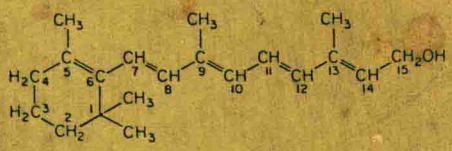
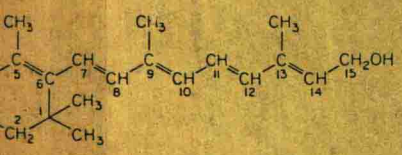
Applied Nutrition for Health Professions:



Basic Nutrition



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Any errors in the text are the responsibility of the editor, who would appreciate learning about them from colleagues.

John J.B. Anderson
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Unit I: Food and Health

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INTRODUCTION

Food provides the nutrients essential for the maintenance of human health. Throughout the history of mankind, cultures have propagated and survived on a great variety of diets, ranging from extreme vegetarianism to nearly total intake of animal products. This illustrates the extensive adaptability of the human body to different dietary intakes. This adaptiveness has permitted man to live in a wide range of environments without evolving into a different form or species.

The products of nature's bounty have supplied the basic physiological requirements for nutrients for over a million years. Most early cultures utilized both vegetable and animal foods whenever they were available. It was only about 10,000 to 20,000 years ago that agriculture began and, since that time, cereal grains have served as the staples upon which human societies have flourished. In the United States, for example, wheat and corn have been the traditional "staffs of life," and in southeast Asia rice has been the main source of sustenance.

This unit presents an overview of the nutrients, the Recommended Dietary Allowances (RDAs), and general concepts of nutrition. An understanding of this material will serve as an essential background for the nine subsequent units in this book.

OBJECTIVES

The objectives are presented here to aid the user in focusing attention on expected learning outcomes.

Upon completion of this unit, the user will be able to:

1. Recognize the number of servings needed by the human body from each of the four major food groups.

2. Recognize the relationship of the body's nutrient requirements to a balanced intake of nutrients from a variety of food sources.

3. Recognize the uses of the table of Recommended Dietary Allowances (RDA).

4. Recognize the major food groups and the bulk nutrients contained in each.

5. Identify indications of normal nutrition and malnutrition.

6. Recognize the relationship of malnutrition to disease.

7. Recognize the roles of dietitians and community nutritionists in health care.

RECOMMENDED PREPARATION

In order to realize maximum benefit from this unit, the student should read the following.

Food and Nutrition Board, National Research Council. Recommended Dietary Allowances. 9th ed. Washington, D.C.: National Academy of Sciences, 1980.

I. ADEQUATE INTAKE OF NUTRIENTS

The nutrients derived from foods are used for the growth of cells and tissues, for the maintenance and repair of those tissues, and ultimately, for the successful reproduction of the organism. Knowledge of the cellular uses of these nutrients has been unfolding over the last half-century at an accelerating pace, as the field of molecular biology has advanced. This section emphasizes the more general uses of foods, especially the proper selection of foods in the diet in order to obtain the essential nutrients each day.

A. DIETARY ADEQUACY

Although nutrition is not an exact science, nutritional scientists have determined that almost 50 specific nutrients are required by the body. The optimal daily amount for a given individual of each of these 50 nutrients is not known, but adequate intake levels of 18 nutrients have been estimated for age- and sex-specific groups of individuals. These estimates are incorporated into a table known as the Recommended Dietary Allowances (RDAs), which will be discussed later.

The approximately 40 required nutrients which comprise an adequate diet consist of energy nutrients (often referred to as calories), one essential fatty acid, essential amino acids, fat-soluble vitamins, water-soluble vitamins, macro-minerals, micro-minerals, and water. In addition, man has a requirement for nitrogen from the non-essential or dispensable amino acids. Essential nutrients, except for water, are tabulated as follows:

TABLE 1. Essential Nutrients

Energy	Fatty Acids	Amino Acids	Fat-Soluble Vitamins	Water-Soluble Vitamins	Macro-Minerals	Micro-Minerals
Carbohydrates	Linoleic	Isoleucine	A-Retinol	B_1-Thiamin	Calcium	Iron
Fats	Others[1]	Leucine	D-Calciferols	B_2-Riboflavin	Phosphorus	Iodine
Proteins		Lysine	E-Tocopherols	Niacin	Magnesium	Zinc
(Alcohol)		Methionine	K-Quinones	Folacin	Sodium	Chromium
		Phenylalanine		B_6-Pyridoxine	Potassium	Copper
		Threonine		B_{12}-Cobalamin	Chlorine	Fluorine
		Tryptophan		C-Ascorbic Acid	Sulfur[3]	Manganese
		Valine		Biotin		Molybdenum
		Arginine[2]		Pantothenic Acid		Selenium
		Histidine[2]				Others[4]

[1]Cholesterol is not an essential nutrient.

[2]Arginine and histidine are considered essential for infants, and possibly essential for adults.

[3]Sulfur is essential as part of the sulfur-containing amino acids, such as methionine.

[4]Cobalt is essential as part of cobalamin; other trace elements such as aluminum, arsenic and silicon are possibly essential for life.

The diet must supply most of these nutrients, with the possible exceptions of the fat-soluble vitamins and cobalamin, each day for the maintenance of optimal health. These particular vitamins are stored extensively in the liver and/or fat deposits of the body. However, most micro-nutrients, i.e., the water-soluble vitamins and trace or micro-minerals, are needed in minute amounts each day. Their storage is limited from a few days to a few weeks. Vitamin C, or ascorbic acid, is a classic example. If it is not consumed at all or in amounts less than 10 mg per day, symptoms of scurvy will develop in about two weeks.

For the bulk nutrients, i.e., energy (calories), amino acids and macro-minerals, some adaptation occurs when they are supplied in deficient amounts. Glucose is generated at the expense of body proteins, fat stores become mobilized for the production of cellular energy, and calcium is released from the skeleton at the expense of its own structural integrity. These adaptations allow for a limited amount of time, depending on the organ systems involved, before dysfunction or disease follows. Diet-disease relationships, as a result of excesses and/or deficiencies, will be reviewed later in this unit.

Increasingly, in American society, nutrients are being consumed from sources other than foods to ensure that the body's daily needs are being met. The use of supplemental nutrients, especially vitamins and chemically purified minerals, has become widespread, both as additions to processed food and as direct supplements. One concern regarding the consumption of the more chemically defined diets, which were developed for the astronauts during extended space flights, is their lack of fiber. Fiber, though not a nutrient, is recommended for all of us in, as yet, undefined amounts. By definition, fiber comprises the non-digestible components of plant-cell walls and intracellular structures. Fiber provides bulk in the gastrointestinal tract and aids in its normal movement. Furthermore, this indigestible material may adsorb bacterial by-products, cholesterol, bile salts, and other adventitious environmental chemicals. This adsorption reduces the likelihood of their penetrating the cells of the gastrointestinal epithelial lining.

B. THE TRADITIONAL AMERICAN DIET

What do Americans eat in order to obtain these essential nutrients? Is the traditional American diet an optimal diet, supplying all the nutrients in approximately the right amounts with respect to one another?

The traditional American diet has been based on meats and dairy products, with cereals, vegetables, and fruits providing the additional energy and bulk needs. It has only been in the recent decade or so that concern has arisen regarding the high meat consumption of Americans and their relatively low intake of the vegetables, fruits and wholegrain cereals which supply dietary fiber. Today, an estimated 7 million adult Americans do not eat any meat and another 40 million have reduced their intake of meat. The reasons for meat restriction are varied. They relate not only to the high cost of meats in the marketplace but also to the beliefs that the production of meats from grains is wasteful and that high meat consumption may not be healthful. Perhaps the biggest concern among consumers is that meats carry saturated fats and cholesterol (see Table 2, page 7). These nutrients have been shown to be associated

with cardiovascular and other chronic degenerative diseases. On the other hand, meat and dairy products are high-quality sources of proteins. Meats also contain the most readily available and digestible sources of iron and zinc. Thus, they are excellent foods and should present no health problems when consumed in modest quantities.

TABLE 2. Fat and Cholesterol in Selected Foods[1]

Foods by Groups	Quantity	Fat, g[2]	Cholesterol, mg[2]
Eggs and Dairy Products			
Egg, whole or yolk	1 large	6	250
Butter	0.5 cup	92	300
Cream heavy	1 cup	60	300
half & half	1 cup	28	100
Custard, egg	1 cup	15	275
Cheese	1 ounce	5-9	20-30
Ice Cream, 16% fat	1 cup	24	85
Whole Milk, 3.5% fat	1 cup	9	34
Skim Milk, 2 % fat	1 cup	5	7
Yoghurt, whole milk	1 cup	8	30
Sea Food			
Lobster	1 cup	2	125
Clams, Crabs & Oysters	1 cup	4	100
Shrimp	1 cup	3	200
Fish, cooked	3.5 ounces	5-20	50-60
Herring, cooked	3.5 ounces	12	100
Tuna, raw	1 cup	21	100
Meats and Poultry			
Beaf & Veal, cooked	3 ounces	10-30	80
Lamb & Pork, cooked	3 ounces	20-30	75-85
Liver, beef, cooked	3 ounces	9	400
Poultry, breast, cooked	3.5 ounces	5	80
Liver, chicken, cooked	2.5 ounces	4	750
Kidney, beef, cooked	2 ounces	4	250
Brains, beef, cooked	2 ounces	8	1700
Lard	1 cup	205	200
Other Foods			
Mayonnaise	1 cup	120	150
Noodles, egg	1 cup	2	50
Waffle, egg	1 large	8	120
Foods Without Cholesterol			
Breads	1 slice	1	
Cereals, breakfast	1 cup or biscuit	1	
Fruits (exception: avocado, 7 mg)	---	Variable	
Vegetables	---	Variable	
Nuts (exceptions: coconut, brazil)	---	Variable	
Sherbet	1 cup	2	
Margarine	0.5 cup	92	
Imitation Cream	1 cup	30	
Vegetable Oils	1 cup	220	
Alcoholic Beverages	12 ounces	0	

[1]Source: USDA, Nutritive Value of American Foods, Handbook No. 456. Washington, D.C.: U.S. Government Printing Office, 1975.

[2]Approximate amounts.

One of the greatest problems in the current American diet is the excessive consumption of energy (calories) from foods and alcoholic beverages when compared to the energy expended. Although the average adult energy intake has decreased significantly since the turn of the century, American energy expenditure in work and other activities has decreased even more. Thus, obesity is now a major concern in the American population; the jogging craze and other sports activities are having little effect on the population as a whole. American affluence encourages the overconsumption of foods.

In addition, even those Americans at or below the Poverty Income Ratio (20-25%) may be eating too many foods which have little nutrient value. The ready availability of so-called "junk" foods and snack items, as well as the proliferation of fast-food establishments, clearly demonstrate that there is no internal mechanism controlling American food selection and consumption habits. The problem of obesity has been considered preeminent by the Senate Select Committee on Nutrition and Human Needs in its second edition of the U. S. Dietary Goals.

C. FOOD TABLES

Most of the nutrients found in foods have been tabulated by the U.S. Department of Agriculture. USDA Handbook Number 8 provides information on foods based on 100 g sample sizes, whereas Handbook Number 456 gives this same information based on average portions. USDA's Home and Garden Bulletin Number 72, entitled "Nutritive Value of Foods," is an abbreviated version of the above handbooks. The latter publication is available, at no cost, by writing to your Congressman.

A sample food, milk, is given here to illustrate how H&G Bulletin No. 72 lists the nutrients (see Table 3). Note that fiber is not included in this table.

TABLE 3. Milk, Fluid - One Cup and 244 to 246 Grams

Nutrient	Whole, 3.5%	Nonfat (Skim)	Partly Skimmed (2%)
Water, %	87	90	87
Calories, kcal	160	90	145
Protein, g	8.5	8.8	10.3
Fat, g	9	Trace	5
Saturated fatty acids, g	5	Trace	3
Unsat. fatty acids, g	3	Trace	2
linoleic, g	Trace	Trace	Trace
Carbohydrate[2], g	12	12	15
Calcium, mg	288	296	352
Iron, mg	0.1	0.1	0.1
Vitamin A, IU	350	10[3]	200
Thiamin, mg	0.07	0.09	0.10
Riboflavin, mg	0.41	0.44	0.52
Niacin, mg	0.2	0.2	0.2
Ascorbic Acid, mg	2	2	2

[1]Nonfat milk solids added
[2]Lactose, about 100%
[3]Not fortified

The food tables are essential for the calculation of nutrient intake, whether a 24-hour recall, food-record, or food-frequency method is used.

D. FOOD GROUPS FOR MEAL PLANNING

In order to ensure dietary adequacy, relatively simple guidelines have been formulated by nutritionists for the purpose of meal planning. An adequate diet, by definition, supplies all of the essential nutrients in adequate amounts each day to maintain optimal health and to prevent nutrition-related disease. A "fad" diet may be imbalanced or inadequate if it eliminates one or more nutrients and, thus, may eventually lead to nutritional disorders. Vegetarian diets may not provide adequate amounts of the micro-nutrients for pregnant and lactating women and for infants and children unless foods are selected carefully.

The planning of meals is aided by grouping foods according to the predominant essential nutrients they contain. The simplest scheme in use, the Basic Four Food Groups[1], is designed for consumers as well as health professionals. The purpose of the Basic Four is to provide diversity in the diet so that all of nature's preformed essential nutrients can be eaten. Careful use of the Basic Four should ensure that adequate energy is consumed. The foods containing these energy substances will also supply all the other essential nutrients. Foods that are not classified into one of the four food groups, on the other hand, are usually high in energy but low in nearly all other nutrients. These foods are said to have a low nutrient density. The so-called "junk foods" fall into this category.

A table of the number of daily servings recommended from the Basis Four Food Groups for adults and children is given below (see Table 4).

TABLE 4. Recommended Daily Servings of Food Groups

Food Group[1]	Minimal Number of Servings		
	Adults[2]	Children	Adolescents
Milk	2	3	4
Meats and Legumes	2	2	2
Vegetables and Fruits	4	4	4
Breads and Cereals	4	4	4

[1]Additional energy is usually needed from fats and other foods not in one of the groups.

[2]Pregnant and lactating women need additional servings (see self-instructional program, Prewitt-Rice, E., and Anderson, J. Nutrition in Pregnancy and Lactation. Chapel Hill, N.C.: Health Sciences Consortium, 1977.

[1]A fifth or miscellaneous group, which includes margarine, oils, snacks and a few other food items, has recently been added to make this the Basic Five.

The major nutrients supplied in each of the Basic Four Food Groups are as follows (see Table 5). Note that the milk group is high in calcium and low in iron, compared to most other food groups.

TABLE 5. Distribution of Nutrients in Food Groups

Food Group	Nutrients				
	Energy	Protein	Vitamins	Calcium	Iron
Milk[1]	X	X	X	X	
Meats and Legumes	X	X	B vitamins		X
Vegetables[2] and Fruits[3]	(X)		X	X[4]	X
Breads and Cereals	X	X	B vitamins		X

[1]See Table 2, page 7.
[2]Leafy, green and yellow vegetables are rich in iron, folacin and vitamin A.
[3]Citrus fruits, tomatoes and some vegetables are rich in ascorbic acid.
[4]Dark, green leafy vegetables.

REVIEW QUESTIONS (I)

DIRECTIONS. Indicate which of the following statements are true (T) and which are false (F) by circling the appropriate letters.

T F 1. Adequate daily nutrient intake is essential for the health of human bodies.

T F 2. The milk food group is high in calcium and iron.

T F 3. A water-soluble vitamin which is required in the diet is ascorbic acid.

T F 4. Fats are not included in the Basic Four Food Groups.

T F 5. Of the approximately 50 known nutrients, only a few are known to be essential.

T F 6. A balanced or adequate diet is one which supplies, each day, all the essential nutrients in amounts corresponding to the RDAs.

T F 7. An example of an unbalanced "fad" diet is a vegetarian diet.

T F 8. Energy is considered a nutrient, whereas fiber is not.

T F 9. The vegetable food group is particularly rich in vitamins and protein.

T F 10. Whole milk contains more than trace amounts of linoleic acid, an essential fatty acid.

Check your responses on page 26.

II. RECOMMENDED DIETARY ALLOWANCES

The daily nutrient needs of population groups, but not individuals, within our society have been estimated in the form of daily allowances. The Recommended Dietary Allowances (RDAs) are provided for different age groups, approximate weights and heights, both sexes, and for women during pregnancy and lactation.

About every five years a panel of experts, the Food and Nutrition Board of the National Research Council, revises the RDAs by examining and interpreting new information concerning nutrient requirements in human subjects or animal models. The ninth edition of the Recommended Dietary Allowances, as published by the National Academy of Sciences in 1980, lists RDA values or "Safe and Adequate Intakes" for energy, protein, four fat-soluble vitamins, nine water-soluble vitamins, six macro-minerals, and nine trace minerals. The entire list of these thrity nutrients, including energy and protein, is given in Table 6. Note that values for all of these nutrients are not available in the USDA's food tables (see Table 3).

TABLE 6. Nutrients with Recommended Allowances in the Ninth Edition of the Recommended Dietary Allowances*

Energy	Protein	Fat-Soluble Vitamins	Water-Soluble Vitamins	Macro-Minerals	Micro-Minerals
		A Activity	Ascorbic acid	Calcium	Iron
		D	Folacin	Phosphorus	Iodine
		E Activity	Niacin	Magnesium	Zinc
		K[1]	Riboflavin	Sodium[1]	Chromium[1]
			Thiamin	Potassium[1]	Copper[1]
			Vitamin B_6	Chlorine[1]	Fluorine[1]
			Vitamin B_{12}		Manganese[1]
			Biotin[1]		Molybdenum[1]
			Pantothenic Acid[1]		Selenium[1]

[1]Estimated safe and adequate daily dietary intakes.

*From the Food and Nutrition Board, National Research Council. Recommended Dietary Allowances. 9th ed. Washington,D.C.: National Academy of Sciences, 1980.

In general, the allowances are designed to meet or exceed the requirements of about 97.5% of all Americans. The energy RDA is an exception. Except for energy, each RDA provides a safety factor of intake for nearly all members of society. From a statistical point of view, then, about 50% of the population's nutrient needs will be significantly exceeded, if the mean requirement is the same as the mean intake for a given nutrient (see Figure 1).

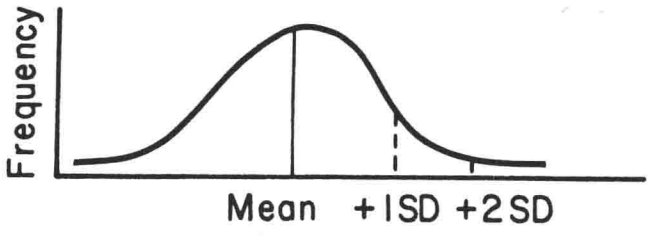

FIGURE 1. Normal population distribution (bell shaped) showing statistical mean and standard deviations (SD) of nutrient intake. The percent of the population to the left of +2SD is about 97.5.

For most nutrients, both the actual intake and requirement distributions of the population overlap, as in Figure 1, indicating that they have a high degree of correlation. The intake at the mean requirement plus two standard deviations provides a safety factor and should satisfy the requirements of 97.5% of the population. However, if the mean requirement is greater than or less than the mean intake, different normal distributions for the requirement would exist, as shown in Figure 2. If the mean requirement of a nutrient is less than the mean intake (Case A), most members of a population will be consuming the nutrient in excessive, rather than optimal, amounts. This situation exists for about 25% of the adults in our society with respect to energy intake; otherwise it is difficult, if not impossible, to account for the high prevalence rate of obesity. Case B illustrates the opposite end of the spectrum. When the mean requirement is higher than the mean intake, most members of a population will be consuming less than their physiological needs and will be in marginal or frank deficiency.

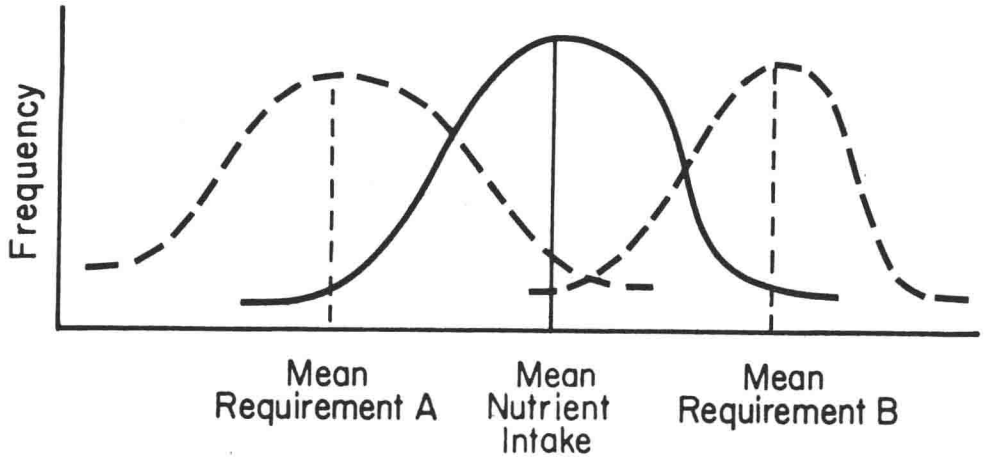

FIGURE 2. Hypothetical frequency distributions of nutrient requirement and intakes.

The allowances can be set at any point on a normal distribution for a nutrient requirement, as shown in Figure 1. For most nutrients, the RDA is set at about the mean requirement plus two standard deviations. The allowances for energy intake for adults have recently been reduced to less than the mean intake in order to avoid promotion of excessive calorie consumption and, hence, obesity. An illustration of this phenomenon is given in Figure 3. Note the flatter and more dispersed curve for intake compared to requirement.

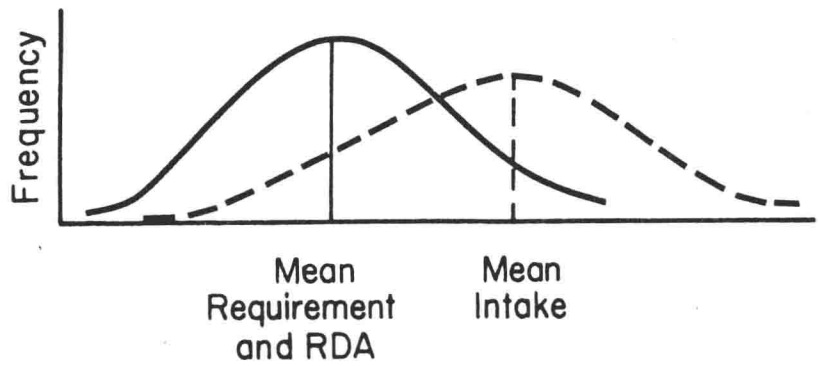

FIGURE 3. Distributions for adult energy requirements and intake.

Informed judgment is necessary for setting an adult RDA. Take ascorbic acid as an example. Daily ascorbic acid intake has a relatively direct linear relationship to the plasma concentration of the vitamin at normal intakes, but if you consume more Vitamin C each day the plasma values plateau (see Figure 4). However, tissues become saturated only when the ascorbic acid concentration in the blood begins to level off. A decision must be made (by committee) as to where to set the RDA. Committees from different nations have selected different recommendations according to their own interpretations of the nutritional needs.

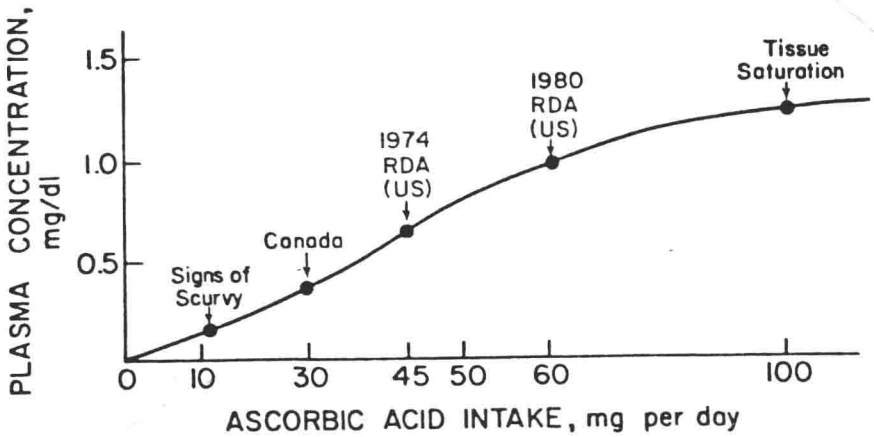

FIGURE 4. Plasma concentration of ascorbic acid in relation to intake. In the U.S., the adult RDA was set at 45 mg/day (1974 edition), whereas it was increased to 60 in 1980. The allowance selected in Canada is only 30 mg/day.