

14 - 343 Nutrient Requirements and Dietary Assessment

343 Nutrient Requirements and Dietary Assessment

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Nutrient Requirements

and Dietary Assessment PART 10 Disorders of the Gastrointestinal System Nutrients are substances that are essential but not synthesized in sufficient amounts in the body and therefore must be supplied by the diet. Nutrient requirements for groups of healthy persons have been determined experimentally. The absence of essential nutrients leads to growth impairment, organ and metabolic dysfunction, and failure to maintain nitrogen balance or adequate status of protein and other nutrients. For good health, we require energy-providing nutrients (protein, fat, and carbohydrate), vitamins, minerals, and water. Requirements for organic nutrients include 9 essential amino acids, several fatty acids, glucose, 4 fat-soluble vitamins, 10 water-soluble vitamins, dietary fiber, and choline. The inorganic nutrients include 4 minerals, 7 trace minerals, 3 electrolytes, and the ultra trace elements that must also be supplied by diet. Individuals of different ages and physiologic states differ in the amounts of nutrients they require. Conditionally essential nutrients are not required in the diet but must be supplied to certain individuals such as those with genetic defects; pathologies such as infection, disease, or trauma with nutritional implications; and some developmentally immature infants who need them because they do not synthesize inositol,

taurine, arginine, and/or glutamine in adequate amounts. Many other organic and inorganic bioactive compounds that are present in foods and dietary supplements may also have health effects, including pesticides, heavy metals like lead, phytochemicals, zoochemicals, and microbial products. ■ ■ ESSENTIAL NUTRIENT REQUIREMENTS Energy The estimated energy requirement (EER) is the predicted average requirement to maintain energy balance and health in an adult of a defined age, sex, weight, height, level of physical activity, and life stage. For weight to remain stable, energy intake must match total energy expenditure (TEE). The major components of TEE are resting energy expenditure (REE) and the physical activity level (PAL), and minor components include the energy cost of metabolizing food (thermic effect of food, or specific dynamic action) and cold-induced (shivering) thermogenesis. The average energy intake is ~2600 kcal/d for American men and ~1800 kcal/d for American women, but individuals vary with body size and activity level. Although estimates introduce considerable error, energy intakes are usually calculated from formulas

rather than measuring TEE directly. In individuals whose weights are stable, for males, $REE = 900 + 10m$, and for females, $REE = 700 + 7m$, where m is mass in kilograms. The calculated REE is then multiplied by the appropriate PAL to account for physical activity that ranges from 1.4 (inactive) for individuals who perform only essential activities of daily living (e.g., 30 minutes walking and 90 minutes light to moderate activity) to 1.6 (low active), 1.75 (active), and 2.05 (very active). The result is the estimated energy (EER) or intake. When describing their PALs, sedentary, inactive, and low active individuals tend to overestimate, and so in practice, use of PALs of 1.2 to 1.4 may be closer to their actual activity levels. The EER provides a rough target for planning caloric needs for a person of a certain age, sex, weight, height, and physical activity level who is neither gaining nor losing weight. For further discussion of energy balance in health and disease, see Chap. 345. Protein Dietary protein consists of both “essential” (e.g., not synthesized endogenously and must be supplied by diet) and “nonessential” (e.g., synthesized endogenously or obtained from diet) amino acids that are all required for protein synthesis. The nine essential amino acids are histidine, isoleucine, leucine, lysine, methionine/cystine, phenylalanine/tyrosine, threonine, tryptophan, and valine. Several amino acids, such as alanine, arginine, aspartic acid, glutamic acid, glutamine, and glycine can also be converted to glucose and used for energy and gluconeogenesis. When energy intake is inadequate, protein intake must be increased, because ingested amino acids are diverted into pathways of glucose synthesis and oxidation. In extreme energy deprivation, protein-calorie malnutrition may ensue (Chap. 345). For adults, the recommended dietary allowance (RDA) for protein is ~0.8 g/kg desirable body mass per day, assuming that energy needs are met and that the protein is of relatively high biological value. Current recommendations for a healthy diet call for at least 10–14% of calories from protein. Most American diets provide at least those amounts. Biologic value tends to be highest for animal proteins, followed by proteins from legumes (beans), cereals (rice, wheat, corn), and roots. Combinations of plant proteins that complement one another in their essential amino acid profiles or combinations of animal and plant proteins can increase biologic value and lower total protein intakes necessary to meet requirements. In healthy people with adequate diets, the timing of protein intake over the course of the day has little effect. Protein needs increase during growth, pregnancy, lactation, and rehabilitation after injury or undernutrition. Tolerance to dietary protein is decreased in renal insufficiency (with consequent uremia) and in liver failure. Usual protein intakes can precipitate encephalopathy in patients with cirrhosis of the liver. Fat and Carbohydrate Carbohydrate (4 kcal/g), fat (9 kcal/g), and protein (4 kcal/g) all provide energy. So does alcohol

(ethanol) (7 kcal/g), but it is not a nutrient. Fats are a concentrated source of energy and constitute, on average, 34% of calories in U.S. diets. However, for optimal health, fat intake should total no more than 30% of calories. Saturated fat and trans-fat should be limited to <10% of calories and polyunsaturated fats to <10% of calories, with monounsaturated fats accounting for the remainder of fat intake. At least 45–55% of total calories should be derived from carbohydrates, with <10% and preferably <6% from added sugars. The brain requires ~100 g of glucose per day for fuel; other tissues use ~50 g/d. Some tissues (e.g., brain and red blood cells) rely on glucose supplied either exogenously or from muscle proteolysis. Over time, during hypocaloric states, adaptations that lower carbohydrate needs are possible. Water For adults, 1–1.5 mL of water per kilocalorie of energy expenditure is sufficient under usual conditions to allow for normal variations in physical activity, sweating, and the diet's solute load. Water losses include 50–100 mL/d in the feces; 500–1000 mL/d by evaporation or exhalation; and, depending on the renal solute load, ≥1000 mL/d in the urine. If external losses increase, intakes must increase accordingly to avoid underhydration. Fever increases water losses by ~200 mL/d per °C; diarrheal losses vary but may be as great as 5 L/d in severe diarrhea. Heavy sweating, vigorous exercise, and

vomiting also increase water losses. When renal function is normal and solute intakes are adequate, the kidneys can adjust to increased water intake by excreting up to 18 L of excess water per day (Chap. 393). However, obligatory urine outputs can compromise hydration status when there is inadequate water intake or when losses increase in disease or kidney damage. Infants have high requirements for water because of their large surface area to volume ratios, their inability to communicate their thirst, and the limited capacity of the immature kidney to handle high renal solute loads. Increased water needs during pregnancy are ~30 mL/d. During lactation, milk production increases daily water requirements so that ~1000 mL of additional water is needed, or 1 mL for each milliliter of milk produced. Special attention must also be paid to the water needs of the elderly, who have reduced total-body water, blunted thirst sensation, and frequently use medications such as diuretics. Other Nutrients See Chap. 344 for detailed descriptions of vitamins and minerals. ■ ■DIETARY REFERENCE INTAKES AND RDAs Fortunately, human life and well-being can be maintained within a fairly wide range of most nutrient intakes. However, the capacity for adaptation is not infinite—too much, as well as too little, intake of a nutrient can have adverse effects itself or decrease health benefits conferred by another nutrient. Therefore, benchmark recommendations regarding nutrient intakes have been developed to guide menu development and clinical practice. They are referred to in the United States and Canada as the dietary reference intakes (DRIs) and are set by National Academy of Medicine's (formerly Institute of Medicine [IOM]) Food and Nutrition Board and Health Canada. The recommendations apply to the general population, including those with or at risk for chronic diseases, overweight, and obesity. Exceptions may be needed for individuals with severe comorbidities, diseases, disabilities, or use of medications known to alter energy or some nutrient requirements. The DRIs supplanted the recommended dietary allowances (RDAs)—the single reference values used in the United States until the early 1990s. DRIs now include an estimated average requirement (EAR) as well as other reference values used for dietary planning: the RDA, the adequate intake (AI), the chronic disease risk reduction intake (CDRR), and the tolerable upper level (UL). The DRIs also include acceptable macronutrient distribution ranges (AMDRs) for protein, fat, and carbohydrate. The types of evidence and criteria used to establish nutrient requirements vary by nutrient, age, and physiologic group. The current DRIs for vitamins and elements are provided in Tables 343-1 and 343-2, respectively. Table 343-3 provides DRIs for water and macronutrients. Energy has

neither an RDA nor a UL because intakes above or below requirements lead to weight gain or loss; EERs are used instead and are discussed in Chap. 345 on energy balance in health and disease. Estimated Average Requirement (EAR) When florid manifestations of the classic dietary-deficiency diseases such as rickets (deficiency of vitamin D and calcium), scurvy (deficiency of vitamin C), xerophthalmia (deficiency of vitamin A), and protein-calorie malnutrition were common, nutrient adequacy was inferred from the absence of their clinical deficiency signs. Later, biochemical and other earlier changes were used that appeared long before the deficiency was clinically apparent. Today, criteria of adequacy are based on biologic markers when they are available, and to sensitive biochemical, physiologic, or behavioral tests that reflect early changes in regulatory processes; maintenance of body stores of nutrients; or, if available, the amount of a nutrient that minimizes the risk of chronic degenerative disease. However, relevant biomarkers of disease risk are often not available, and the long time lags between intake and disease outcomes further complicate the picture. The EAR is the amount of a nutrient estimated to be adequate for half of the healthy individuals of a specific age and sex. It is not an effective estimate of nutrient adequacy in individuals because it is a median requirement for a group, with 50% of individuals in a group falling below and 50% falling above the requirement. Thus, a person with a usual intake at the EAR has a 50% risk of inadequate intake. For

these reasons, the other standards described below are more useful for clinical purposes.

Recommended Dietary Allowances The RDA is the nutrient intake goal for planning diets of individuals. It is the average daily dietary intake level that meets the nutrient requirements of nearly all healthy persons of a specific sex, age, life stage, or physiologic condition (e.g., pregnancy or lactation). The RDA is set two standard deviations above the EAR to ensure that the needs of virtually any individual are met. The risk of dietary inadequacy increases as one's intake falls below the RDA. However, the RDA is an overly generous criterion for evaluating nutrient adequacy because, by definition, the RDA exceeds the actual requirements of all but ~2-3% of the population. Therefore, many people whose intake falls below the RDA are still getting enough of the nutrient. The RDAs are used to formulate food guides such as the U.S. Department of Agriculture's (USDA) MyPlate Plan for individuals (<https://www.choosemyplate.gov/resources/MyPlatePlan>), as well as to create food-exchange lists for therapeutic diet planning. An online tool, available at <https://www.nal.usda.gov/fnic/dri-calculator/>, allows health professionals to calculate individualized daily nutrient recommendations for dietary planning based on the DRIs. The RDAs are also used as a standard for labels describing the nutritional content of foods and nutrient-containing dietary supplements. On food labels, the nutrient content in a food is stated by weight and/ or as a percentage of the daily value (DV), a variant of the RDA used on the nutrition facts panel that, for an adult, represents the highest RDA for an adult consuming 2000 kcal.

CHAPTER 343 Adequate Intake (AI) Some nutrients lack an EAR and so an RDA cannot be set. In this circumstance, the AI is used, based on observed or experimentally determined approximations of nutrient intakes in healthy people. In the DRIs, AIs rather than RDAs are proposed for nutrients consumed by infants (up to age 1 year) as well as for chromium, fluoride, manganese, sodium, potassium, pantothenic acid, biotin, choline, fiber, and water consumed by persons of all ages.

Nutrient Requirements and Dietary Assessment Tolerable Upper Levels (UL) Healthy individuals derive no established benefit from consuming nutrient levels above the RDA or AI. In fact, excessive nutrient intake can disturb body functions and cause acute, progressive, or permanent disabilities. The tolerable UL is the highest level of chronic (usually

daily) nutrient intake that is unlikely to pose a risk of adverse health effects for most of the population. Data on the adverse effects of large amounts of many nutrients are unavailable or too limited to establish a UL and so the lack of a UL does not mean that the risk of adverse effects from high intake is nonexistent. Nutrient levels in commonly eaten foods rarely exceed the UL, although very highly fortified foods and dietary supplements provide more concentrated amounts of nutrients per serving and thus pose a potential risk of toxicity. Dietary supplements have Supplement Facts panels on labels that express the amount of nutrients present in absolute units or as the percentage of the DV provided per recommended serving size. Total nutrient intakes, including that from foods, supplements, and over-the-counter medications (e.g., antacids), should not exceed RDA levels. Chronic Disease Risk Reduction Intake (CDRR) The CDRR is the level above which a reduction in intake is expected to lower chronic disease risk is the CDRR. For example, the sodium CDRR for adults is 2300 mg/d; this is the lowest level of intake for which there is sufficiently strong evidence to characterize a CDRR. CDRRs are not available for potassium or other nutrients, but note that the AI for potassium was recently reduced to 2500 mg/d. Acceptable Macronutrient Distribution Ranges (AMDRs)

AMDRs are estimated ranges from epidemiologic data of energy-providing macronutrient intakes (protein, carbohydrate, and fat) considered to be healthful. These ranges are 10–35% of calories for protein, 20–35% of calories for fat, and 45–65% of calories for carbohydrate. Alcohol, which also provides energy, is not a nutrient; therefore, no recommendations for it are provided. The latest DRI committee

(µg/d) CHOLINE (mg/d)g Birth to 6 mo 400* 40*

4* 2.0* 0.2* 0.3* 2* 0.1* 65* 0.4* 1.7* 5* 125* 6–12 mo 500* 50*

5* 2.5* 0.3* 0.4* 4* 0.3* 80* 0.5* 1.8* 6* 150* 1–3 y

30* 0.5 0.5

0.5

0.9 2* 8* 200* 4–8 y

55* 0.6 0.6

0.6

1.2 3* 12* 250* 9–13 y

60* 0.9 0.9

1.0

1.8 4* 20* 375* 14–18 y

75* 1.2 1.3

1.3

2.4 5* 25* 550* 19-30 y

120* 1.2 1.3

1.3

2.4 5* 30* 550* 31-50 y

120* 1.2 1.3

1.3

2.4 5* 30* 550* 51-70 y

120* 1.2 1.3

1.7

2.4h 5* 30* 550*

“ 70 y

120* 1.2 1.3

1.7

2.4h 5* 30* 550* 9-13 y

60* 0.9 0.9

1.0

1.8 4* 20* 375* 14-18 y

75* 1.0 1.0

1.2 400i 2.4 5* 25* 400* ACID (mg/d) BIOTIN

(lg/d) PANTOTHENIC (lg/d)f VITAMIN B12 (mg/d) FOLATE (mg/d)e VITAMIN B6 PART 10 Disorders of the Gastrointestinal System (mg/d) NIACIN TABLE 343-1 Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes for Vitamins (mg/d) RIBOFLAVIN (lg/d) THIAMIN (mg/d)d VITAMIN K (lg/d)b,c VITAMIN E (mg/d) VITAMIN D (lg/d)a VITAMIN C GROUP VITAMIN A LIFE-STAGE

aAs retinol activity equivalents (RAEs). 1 RAE = 1 µg retinol, 12 µg β-carotene, 24 µg α-carotene, or 24 µg β-cryptoxanthin. The RAE for dietary provitamin A carotenoids is twofold greater than the retinol equivalent (RE), whereas the RAE for bound B12, it is advisable for those >50 years of age to meet their RDA mainly by consuming foods fortified with B12 or a supplement containing B12. In view of evidence linking inadequate folate intake with neural tube defects in the fetus, it (SRR-, SSR-, SRS-, and SSS-α-tocopherol) also found in fortified foods and supplements. eAs niacin equivalents (NEs). 1 mg of niacin = 60 mg of tryptophan; 0-6 months = preformed niacin (not NE). fAs dietary folate equivalents intake level sufficient to meet the nutrient requirements of nearly all healthy individuals (97-98%) in a group. The RDA is calculated from an estimated average requirement (EAR). If sufficient scientific evidence is not available to establish is recommended that all women capable of becoming pregnant consume 400 µg of folate from supplements or fortified foods in addition to intake of food folate from a varied diet. It is assumed that women will continue consuming 400 µg an EAR and thus to calculate an RDA, an AI is usually developed. For healthy breast-fed infants, an AI is the mean intake. The AI for other life-stage and sex-specific groups is believed to cover the needs of all healthy individuals in those whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages. hBecause 10-30% of older people may malabsorb foodpreformed vitamin A is the same as the RE. bAs cholecalciferol. 1 µg cholecalciferol = 40 IU vitamin D. cUnder the assumption of minimal sunlight. dAs α-tocopherol. α-Tocopherol includes RRR-α-tocopherol, the only form of α-tocopherol (DFEs). 1 DFE = 1 µg food folate = 0.6 µg of folic acid from fortified food or as a supplement consumed with food = 0.5 µg of a supplement taken on an empty stomach. gAlthough AIs have been set for choline, there are few data to assess Note: This table (taken from the DRI reports; see www.nap.edu) presents recommended dietary allowances (RDAs) in bold type and adequate intakes (AIs) in ordinary type followed by an asterisk (*). An RDA is the average daily dietary that occurs naturally in foods, and the 2R-stereoisomeric forms of α-tocopherol (RRR-, RSR-, RRS-, and RSS-α-tocopherol) that occur in fortified foods and supplements. It does not include the 2S-stereoisomeric forms of a-tocopherol Source: National Academies of Sciences, Engineering, and Medicine. 2019. Dietary Reference Intakes for Sodium and Potassium. <https://doi.org/10.17226/25353>. Adapted and reproduced with permission from the National Academy of 19-30 y

90* 1.1 1.1

1.3 400i 2.4 5* 30* 425* 31-50 y

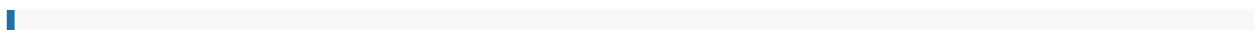
90* 1.1 1.1

1.3 400i 2.4 5* 30* 425* 51-70 y

90* 1.1 1.1

1.5

2.4h 5* 30* 425*



90* 1.1 1.1

1.5

2.4h 5* 30* 425* 14-18 y

75* 1.4 1.4

1.9 600j 2.6 6* 30* 450* 19-30 y

90* 1.4 1.4

1.9 600j 2.6 6* 30* 450* 31-50 y

90* 1.4 1.4

1.9 600j 2.6 6* 30* 450* 14-18 y

75* 1.4 1.6

2.0

2.8 7* 35* 550* 19-30 y

90* 1.4 1.6

2.0

2.8 7* 35* 550* 31-50 y

90* 1.4 1.6

2.0

2.8 7* 35* 550* from supplements or fortified food until their pregnancy is confirmed and they enter prenatal care, which ordinarily occurs after the end of the periconceptual period—the critical time for formation of the neural tube. groups, but lack of data or uncertainty in the data makes it impossible to specify with confidence the percentage of individuals covered by this intake. Sciences, Courtesy of the National Academies. Lactating Women Pregnant Women

(g/d) CHLORIDE Birth to 6 mo 200* 0.2* 200* 0.01* 110* 0.27* 30* 0.003* 2* 100* 15* 2* 0.4* 0.12* 0.18* 6-12 mo 260* 5.5* 220* 0.5* 130*

75* 0.6* 3* 275* 20*

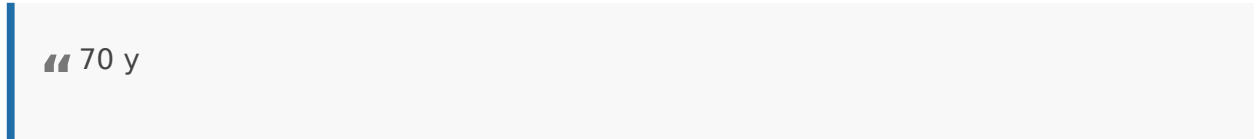
0.7* 0.37* 0.57* (g/d) 9-13 y

21*

2*

1.6*

4.5* 1.5* 2.3*



30*

4*

2.3*

4.7* 1.2* 1.8* 51-70 y

30*

4*

2.3*

4.7* 1.3* 2.0* 31-50 y

35*

4*

2.3*

4.7* 1.5* 2.3* 19-30 y

35*

4*

2.3*

4.7* 1.5* 2.3* 14-18 y

35*

3*

2.2*

4.7* 1.5* 2.3* 9-13 y

25*

2*

1.9*

4.5* 1.5* 2.3* 4-8 y

15*

1*

1.5*

3.8* 1.2* 1.9* 1-3 y

11*

0.7*

1.2*

3.0* 1.0* 1.5* (g/d) SODIUM (mg/d) POTASSIUM (lg/d) ZINC (mg/d) SELENIUM (lg/d) PHOSPHORUS (mg/d) MOLYBDENUM TABLE 343-2 Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes for Elements (mg/d) MANGANESE (mg/d) MAGNESIUM (lg/d) IRON (mg/d) IODINE (lg/d) FLUORIDE (lg/d) COPPER (mg/d) CHROMIUM GROUP CALCIUM LIFE-STAGE

Children Females Infants Males

intake level sufficient to meet the nutrient requirements of nearly all healthy individuals (97-98%) in a group. The RDA is calculated from an estimated average requirement (EAR). If sufficient scientific evidence is not available to establish an EAR and thus to calculate an RDA, an AI is usually developed. For healthy breast-fed infants, an AI is the mean intake. The AI for other life-stage and sex-specific groups is believed to cover the needs of all healthy individuals in those Note: This table (taken from the DRI reports; see www.nap.edu) presents recommended dietary allowances (RDAs) in bold type and adequate intakes (AIs) in ordinary type followed by an asterisk (*). An RDA is the average daily dietary Source: National Academies of Sciences, Engineering, and Medicine. 2019. Dietary Reference Intakes for Sodium and Potassium.

<https://doi.org/10.17226/25353>. Adapted and reproduced with permission from the National Academy of 31-50 y

45*

3*

2.6*

5.1* 1.5* 2.3* 19-30 y

45*

3*

2.6*

5.1* 1.5* 2.3* 14-18 y

44*

3*

2.6*

5.1* 1.5* 2.3* 31-50 y

30*

3*

2.0*

4.7* 1.5* 2.3* 19-30 y

30*

3*

2.0*

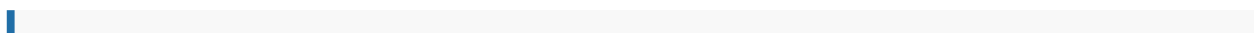
4.7* 1.5* 2.3* 14-18 y

29*

3*

2.0*

4.7* 1.5* 2.3*



70 y

20*

3*

1.8*

4.7* 1.2* 1.8* 51-70 y

20*

3*

1.8*

4.7* 1.3* 2.0* 31-50 y

25*

3*

1.8*

4.7* 1.5* 2.3* 19-30 y

25*

3*

1.8*

4.7* 1.5* 2.3* 14-18 y

24*

3*

1.6*

4.7* 1.5* 2.3* groups, but lack of data or uncertainty in the data makes it impossible to specify with confidence the percentage of individuals covered by this intake. CHAPTER 343 Nutrient Requirements and Dietary Assessment Sciences, Courtesy of the National Academies. Lactating Women Pregnant Women

TABLE 343-3 Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes for Total Water and Macronutrients LIFE-STAGE

GROUP TOTAL WATER^a (L/d) CARBOHYDRATE (g/d) TOTAL FIBER (g/d) Infants Birth to 6 mo 0.7*
60* ND^c 31* 4.4* 0.5* 9.1* 6-12 mo 0.8* 95* ND 30* 4.6* 0.5* 11.0 Children 1-3 y 1.3*

19* ND 7* 0.7*

4-8 y 1.7*

25* ND 10* 0.9*

Males 9-13 y 2.4*

31* ND 12* 1.2*

14-18 y 3.3*

38* ND 16* 1.6*

19-30 y 3.7*

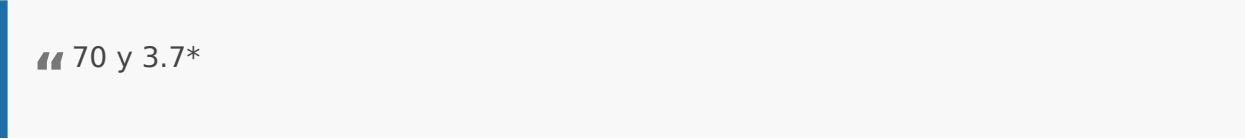
38* ND 17* 1.6*

31-50 y 3.7*

38* ND 17* 1.6*

51-70 y 3.7*

30* ND 14* 1.6*



70 y 3.7*

30* ND 14* 1.6*

Females 9-13 y 2.1*

26* ND 10* 1.0*

14-18 y 2.3*

26* ND 11* 1.1*

19-30 y 2.7*

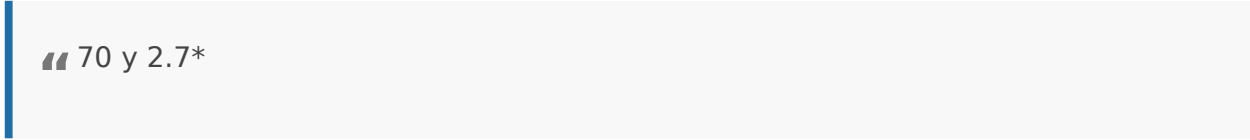
25* ND 12* 1.1*

31-50 y 2.7*

25* ND 12* 1.1*

51-70 y 2.7*

21* ND 11* 1.1*



70 y 2.7*

21* ND 11* 1.1*

Pregnant Women PART 10 Disorders of the Gastrointestinal System 14-18 y 3.0*

28* ND 13* 1.4*

19-30 y 3.0*

28* ND 13* 1.4*

31-50 y 3.0*

28* ND 13* 1.4*

Lactating Women 14-18 3.8*

29* ND 13* 1.3*

19-30 y 3.8*

29* ND 13* 1.3*

31-50 y 3.8*

29* ND 13* 1.3*

Note: This table (taken from the DRI reports; see www.nap.edu) presents recommended dietary allowances (RDAs) in bold type and adequate intakes (AIs) in ordinary type followed by an asterisk (*). An RDA is the average daily dietary intake level sufficient to meet the nutrient requirements of nearly all healthy individuals (97-98%) in a group. The RDA is calculated from an estimated average requirement (EAR). If sufficient scientific evidence is not available to establish an EAR and thus to calculate an RDA, an AI is usually developed. For healthy breast-fed infants, an AI is the mean intake. The AI for other life-stage and sex-specific groups is believed to cover the needs of all

healthy individuals in those groups, but lack of data or uncertainty in the data make it impossible to specify with confidence the percentage of individuals covered by this intake. aTotal water includes all water contained in food, beverages, and drinking water. bBased on grams of protein per kilogram of body weight for the reference body weight (e.g., for adults: 0.8 g/kg body weight for the reference body weight). cNot determined. Source: National Academies of Sciences, Engineering, and Medicine. 2019. Dietary Reference Intakes for Sodium and Potassium. <https://doi.org/10.17226/25353>. Adapted and reproduced with permission from the National Academy of Sciences, Courtesy of the National Academies. recommended that the CDRR method be used instead of the AMDR for establishing DRIs for macronutrients in the future. ■ ■FACTORS ALTERING NUTRIENT NEEDS The DRIs are affected by age, sex, growth rate, pregnancy, lactation, physical activity level, concomitant diseases, drugs, and dietary composition. Physiologic Factors Growth, strenuous physical activity, pregnancy, and lactation all increase needs for energy and several essential nutrients. Energy needs rise during pregnancy due to fetal growth demands and increased energy required for milk production during lactation. Energy needs decrease with loss of lean body mass, the major determinant of REE. The energy needs of older persons, especially those aged >70 years, tend to be lower than those of younger persons because lean tissue, physical activity, and health often decline with age. Dietary Composition Dietary composition affects the biologic availability and use of nutrients. For example, iron absorption may be impaired by large amounts of calcium or lead; likewise, non-heme iron uptake may be impaired by a lack of ascorbic acid and amino acids in the meal. Bodily protein may be decreased when essential amino acids

`-LINOLENIC ACID (g/d) FAT

(g/d) LINOLEIC ACID (g/d) PROTEINb

(g/d) are not present in sufficient amounts—a rare scenario in U.S. diets. Animal foods, such as milk, eggs, and meat, have high biologic values, with most of the needed amino acids present in adequate amounts. Plant proteins in corn (maize), soy, rice, and wheat have lower biologic values and must be combined with other plant or animal proteins or fortified with the amino acids that are deficient to achieve optimal use by the body. Route of Intake The RDAs apply only to oral intakes. When nutrients are administered parenterally, similar values can sometimes be used for amino acids, glucose (carbohydrate), fats, sodium, chloride, potassium, and most vitamins because their intestinal absorption rate is nearly 100%. However, the oral bioavailability of most mineral elements may be only half that obtained by parenteral administration. For some nutrients that are not readily stored in the body or that cannot be stored in large amounts, timing of administration may also be important. For example, amino acids cannot be used for protein synthesis if they are not supplied together intravenously; instead, they will be used for energy production. In contrast, among healthy individuals eating adequate diets, the distribution of protein intake over the course of the day has little effect on health.

Disease Dietary deficiency diseases include protein-calorie malnutrition, iron-deficiency anemia, goiter (due to iodine deficiency), rickets and osteomalacia (vitamin D deficiency), xerophthalmia (vitamin A deficiency), megaloblastic anemia (vitamin B12 or folic acid deficiency), scurvy (vitamin C/ascorbic acid deficiency), beriberi (thiamin deficiency), and pellagra (niacin and tryptophan deficiency) (Chaps. 344 and 345). Each deficiency disease is characterized by imbalances at the cellular level between the supply of nutrients or energy and the body's nutritional needs for

growth, maintenance, and other functions. Imbalances and excesses in nutrient intakes are recognized as risk factors for certain chronic degenerative diseases, such as saturated/trans-fat and cholesterol in coronary artery disease; sodium in hypertension; obesity in hormone-dependent cancers (endometrial and breast); and ethanol in alcohol addiction. These disorders are multifactorial in their etiology and pathogenesis, and diet is only one of the many risk factors for their occurrence. Osteoporosis, for example, is sometimes associated with calcium deficiency secondary to vitamin D deficiency, as well as with environment-related risk factors (e.g., smoking, sedentary lifestyle), physiology (e.g., estrogen deficiency), genetic determinants (e.g., defects in collagen metabolism), and drug use (chronic steroids and aromatase inhibitors) (Chap. 423). ■

■ **DIETARY ASSESSMENT** Nutrition assessment in clinical situations is an iterative process involving screening for malnutrition risk; assessing the diet and other biomarkers to determine if malnutrition is present and if so its possible causes; planning and implementing appropriate dietary intakes and medical nutrition therapy; and reassessing to make sure that intakes have been consumed.

Disease states affecting the bioavailability, requirements, use, or excretion of specific nutrients may require specific measurements of certain nutrients or their biomarkers to assess status and ensure that nutrient replacement is adequate (Chap. 344). The Joint Commission, which accredits and certifies health care organizations in the United States, requires most health care facilities to perform nutrition screening for identifying possible malnutrition risk within 24 h after hospital admission. However, a single universally recognized or validated standard is not used yet. The Global Leadership Initiative on Malnutrition (GLIM) proposes that in acute care settings a tool be used that evaluates weight loss, low body mass index (BMI), reduced muscle mass, reduced food intake or absorption, and increased disease burden or inflammation. Other screens usually include these and also abnormal weight for height or body mass index (e.g., BMI <19 or >25); reported weight change (involuntary loss or gain of >5 kg in the past 6 months) (Chap. 50); diagnoses with known nutritional implications (e.g., metabolic disease, any disease affecting the gastrointestinal tract, alcohol abuse); present therapeutic dietary prescription; chronic poor appetite; presence of dental, chewing, and swallowing problems; major food allergies or intolerances; need for assistance with preparing or shopping for food, eating, or other aspects of self-care; and social isolation. The nutritional status of hospitalized patients should be reassessed periodically—at least once every week. Patients who exhibit frank malnutrition or a high risk of it on nutritional screening need more complete dietary assessment that varies with the clinical setting, the severity of the patient's illness, and the stability of the patient's condition.

Acute-Care Settings The goal is to identify and avoid inadequate intake, assure intake is appropriate, and gather enough information to determine if malnutrition is due to poor dietary intake or other causes and whether nutritional therapy is indicated (Chap. 346). In acute-care settings, anorexia, various diseases, test procedures, and medications can further compromise dietary intake. Dietary assessment focuses on what patients are currently eating, whether or not they are able and willing to eat, and whether or not they experience any problems with eating. Simple observations may suffice to suggest inadequate oral intake. These include dietitians' and nurses' notes; observation of a patient's frequent refusal to eat or the amount of food served versus that eaten on trays; the frequent performance of tests and procedures that are likely to cause meals to be skipped; consumption

limited to nutritionally inadequate diet orders (e.g., clear liquids or full liquids) for more than a few days; the occurrence of fever, dehydration, gastrointestinal distress, vomiting, diarrhea, or a comatose state; and the presence of diseases or use of treatments that involve any part of the alimentary tract. Acutely ill patients with diet-related diseases such as diabetes and chronic renal

failure are in particular need of assessment because an inappropriate diet may exacerbate these conditions and adversely affect other therapies. Abnormal biochemical values (serum albumin levels <35 g/L [<3.5 mg/dL]; serum cholesterol levels <3.9 mmol/L [<150 mg/dL]) are nonspecific but may indicate a need for further nutritional assessment.

Most therapeutic diets offered in hospitals are calculated to meet individual nutrient requirements and the RDA if they are eaten. Exceptions include clear liquids, some full-liquid diets, and test diets (such as those adhered to in preparation for gastrointestinal procedures), which are inadequate in several nutrients and should not be used, if possible, for >24 h. However, because as much as half of the food served to hospitalized patients is not eaten, it cannot be assumed that the intakes of hospitalized patients are adequate. Dietary assessment should compare how much and what kinds of food the patient has consumed with the diet that has been provided. Major deviations in intakes of energy, protein, fluids, or other nutrients of special concern for the patient's illness should be noted and corrected, especially for long-staying patients. Nutritional monitoring is especially important for patients who are very ill, who have extended lengths of hospital stay, or who are discharged home with diagnoses involving the gastrointestinal tract, end-stage renal disease, and insulin-dependent diabetes. Patients who are fed by enteral and parenteral routes and those receiving home chemotherapy infusions also require special nutritional assessment and monitoring by physicians and/or dietitians with certification in nutritional support (Chap. 346).

CHAPTER 343 Ambulatory Settings

The aim of dietary assessment in the out patient setting is to determine whether or not the patient's usual diet is a health risk in itself, if it contributes to existing chronic disease-related problems, and if medical nutrition therapy is required. The information is used to plan an eating pattern that fulfills therapeutic goals while ensuring patient adherence. Dietary assessment should review the adequacy of present and usual food intakes, including vitamin and mineral supplements, oral nutritional supplements, medical foods, other dietary supplements, medications, and alcohol, because all of these may affect the patient's nutritional status. Assessment should focus on the dietary constituents that are most likely to be involved or compromised by the specific diagnosis as well as on any comorbidities that are present. A diet history of several days of intake or a food-frequency questionnaire can be used and reviewed to provide a representation of the usual diet and assess the adequacy of the patient's habitual diet. The Automated Self-Administered 24-Hour Dietary Assessment Tool (ASA24) (which is a web-based, self-administered, 24-h recall tool), a diet history questionnaire (DHQ), a daily food checklist, and validated short dietary instruments are all available at the National Institute of Health's National Cancer Institute webpage at <https://epi.grants.cancer.gov/dietary-assessment/resources.html>. The Nutritools interactive website (www.nutritools.org) guides clinicians and researchers to choose among suitable validated dietary assessment tools used in North America and elsewhere. Assessment findings are used to craft dietary recommendations for changes in healthier directions. These may be as simple as a food guide, a food-exchange list, or more personalized and detailed recommendations by a dietitian that are tailored to the patient's food preferences and medical nutrition therapy needs. Therapeutic dietary prescriptions and menu plans for most diseases are available in the diet manuals of most hospitals and from the Academy of Nutrition and Dietetics for many other diseases. For persons on therapeutic diets, counseling using food-exchange lists such as those available from the American Diabetes Association for diabetes and from the Academy of Nutrition and Dietetics or the National Kidney Foundation's Council on Renal Nutrition for renal disease is helpful. Patients who follow ethnic or unusual dietary

Nutrient Requirements and Dietary Assessment

TABLE 343-4 Choose My Plate: A Guide to Individualized

Dietary Planning EXAMPLES OF STANDARD PORTION SIZES AT INDICATED ENERGY LEVEL DIETARY FACTOR, UNIT OF MEASURE (ADVICE) LOWER:

1600 kcal MODERATE: 2200 kcal HIGHER: 2800 kcal Fruits, cups (Focus on fruits.) 1.5

2.5 Vegetables, cups (Vary vegetables.)

3.5 Grains, oz eq (Make at least half of grains whole.)^a

Protein foods, oz eq (Go lean with protein.)^b

Dairy, cups or oz^c (Choose calcium-rich foods.)

“Empty” calories, kcal^d

Sodium, mg <2300 at all energy levels Physical activity, min At least 150 min vigorous physical activity per week at all energy levels Note: Oils (formerly listed with portions of 5, 6, and 8 teaspoons for the lower, moderate, and higher energy levels, respectively) are no longer singled out in Choose My Plate, but rather are included in the empty calories/added sugar category with SOFAS (calories from solid fats and added sugars). The limit is the remaining number of calories in each food pattern above after intake of the recommended amounts of the nutrient-dense foods. ^aFor example, 1 serving equals 1 slice bread, 1 cup ready-to-eat cereal, or 0.5 cup cooked rice, pasta, or cooked cereal. ^bFor example, 1 serving equals 1 oz lean meat, poultry, or fish; 1 egg; 1 tablespoon peanut butter; 0.25 cup cooked dry beans; or 0.5 oz nuts or seeds. ^cFor example, 1 serving equals 1 cup milk or yogurt, 1.5 oz natural cheese, or 2 oz processed cheese. ^dFormerly called “discretionary calorie allowance.” Portions are calculated as the number of calories remaining after all of the above allotments are accounted for. Abbreviation: oz eq, ounce equivalent. Source: Data from U.S. Department of Agriculture (<http://www.Choosemyplate.gov>). PART 10 Disorders of the Gastrointestinal System patterns need extra instruction on how to categorize their foods and on the appropriate portion sizes that constitute a serving. For healthy persons who do not require medical nutrition therapy, a rough guide for avoiding inadequate nutrient intakes as well as excessive intakes of fat (especially saturated and trans fats), sodium, sugar, and alcohol is the USDA’s Choose My Plate (Table 343-4). The Choose My Plate graphic emphasizes a balance between calories and nutritional needs, encouraging increased intake of fruits and vegetables, whole grains, and low-fat milk in conjunction with reduced intake of sodium and high-calorie sugary drinks. The guide provides a web-based calculator that tailors the number of servings suggested for healthy people of different weights, sexes, ages, and life-cycle stages to meet their needs while avoiding excess (<https://www.myplate.gov/myplate-plan> and www.ChooseMyPlate.gov). Reviewing the guide with patients helps them identify food groups eaten in insufficient amounts or in excess and aids the transition to healthier dietary patterns. ■

■ **NUTRITIONAL STATUS ASSESSMENT** Full nutritional status assessment is reserved for seriously ill patients and those at very high nutritional risk when the cause of malnutrition is still uncertain after initial clinical evaluation and dietary assessment. It involves multiple dimensions, including documentation of dietary intake, health history, anthropometric measurements, biochemical measurements of blood and urine, clinical examination, and functional status evaluation. For

further discussion of nutritional assessment, see Chap. 345. ■ ■GLOBAL CONSIDERATIONS Several DRIs (e.g., the EAR, the UL, and energy needs) are estimates of physiologic requirements based on experimental evidence that apply globally to healthy individuals when adjusted for age, sex, body size, and physical activity level. However, the AIs, AMDRs, and CDRRs are not exportable and should be used with caution in other countries.

AIs for micronutrients are based on epidemiologic observations of customary and adequate intakes in healthy U.S. and Canadian populations. The AMDRs are not based on direct experimental evidence but represent expert opinion on potentially healthy intakes of energy-providing nutrients in North American populations. The CDRR may also vary in other populations. Nutrient-based standards like the DRIs have also been developed by the World Health Organization/ Food and Agricultural Organization of the United Nations. They are available at <https://www.who.int/activities/establishing-global-nutrientrequirements>. The European Food Safety Authority (EFSA) Panel on Dietetic Products, Nutrition, and Allergies periodically publishes its recommendations in the EFSA Journal (<https://efsa.onlinelibrary.wiley.com/journal/18314732>). Other countries have also promulgated recommendations similar to the DRI. The different standards have many similarities in their basic concepts, definitions, and nutrient recommendation levels, but some differ from the DRIs as a result of the functional criteria chosen for nutrient requirements, environmental differences, the timeliness of the evidence reviewed, and expert judgment. There is a growing trend toward global harmonization of these recommendations.

DISCLAIMER The opinions expressed in this article are the author's own and do not reflect the views of the National Institutes of Health, the U.S. Department of Health and Human Services, or the U.S. government. ■ ■FURTHER READING Alves LF et al: GLIM criteria to identify malnutrition in patients in hospital settings: A systematic review. *J Parenteral Enteral Nutr* 47:702, 2023. Lewis JL, Dwyer JT: Establishing nutrient intake values, in *Present Knowledge in Nutrition, Vol 2*. BP Marriott, DF Birt, VA Stallings, AA Yates, eds. London, Academic Press, 2020, pp 267–289. National Academy of Sciences, Engineering, and Medicine: *Guiding Principles for Developing Dietary Reference Intakes Based on Chronic Disease*. Washington, DC, National Academies Press, 2017. National Academy of Sciences, Engineering, and Medicine: *Dietary Reference Intakes for Sodium and Potassium*. Washington, DC, National Academies Press, 2019. National Academy of Sciences, Engineering, and Medicine: *Harmonizing the Process for Establishing Nutrient Reference Values: A Tool Kit*. Washington, DC, National Academies Press, 2020. National Academy of Sciences, Engineering, and Medicine: *Nutrition During Pregnancy and Lactation: Exploring New Evidence: Proceedings of a Workshop—in Brief*. Washington, DC, National Academies Press, 2020. National Academy of Sciences, Engineering, and Medicine: *Approaches to assessing intake of food and dietary supplements in pregnant women and children 2 to 11 years of age: Proceedings of a workshop series*. Washington, DC, National Academies Press, 2022. National Academy of Sciences, Engineering, and Medicine: *Defining populations for Dietary Reference Intake recommendations: A letter report*. Washington, DC, National Academies Press, 2022. National Academy of Sciences, Engineering, and Medicine: *Assessing intake of food and dietary supplements in older adults: Proceedings of a workshop series*. Washington, DC, National Academies Press, 2023. National Academy of Sciences, Engineering, and Medicine: *Dietary Reference Intakes for Energy*. Washington, DC, National Academies Press, 2023. National Academy of Sciences, Engineering, and Medicine: *Using systematic reviews to support future Dietary Reference Intakes: A letter report*. Washington, DC, National Academies Press, 2023. US Department of Agriculture and U.S. Department of Health and Human Services: *Dietary Guidelines for Americans, 2020–2025*, 9th ed. Washington, DC, US Government Printing Office, 2020.

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