intake stays within the range of DG. Note: Comprehensive consideration of other nutrition-related and non-nutrition-related factors of target lifestyle-related diseases is needed, as well as characteristics of lifestyle-related diseases and the sustainability of the menu plan.

[1] These are concepts are drawn from the field of public health. When the subject of an education or intervention initiative is a whole group, it is called "approach to a group." When a small group with particular risk is selected from the whole group and subjected to education and intervention, it is call "approach to a high risk group."

6-4. Making dietary plans

Dietary plans should be made using DRIs-J based on data on subject characteristics and intake. Also, it is necessary consider whether every meal or only single daily meals are served. Serving energy volume should be based on distribution of gender, age group, PAL and the chosen indices such as BMI. The assessment result of changes in BMI and body weight should be also used as needed.

For nutrients where the aim is to ensure adequate intake, referring to assessment result, menus should be planned such that nearly no individual intake is less than the EAR; the number of individuals with intake below AI should be reduced as much as possible. Specifically, a menu should be planned to meet EAR or AI when current intake is below the indices. If an intake near or above EAR or near or above AI is possible, it should be implemented. Even when it is difficult to achieve EAR, falling below EAR should be avoided.

However, not all individuals in the group have to meet the EAR or AI, which may increase the percentage of individuals with excessive intake. It is desirable to use not only "approach to groups" but also "approach to high risk group" (refer to footnotes of Table 20).

For nutrients where the aim is to prevent excessive intake, menus should be planned avoiding individuals' intake exceeding UL. For nutrients for primary prevention of lifestyle-related diseases, referring to the assessment results, menus should be planned such that nearly no individuals' intake is within the range of DG where possible. Specifically, menus should be planned to be within the range. It is also important to consider the existence and degree of other nutrition- and non-nutrition-related factors associated with lifestyle-related diseases, aiming to prevent them before determining an improvement plan for the target nutrient. In addition, with regard to the characteristics of lifestyle-related diseases, it is desirable to plan menus which are sustainable over a long term.

6-5. Supplementary note for decisions on dietary planning

6-5-1. Deciding serving energy values

When subjects are sorted into two or more groups according to gender, age group and PAL, the DRIs-J, energy and nutrients serving targets are different. Therefore it is desirable to create menus based on serving energy values. However, if this is difficult to implement, the following method is practical.

The EAR is calculated based on gender, age group and PAL. When several EARs exist, they are approximately grouped together; for example, when requirement difference is within the range of 200 kcal/day, an EAR can be chosen based on the number fraction of individuals, and treat as a single group if needed. However, the range of energy intake should be designed flexibly considering its practicality. A group developed in this way is then prescribed a dietary plan (serving value), on the basis of which menus are planned and served.

6-5-2. Priority of energy and nutrients

The order of priority in dietary planning is basically as follows: (1) energy, (2) protein, (3) lipids,(4) vitamins A, B1, B2, C, calcium, and iron, (5) saturated fatty acids, dietary fiber, sodium(salt) and potassium, (6) important nutrients for the study group, and (7) others.

Among these, (1) is essential and should be carefully maintained within ±10% of the EAR of those receiving the food service. If there is a difficulty to keep a certain subject's intake within the range, it is desirable to approach that person individually where possible. (2) is also essential. Where possible it is desirable to maintain the condition without individuals with inadequate or excessive intake. (3), (4), and (5), should correspond as much as possible in order to maintain a suitable energy balance. For (6), it is necessary to understand characteristics (including health conditions) of those receiving food services and use the service to maintain and improve health and carry out primary prevention of lifestyle-related diseases. For (7), it is desirable to confirm periodically whether the intake deviates from the DRIs-J range.

6-5-3. Serving a part of daily meals

Food services may provide a certain meal and not every meal of the day. In such cases, it is necessary to determine the energy and nutritional intake of the subject group, decide the percentage of serving value of energy and nutrients needed, and make dietary plan to fulfill the values. When it is difficult to identify the energy and nutritional requirements of the subject group, results based on other groups with has similar characteristics can be referred to. However, in such cases, it is necessary to understand the different characteristics of the groups and deal carefully with interpretation of the results.

Based on research results for 153 healthy adult men, the energy intake percentage at breakfast, lunch, dinner, and a snack on weekdays were 18 %, 34 %, 40 %, and 8 % respectively (calculated from intake, kcal).[52] When serving only single meal out of breakfast, lunch, dinner, and snack, such results can be referred to, considering any individual variability in non-served meals (when serving lunch, consider breakfast, dinner, and snacks), and providing energy and nutrient serving values to avoid inadequate or excessive intake of energy or nutrients.

6-6. Other notes

When applying the DRIs-J, it is desirable to control or adjust the serving volume based on the characteristics of subjects receiving food service. Also, even if the dietary plan is based on the DRIs-J, it is not correctly applied if it is not eaten by subjects. This is because DRIs-J is a standard of intake and not that of serving volume. It is desirable to deal flexibly with the whole quantity of the meal. Therefore, it is desirable not just serve a meal to the subjects but make efforts such that they are positively eaten, preventing plate-waste.

7. **Considerations for the elderly and disabled**

Several studies have reported that EAR and other nutrient requirement differences between certain elderly (e.g. those needing support or nursing care) and disabled people and healthy individuals in the same age groups.[53-55] However, findings are not yet sufficiently accumulated and the way to apply values developed for healthy subjects to such individuals remains unclear. Therefore, at application, subjects should be observed carefully and dealt with flexibly depending on their individual conditions.

8. Consideration for prevalent and high risk groups

The subjects of DRIs-J are healthy individuals and groups. However, there are cases of where applying DRIs-J to individuals or groups with diseases or high risk of certain diseases has been effective. In such cases, attention is needed to the application:

1) Nutritional management guidelines or treatment guidelines on the disease should be mainly referred to rather than DRIs-J when energy and nutritional intakes are specific points of treatment.
2) DRIs-J should be mainly referred to when energy and nutritional intakes are NOT specific points of treatment.
3) DRIs-J should be referred to for preventing diseases which are not the target of treatment.

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II. Particular Topics

1. Energy and Nutrients

1 Energy

1. Basics

The role of energy [unit: kcal or MJ (M joule), 1.00 kcal = 4.18 kJ, M (mega) = 10^6] in an adult is to provide a basal metabolic rate for synthesis and degradation of body components, maintenance of body temperature, and minimal conservation of organ activities and resynthesis of adenosine triphosphate (ATP) that is consumed in association with muscular activities during physical activity.

Daily energy expenditure (total energy expenditure) is composed of the basal metabolic rate, energy for physical activities and thermogenic action from meals (diet-induced thermogenesis). In addition, children and infants in the growth stage require energy not only to meet their daily needs but energy corresponding to increased tissue for their growth (energydeposition) and energy for tissue formation. Of the two, energy for tissue formation is included in total energy expenditure but energy deposition is not included. Therefore, to decide the energy requirement, energy deposition needs to be added to the total energy expenditure.

During pregnancy, in addition to total energy expenditure (including energy expenditure and energy for the formation of tissues of fetus), energy corresponding to the increased tissue for the growth of fetus needs to be considered. For lactating women, in addition to total energy expenditure (including energy expenditure to produce milk), energy of milk and corresponding energy of weight loss need to be considered. Therefore, corresponding energy for the increased or decreased tissue needs to be considered in addition to total energy expenditure.

> Energy requirement = total energy expenditure + energy for the increase or decrease tissue

For adults with no change in body weight and no increase or decrease of tissue volume, corresponding energy for increase or decrease for tissues is zero making energy expenditure and energy intake are equal. Therefore, when energy intake exceeds energy requirement, unconsumed energy substrate is accumulated mainly in adipose tissues as triglyceride (TG). Increased adipose tissues cause increases in body weight and body fat in the short term, and are exposed as obesity in the long term. Obesity is a risk factor of many lifestyle-related diseases and increases risk of total mortality. In contrast, when energy intake is below energy expenditure, accumulated fat in adipose tissues and body protein such as muscles decrease, bodily function and quality of life decreases, morbidity risk of infection diseases and certain cancer risks are increased, and total

mortality is increased. Therefore, energy intake should be equal to the amount of energy expended for adults with adequate body weight. This is the true energy requirement.

2. Estimated energy requirement

2-1. Definition of estimated energy requirement

For DRIs-J of energy, the concept of Estimated Energy Requirement (EER) is applied in the same for as DRIs of the United States and Canada.[1,2] The EER is established as an index for individuals and groups.

The definition of EER for individuals is "the average normal energy intake for a day which is predicted to have the highest probability that energy balance (in adults, energy intake - energy expenditure) become zero in an individual of a given age, gender, height, weight, and level of physical activity that does not harm their health condition."

When energy intake of the individual is the same as the EER, the probability of inadequate intake, that the individual's intake is below his/her true energy requirement, is 50% and the probability of excessive intake is 50%. For many other nutrients, probability of adequate intake decreases as intake decreases, while probability of adequate intake increases as intake increases(sufficiently below UL). However, for energy, probability of inadequate energy balance increases equally whether intake is below or above EER. That is, probability of weight gain increases when an individual's energy intake is above EER and probability of weight loss decreases when the individual's energy intake is below EER. This is why DRIs concepts used for other nutrients can not be applied to energy.

In contrast, the definition of EER for a group is "the average normal energy intake in a day which is predicted to have highest probability that energy balance (in adults, energy intake - energy expenditure) become zero in the group." When energy intake of a defined group is the same as the EER, the probability (number of individuals) for whom the intake is below the group's true energy requirement is 50% and probability that intake is above the requirement is 50%. Factors which have great impact on total energy expenditure are energy consumed for basal metabolic rate (BMR) and physical activities. Therefore to achieve a more accurate EER, it is necessary to know defined individuals' or groups' basal metabolic rates and amount of physical activity.

2-2. Basics

2-2-1. Basal metabolic rate

The Basal metabolic rate (BMR) (kcal/day) is computed as follows (Table 1):

Table 1 Basal Metabolic Rate (BMR)

Sex	Males			Females		
Age (years)	Reference BMR (kcal/kg weight/day)	Reference weights (kg)	BMR (kcal/day)	Reference BMR (kcal/kg weight/day)	Reference weights (kg)	BMR (kcal/day)
1-2	61. 0	11. 7	710	59. 7	11. 0	660
3-5	54. 8	16. 2	890	52. 2	16. 2	850
6-7	44. 3	22. 0	980	41. 9	22. 0	920
8-9	40. 8	27. 5	1, 120	38. 3	27. 2	1, 040
10-11	37. 4	35. 5	1, 330	34. 8	34. 5	1, 200
12-14	31. 0	48. 0	1, 490	29. 6	46. 0	1, 360
15-17	27. 0	58. 4	1, 580	25. 3	50. 6	1, 280
18-29	24. 0	63. 0	1, 510	22. 1	50. 6	1, 120
30-49	22. 3	68. 5	1, 530	21. 7	53. 0	1, 150
50-69	21. 5	65. 0	1, 400	20. 7	53. 6	1, 110
70 and over	21. 5	59. 7	1, 280	20. 7	49. 0	1, 010

Reference BMR (kcal/kg weight/day) x reference weight (kg)

The BMR is measured early in the morning (before breakfast) while the subject is resting in the supine position in a comfortable indoor environment (room temperature etc.). A representative value for BMR per kg is based on a number of reports. This is called the Reference value of basal metabolic rate (reference BMR).

Reference BMR is established based on reference BMR of 2005 DRIs-J and is also referred to gender- and age-based reference BMR reported since 1980 (Table 2).[3-15)]

2-2-2. Physical activity level

The physical activity level (PAL), although affected by diet-induced thermogenesis, is a mainly level index of physical activity is calculated based on total energy expenditure measured by the doubly labeled water method (DLW) divided by basal metabolic rate.[16-18)]

PAL = total energy expenditure of a day / basal metabolic rate of a day

DLW is the most accurate measurement method for energy expenditure, also employed in DRIs of the United States and Canada. Considering the range of individual variability of energy

expenditure, based on subject's characteristics and evidence a number of PALs were established to calculate more accurate EER.

Table 2 Recently reported data on Basal Metabolic Rate(BMR) of Japanese(mean ± SD)

Ref. No.	Subjects	gender(n)	age (years)	height (cm)	weight (kg)	BMI (Kg/m2)	BMR (kcal/day)	BMR (kcal/Kg/day)
3)	(a)	M(37)	19.3±1.4	170.9±5.5	67.0±13.1	22.9±4.7	1,570±268	23.7±3.0
		F(174)	19.2±1.5	158.0±5.8	54.9±10.1	22.0±3.7	1,228±221	22.3±3.2
4)	(b)	normal(26)	19.9±0.9	159.9±6.2	51.5±4.7	20.1	1,130±74	21.9±1.4
		low(4)	20.0±0.8	159.3±5.7	53.6±4.9	21.1	1,111±73	20.7±1.3
5)	(c)	F (19)	20.1±0.7	159.7±5.1	51.0±5.2	20.0±1.3	1,191±165	23.3±2.3
6)	(d)	F (115)	22.3±2.1	161.3±6.7	55.4±6.5	21.3±1.9	1,190±154	21.5±1.5
7)	(e)	M(21)	30±11	173.6±6.6	70.5±12.6	23.3±3.0	1,586±257	22.4±3.6
		F (20)	32±10	159.8±4.8	53.2±6.1	20.8±1.9	1,155±123	21.7±2.3
8)	(f)	M(71)	36±16	170.5±7.1	68.3±11.5	23.4±3.1	1,527±218	22.3±3.1
		F (66)	37±16	159.1±5.6	54.0±9.2	21.4±3.3	1,156±135	21.4±2.5
9)	(g)	M(50)	44.7±2.9	165.9±5.6	64.8±9.4	23.7±3.4	1,591±220	24.8±2.8
		M(36)	54.3±3.1	163.3±5.0	62.8±7. 5	23.6±2.8	1,460±179	23.4±2.7
		M(37)	64.2±3.0	162.3±4.5	58.2±7.9	22.1±3.0	1,356±174	23.5±3.2
		F (39)	44.3±2.8	154.1±5.2	54.5±8.2	23.5±3.4	1,253±152	23.5±3.2
		F (39)	55.1±3.0	152.6±4.5	53.8±7.2	23.2±3.1	1,194±131	22.4±2.4
		F (38)	64.2±3.0	149.2±4.4	51.7±6.7	23.2±3.0	1,161±139	22.7±2.8
10)	(h)	F (41)	52.6±14.0	157.4±12.5	90.8±17.9	36.7±6.8	1,986±402	21.8±4.4
		F (40)	54.8±12.5	158.8±7.2	90.3±12.2	36.1±3.3	1,980±360	21.9±3.9
11)	(i)	F (70)	60.6±4.2	154.9±5.2	52.7±6.2	21.9±2.1	1,148±126	21.9±2.2
12,13)	(j)	M(10)	76±9	155.5±5.8	48.3±8.9	20.0	877±166	18.1±2.9
		F (15)	80±6	141.6±5.8	45.9±9.2	22.9	897±149	19.9±3.4
		F (14)	80±6	141.2±5.7	45.4±9.3	22.8±4.7	907±150	20.4±3.1
14)	(k)	M(20)	18 - 19	168.6±6.0	58.7±6.3	20.7	1,530±166	26.0±2.8
15)	(l)	M(10)	24.8±4.3	171.4±4.3	64.7±7.2	22.0	1,559±219	24.1±3.3

M, male; F, female

(a) University students on the registered dietitian course,(b) university female students divided by plasma triiodothyronine level,(c) Healthy university female students,(d) healthy young females,(e) healthy males and females,(f) healthy males and females not doing heavy exercise,(g) middle age males and females living in Matsuyama city and its suburbs,(h) obese middle age females,(i) postmenopausal females doing walking or swimming,(j) elderly living in special nursing home or nursing home who does not need nursing care,(k) healthy university male students in boarding school,(l) healthy adult males.

Table 3 Characteristics and physical activity levels on physical activity level basis (mean ± SD)

PAL(range)	N	Sex ratio (% male)	Age (years)	BMI (kg/m^2)	PAL
Level I(<1.6)	38	55	40±11	23.9±2.5	1.50±0.08
Level II(≥1.6, ≤1.9)	65	52	39±11	22.8±3.1	1.74±0.08
Level III(>1.9)	36	39	40±9	21.3±2.6	2.03±0.13
Total	139	50	39±10	22.7±2.9	1.75±0.22

N, number; BMI, body mass index; PAL, physical activity level

2-2-3. Calculation of estimated energy requirement

Using PALs based on Japanese normal total energy expenditure measured by DLW, the EER is calculated based on the PAL as follows:

EER (kcal/day) = BMR (kcal/day) x PAL

For children, energy deposition considers tissue increases due to their growth. For pregnant women, energy deposition is added considering tissue increase due to growth of the mother and fetus; for lactating women, corresponding energy for lactation and weight change after giving birth need to be considered.

2-3. Adults

Based on the data of PAL for Japanese adults(n=139, 20 to 59 years), [19] the group was divided into 3 groups, using the 25th and 75th percentile values(1.60 and 1.90, respectively)(Table 3). Based on the results of stratification, groups were labeled starting from the lowest activity level as level I (low, physical activity representative value = 1.50); level II (normal, physical activity, representative value = 1.75); and level III (high, physical activity representative value = 2.00). According to this classification, the numbers of individuals allocated to each level were roughly given in the ratio 1: 2: 1.

As shown in Table 3, the mean ± standard deviation(SD) for the physical activity of all subjects was 1.75 ± 0.22. The representative value(or mean) for Level I generally corresponds to "the mean − 1 x SD" for the entire group and the representative value(or mean) for Level III, "the mean + 1 x SD."

The results of studies on total energy expenditure and PALs of Japanese using DLW method is shown in Table 4. [19-33] Considering subject characteristics, the PAL of each subject group corresponds to the above stated 3 levels of PAL, thus the above 3 levels are appropriate.

2-4. Aged

For independent healthy elderly subjects, there are many reports on PAL (Table 5). [33-42] The mean value of the reports was 1.69 and a reference PAL for elderly subjects was set as 1.70.