10

Nutrition in the Later Years

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Introduction

This section incorporates some nutritional concepts that are described in more detail in the sections on cardiovascular disease, cancer, skeletal disorders, neuropsychiatric disorders (cognitive), and the adult diet. Information will be provided on the varying problems of the successful and healthy free-living older adults and domiciled elderly, the very old (>85 years), and the old old (centenarians).

Background

The elderly are the fastest growing segment of the U.S. population (see below). It is projected that the number of institutionalized elderly will triple in the next few decades, and the number of people over 85 years of age (the very old) as a percent of the total population will quadruple. The nutritional needs and problems of these groups differ from those of their younger cohorts. Specific changes in lifestyle and physiology influence nutritional status. The prevalence of chronic disease increases with age, and the treatment of these diseases with drugs and diet have an additional impact on nutritional status. Dietary recommendations need to be designed for these people in order to obtain their compliance. Surveys have shown that in people over age 75, malnutrition affects 15% of outpatients, 50% of hospitalized patients, and 85% of institutionalized patients.[1]

The Biology of Aging

Aging is characterized by a gradual, cumulative loss in metabolic control. Homeostatic mechanisms that control body function gradually become less efficient. Physiologically

and biochemically, senescence occurs not in an orderly fashion but at unexpected times and with unanticipated events. Some of these events are predictable, but some are not. For example, the loss of ovarian function is predictable but its timing is not. There is considerable individual variation in the loss of menses among women. Some of the age-related loss in metabolic control can be explained by age-related accumulations of DNA mutations in both the nuclear and mitochondrial genome. Some of these mutations are diet responsive while others are not.

With age there are changes in DNA (base substitutions, deletions, aberrant repair) that result in functional loss in the activity of the gene product(s) the DNA encodes. Changes in the DNA (as well as some of the gene products) are biomarkers of aging.[2] Studies in animals have shown that lifelong food restriction results in a delay in the appearance of DNA aberrations as well as a delay in the changes in the activities of key enzymes. Food–restricted animals live longer than non-restricted animals that are kept under the same conditions, fed the same qualitative diet, and are of the same gender and genetic makeup.[3] The extrapolation of these findings in rats and mice to humans is questionable because of the nature of the experimental conditions used. The animals are genetically similar and they are protected from infectious agents. They are reared under conditions of carefully regulated environments that are temperature, humidity, and light controlled. The food is carefully prepared to contain all the needed nutrients, with the only constraint being the reduction in the energy supply. Humans do not exist under these conditions. They are randomly exposed to environmental insults, their food is seldom consistent from one day to the next, and their genetic backgrounds are highly variable. As social creatures we do not live singly in cages; we experience wars, economic duress, social upheavals, and so forth. Nonetheless, some of the observations in animals have been also made in humans. For example, normal aging in humans is characterized by an accumulation of deletions in mitochondrial DNA in various tissues.[4] This may result from free radical attack on the genome, and may be ameliorated by antioxidants.[5]

Age has a profound effect on membrane saturation and fluidity.[6] An age-related decline in membrane-associated reactions or pathways occurs, independent of changes in the diet or the hormonal milieu. The efficiency of oxidative phosphorylation declines with age (Table 10.1). Mitochondrial damage and loss of function occurs, in part related to increased formation of superoxide and other free radicals.

With age, the efficiency of transmission of hormone and secondary messenger communications decreases (Table 10.2). This is due to numerous structural and functional changes in the endocrine glands, a decline in gene expression, and in the accuracy and efficiency of protein synthesis. The hormones affected regulate the metabolism of carbohydrates, lipid, and protein. The progressive changes in the mitochondria and in gene expression lead to progressive loss in the tight control of intermediary metabolism (Table 10.1). This is coupled with age-related changes in the endocrine and central nervous systems.

Mortality and Aging Statistics

The leading causes of death in the U.S. in 1980 and 1996 are listed in Table 10.3.[7] Over this period the three leading causes of death remain: cardiovascular, neoplastic, and cerebrovascular disease. Chronic obstructive pulmonary disease currently exceeds injuries, followed by diabetes mellitus, human immunodeficiency virus (HIV) infection (not listed in 1980), suicide, and chronic liver diseases. Table 10.4 lists the death rates for 1996.[8] Many

TABLE 10.1

Effects of Age on Intermediary Metabolism and Its Control

Pathway	Control Points	Effects of Age[a]
Glycolysis	Transport of glucose into the cell (mobile glucose transporter)	↓
	Glucokinase	↓
	Phosphofructokinase	↓
	α-Glycerophosphate shuttle	
	Redox state, phosphorylation state	
Pentose phosphate shunt	Glucose-6-phosphate dehydrogenase	↓
	6-phosphogluconate dehydrogenase	↓
Glycogenesis	Stimulated by insulin and glucose	ND
	High-phosphorylation state (ratio of ATP to ADP)	ND
Glycogenolysis	Stimulated by catecholamines	ND
Lipogenesis	Stimulated by insulin	
	Acetyl-CoA carboxylase	
	High-phosphorylation state	
	Malate citrate shuttle	↓
Gluconeogenesis	Stimulated by epinephrine	
	Malate aspartate shuttle	↓
	Redox state	↑
	Phosphoenopyruvate carboxykinase	↓
	Pyruvate kinase	
Cholesterogenesis	HMG CoA reductase	
Ureogenesis	Carbamyl phosphate synthesis	↑,↓
	ATP	ND
Citric acid cycle	All three shuttles	
	Phosphorylation state	↓
Lipolysis	Lipoprotein lipase	↓
Respiration	ADP influx into the mitochondria	↓
	Ca^{2+} flux	
	Shuttle activities	↓
	Substrate transporters	↓
Oxidative phosphorylation	ADP-ATP exchange	↓
	Ca^{2+} ion	
Protein synthesis	Accuracy of gene transcription	↓
	Availability of amino acids	↓
	ATP	↓

[a] ↑ — increased as the animal ages; ↓ — decreased as the animal ages; ND — no data.

From Berdanier, C.D., *Advanced Nutrition: Macronutrients,* 2nd ed., CRC Press, Boca Raton, 2000, pg. 252. With permission.

TABLE 10.2

Hormone Changes with Age

Hormone	Age Effects
Serum thyroxine (T_4)	↓
Serum triiodothyronine (T_1)	↓
Thyroid-binding globulin	No change or ↑
Thyroid-stimulating hormone	↓
Insulin	↑ followed by ↓
ACTH	↓
Epinephrine	↓
Glucagon	↓
Growth hormone	↓
Estrogen	↓
Testosterone	↓
Cortisol (glucocorticoids)	↓
Pancreatic polypeptide	↑

Note: ↑ — increase; ↓ — decrease.

From Berdanier, C.D., *Advanced Nutrition: Macronutrients,* 2nd ed., CRC Press, Boca Raton, 2000, pg. 250. With permission.

TABLE 10.3

Leading Causes of Death and Numbers of Deaths, According to Sex and Race, United States, 1996

Sex, Race, and Rank Order	Cause of Death	Deaths
All Persons		
	All causes	2,314,690
1	Diseases of heart	733,381
2	Malignant neoplasms	539,633
3	Cerebrovascular diseases	159,942
4	Chronic obstructive pulmonary diseases	106,027
5	Unintentional injuries	94,948
6	Pneumonia and influenza	83,727
7	Diabetes mellitus	61,767
8	Human immunodeficiency virus infection	31,130
9	Suicide	30,903
10	Chronic liver disease and cirrhosis	26,047
Male		
	All causes	1,163,569
1	Diseases of heart	360,075
2	Malignant neoplasms	281,898
3	Cerebrovascular diseases	62,475
4	Unintentional injuries	61,589
5	Chronic obstructive pulmonary diseases	54,485
6	Pneumonia and influenza	37,991
7	Diabetes mellitus	27,648
8	Human immunodeficiency virus infection	25,277
9	Suicide	24,998
10	Chronic liver disease and cirrhosis	16,311
Female		
	All causes	1,151,121
1	Diseases of heart	373,286
2	Malignant neoplasms	257,635
3	Cerebrovascular diseases	97,467
4	Chronic obstructive pulmonary diseases	61,642
5	Pneumonia and influenza	45,736
6	Diabetes mellitus	34,121
7	Unintentional injuries	33,359
8	Alzheimer's disease	14,426
9	Nephritis, nephrotic syndrome, and nephrosis	12,662
10	Septicemia	12,177
White		
	All causes	1,992,966
1	Diseases of heart	645,614
2	Malignant neoplasms	489,406
3	Cerebrovascular diseases	138,296
4	Chronic obstructive pulmonary diseases	97,889
5	Unintentional injuries	79,405
6	Pneumonia and influenza	74,194
7	Diabetes mellitus	49,511
8	Suicide	27,856
9	Chronic liver disease and cirrhosis	21,422
10	Alzheimer's disease	20,198

TABLE 10.3 *(Continued)*

Leading Causes of Death and Numbers of Deaths, According to Sex and Race, United States, 1996

Sex, Race, and Rank Order	Cause of Death	Deaths
Black		
	All causes	282,089
1	Diseases of heart	77,841
2	Malignant neoplasms	60,766
3	Cerebrovascular diseases	18,481
4	Human immunodeficiency virus infection	13,997
5	Unintentional injuries	12,656
6	Diabetes mellitus	10,800
7	Homicide and legal intervention	9,983
8	Pneumonia and influenza	7,963
9	Chronic obstructive pulmonary diseases	6,924
10	Certain conditions originating in the perinatal period	4,711

Data based on the National Vital Statistics System, taken from Table 33, *Health*, United States, 1998, page 212.

TABLE 10.4

Leading Causes of Death in the United States, Death Rates and Age-Adjusted Death Rates, 1996

Rank[1]	Cause of Death	% of Total Deaths	Rate/100,000 Population	Age-Adjusted Rate
1	Heart diseases	31.6	276.6	134.6
2	Cancers	23.4	205.2	129.1
3	Stroke	6.9	60.5	26.5
4	Lung diseases	4.5	40.0	21.0
5	Accidents[2]	4.0	35.4	30.1
6	Pneumonia and flu	3.5	31.1	12.6
7	Diabetes mellitus	2.6	23.2	13.6
8	AIDS	1.4	12.3	11.6
9	Suicide	1.3	—	10.8
10	Liver disease	1.1	11.6	7.5
11	Renal diseases	1.1	9.5	4.3
12	Infections	0.9	9.2	4.1

[1] Based on the total number of deaths in 1996 (2,322,421). These 12 causes account for 82.3% of the total.

[2] The preferred term is unintentional death. It includes motor vehicle-related deaths.

Taken from *Morbidity and Mortality Weekly Report*, U.S. Department of Health and Human Services, Vol. 46, Oct. 10, 1997.

of these disorders are nutrition-related in their etiology or treatment, and are discussed in individual sections in this handbook.

These mortality statistics are relatively similar for men and women, with striking differences seen only in the higher prevalence of Alzheimer's disease, renal disease, and septicemia appearing for women, and HIV, suicide, and liver disease replacing these in men.

Life expectancy at birth is expected to exceed 80 years in the first century of this millennium, up from 49 years in 1900. The proportion of people in the U.S. over age 65 increased by 89% between 1960 and 1990, and over age 84 by 232%. The number of centenarians in the U.S. has increased eightfold from 1950 (4447) 1990 (35,808).[9]

Lifestyle and Socioeconomic Changes Affecting the Nutritional Status of the Elderly

Changes with aging include:[10]

- Reduced income with retirement
- Insufficient funds for purchase of food
- Skipping meals
- Illness and increased medical expenses
- Loss of mobility
- Diminished acuity in sensory perceptions (hearing, vision, taste)
- Inability to drive to doctor's appointments or to the grocery store
- Inability to prepare or store food
- Loss of balance
- Diminished self-esteem
- Social isolation

Diseases that are common in the elderly and impact on their nutritional status include:

- Senile dementia of the Alzheimer's type, with cognitive impairment and memory loss
- Arthritis, with limited mobility of joints, and deformities
- Osteopenia, with fractures and deformities
- Parkinson's disease, with rigidity and tremor
- Dental and oral health problems — problems with chewing
- Gastrointestinal disorders — swallowing difficulties
- Neoplasms, with hypercatabolism, anorexia, and cachexia
- Diabetes mellitus, with restrictive diets and medication interactions
- Renal insufficiency, with restrictive diets and dialysis treatment
- Paralysis, limiting mobility
- Depression, leading to anorexia

Some deterioration in mental function may be attributable to malnutrition of protein, energy, and vitamins and/or minerals, either primary or secondary to disease. These aspects are discussed in the sections on the nutrients and the diseases.

A survey of the elderly in South Carolina in 1990[10] showed that 20% skip meals, 33% live alone, 45% use multiple prescription medications. Half of those over 85 years of age are dependent or disabled; 10% over age 65 are cognitively impaired, with 25% so impaired over age 85. Indicators of poor nutritional status were:

- <80% of desirable weight for age
- <10th percentile for triceps skinfold thickness or midarm muscle circumference
- Weight loss >5%/month or 10% loss in 6 months; involuntary weight loss

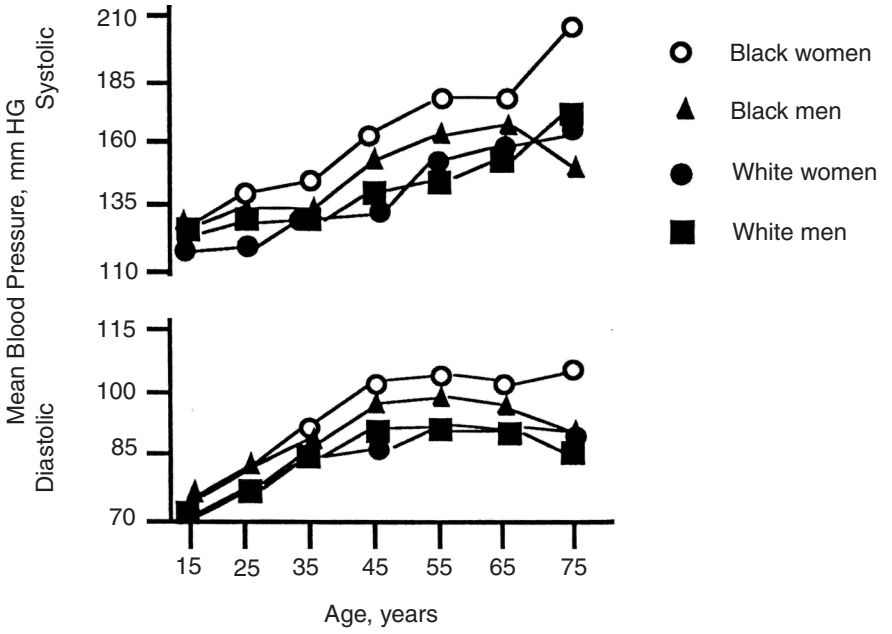

FIGURE 10.1
The change in blood pressure with age. The ordinate represents mean blood pressure, with the upper curves depicting systolic blood pressure and the lower curves diastolic pressure. The circles represent black women, the triangles represent black men, the filled circles represent white women, and the squares represent white men. From Feldman, E.B., *Nutrition in the Middle and Later Years*, Wright-PSG, Littleton, MA, 1983. Data are adapted from Hames, C.G., *Postgrad Med*, 56: 110; 1974, with permission.

- Osteoporosis
- Anemia

Pathophysiology of Aging

The changes with aging and old age that may be nutrition related and/or diet responsive include:

- Blood pressure (Figure 10.1)[11,12] — Both systolic and diastolic blood pressure increase with age, so beyond age 50 half of the population has hypertension. In the Southeast, this is especially prevalent in African-American women.[12] A variety of nutrients affect blood pressure, including energy, sodium, potassium, calcium, magnesium, selenium, lipids, protein, and vitamin C. Consumption of fruits and vegetables (10 servings a day) lowered blood pressure significantly.[13] While the role of sodium has been questioned, recent trials show a beneficial effect of sodium restriction even in the presence of other successful non-pharmacologic interventions.[14]
- Blood lipids — Genetics and lifestyle (diet, exercise) interact to influence the concentration and composition of blood lipids and lipoproteins. To date, there is no convincing evidence that risk factors for cardiovascular disease differ in the elderly, although their impact may differ because of changes in vasculature.

Neither homocysteine levels in relation to age nor the regulation of homocysteine by B vitamins have been adequately studied.[15] Stroke is more common in older adults, and nutrients that affect thrombosis and blood clotting are important in the management of these risk factors. (See section on Cardiovascular Risk.)

- The incidence of cancer and the decline in the immune system with aging may be influenced by many nutrients. Whether advice about diet (plant-based, avoidance of certain foods/nutrients or cooking methods) is equally applicable to the elderly is not known. (See section on Cancer Prevention.)
- Bone density — Bone density declines with aging in women and men, beginning in women around the perimenopausal years, and decades later in men. Bone mineralization is related to the intakes of calcium, vitamin D, and other nutrients, as well as to activity level and alcohol intake. Evaluation with appropriate tests should be part of the geriatric assessment. Women, especially, should be encouraged to achieve a maximum bone density through adequate intake of calcium and physical activity. The greater the bone density at peak, the less serious the effect of estrogen loss that is associated with decreased bone density. Problems with bone and cartilage are being addressed with dietary supplements like glucosamine that are under evaluation. Fish oils and polyunsaturated fatty acids also may be of benefit in various types of arthritis.[16]
- Significant memory loss is not a necessary accompaniment of aging. Nutritional interventions in patients with senile dementia of the Alzheimer type may either ameliorate or slow the progress of the disease, or, more likely, improve the patient's general nutritional status and function.
- The immune system shows impairment, particularly of cellular immunity, and may be improved with B_6, vitamin E, or selenium.[17]

The Geriatric Assessment

Nutrition screening should be part of the geriatric assessment.[18] The clinical nutritional assessment of adults is detailed in the Assessment section. The elderly are a heterogeneous population, so no assumptions should be made about individuals.

Particular attention should be paid to the intake of medications. Polypharmacy is common in the elderly and may lead to drug-nutrient interactions that affect the efficacy and safety of the medication as well as the nutritional status of the patient. Among these are:

- Thiazide diuretics for the management of hypertension. These drugs increase the loss of potassium.
- Antidepressants used for mood management. These drugs may induce dry mouth, altered taste, nausea, vomiting, constipation, and/or reduced appetite.
- Chronic antacids and laxative use (preoccupation with need to have a daily bowel movement) can result in chronic diarrhea and electrolyte imbalance.
- Anti-inflammatory preparations used to relieve muscle or joint pain. These drugs may induce iron-deficiency anemia.
- An annual involuntary weight loss of 4% is a cutpoint that affects 13% of individuals over age 65 whose 2-year mortality is doubled versus weight-stable individuals.[1]

The RDAs for the Elderly

The most recent revisions of the Recommended Dietary Allowances, including the new Dietary Reference Intake values, have added a category for the elderly. Values have been set for males and females for calcium, phosphorus, magnesium, vitamin D, fluoride, thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin, and choline. Values for vitamin D have been increased because of concern about deficient intake, decreased metabolism, and the prevalence of bone disease in the elderly (see section on Skeletal Diseases). More recently, values were set for vitamins C and E and selenium for those over 70 years of age (Table of DRIs). The remaining RDAs and the recommendations for intake of essential nutrients dating from 1989 (vitamin A, macronutrients, some trace minerals) are under revision and may set new values for males and females >70 years of age.

A Food Pyramid for those over 70 years of age has been developed by Tufts University nutritionists (Figure 10.2). In contrast to the original Food Pyramid (Section 11), the need for water forms the base of the pyramid for the elderly, while the number of servings in the various food groups has been modified downward, and supplements of calcium, vitamin D, and vitamin B_{12} are recommended.[19]

Body Composition and Aging

Changes in body composition with aging (Figure 10.3) include an increase in the percent of body fat and a decrease in lean body mass.[20] These changes are associated with an age-related decline in metabolic rate and with a quantitatively greater decline in energy expenditure from physical activity[21] (Figure 10.4).

The fat mass in untrained older men (age 69) was significantly higher than in younger subjects (age 31) and correlated negatively with plasma IGF-1 levels. Older trained subjects had a similar fat mass to untrained younger subjects. The lean body mass (skeletal muscle) was lower in older than in younger untrained men, but older trained men did not differ from similarly trained younger men.[22] Investigators have experimented with the use of growth hormone to lessen age-related changes in body composition, with encouraging results.[23] A study in men age 61 to 81 years showed that injections of human growth hormone given over 6 months increased low levels of IGF-1 to the higher levels of the youthful. Lean body mass increased 9%, and fat mass decreased 14%. Data, however, are inadequate to recommend a costly and potentially toxic therapy that is administered by injection.

Nutrient Requirements and Aging

For many nutrients, requirements in the older adult relate more to gender and body size than age. Important changes (increased or decreased need) in a number of nutrients, however, include energy, vitamins B_{12}, D, and calcium.[1]

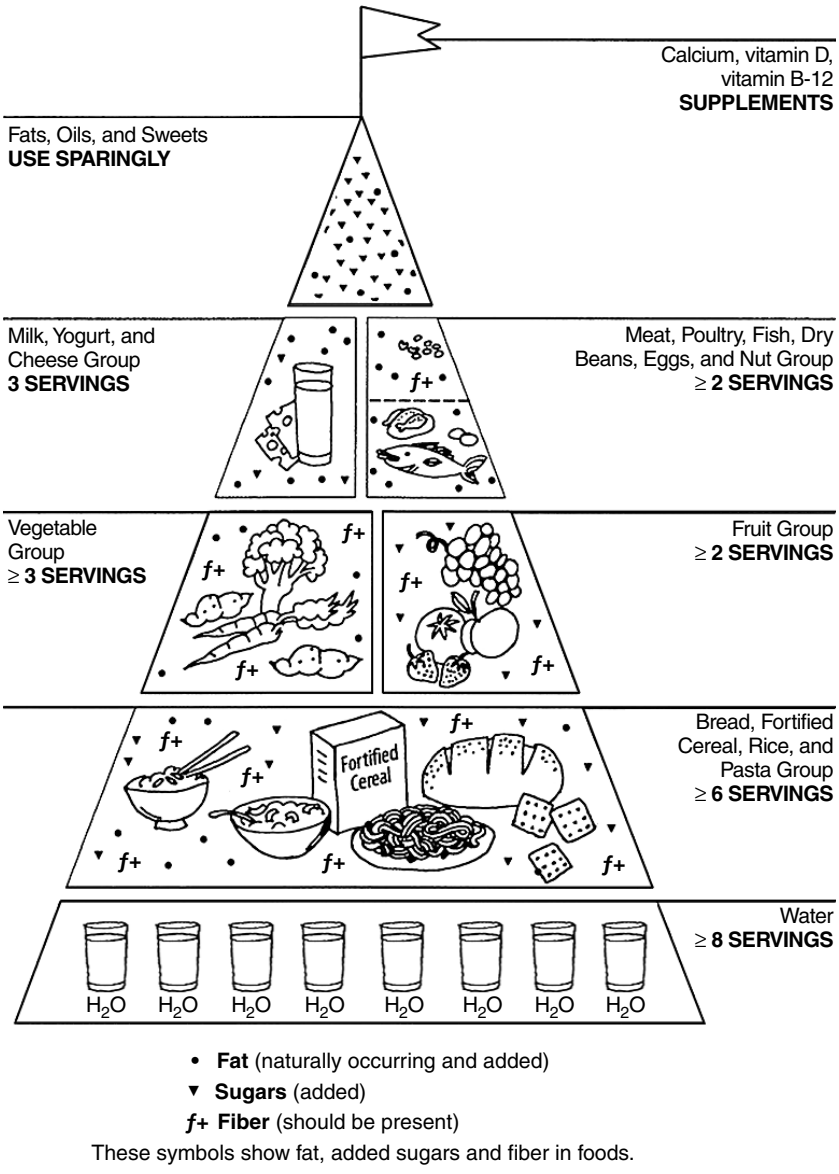

FIGURE 10.2
The Food Pyramid modified for adults 70 years of age and older. From Russell, R.M., Rasmussen, H., and Lichtenstein, A.H. *J. Nutr.* 129: 156; 1999, with permission.

Energy

The decrease with age in the whole body basal metabolic rate (Figure 10.4) is especially pronounced in the cells of the brain, skeletal muscle, and heart that are major contributors to the resting energy expenditure. In combination with the decline in physical activity, overall energy consumption declines on average 10% per decade after age 60. In men between age 28 and 80, energy intake declines by 600 kcal.[21] Women have a lower metabolic rate than men, independent of body size. The resting metabolic rate in women declines

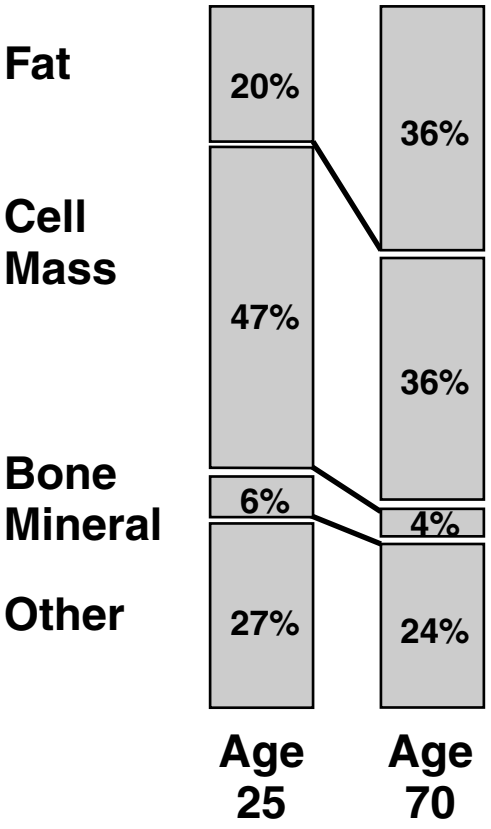

FIGURE 10.3
The age-related change in body composition in men. From Feldman, E.B., *Essentials of Clinical Nutrition*, F.A. Davis, Philadelphia, 1988, with permission.

4% per decade between age 50 and 80, with an increased downward slope after menopause compared to a nonsignificant decline before age 50.[24]

The decline in basal/resting metabolic rate can be lessened somewhat by increased physical activity (Figure 10.5). A combination of strength training and moderate aerobic exercise, e.g., 30 minutes/day or walking 10 to 12 miles per week, can increase the resting metabolic rate by 10%.[25]

Voluntary expenditure can increase significantly with physical activity. An increase in energy expenditure by physical activity in an exercise program will have beneficial effects, improving glucose uptake and metabolism by tissues (Figure 10.6), thereby normalizing glucose tolerance.[26] Studies used the insulin clamp technique and showed no difference in glucose uptake in healthy persons age 21 to 53 years, with significantly lower values in persons over 54 years of age. The relative drop in muscle mass in older subjects may be responsible for this difference.

Fat stores in older men and women can be reduced towards those of younger individuals (Figure 10.7) with an increase in lean body mass.[27] Studies showed that the proportion of body fat was significantly less in 67-year-olds who exercised regularly than in age-matched sedentary controls. The loss of aerobic capacity with aging can be attenuated by 50% with a regular exercise program (Figure 10.8).[27] The maximal aerobic capacity of physically active older subjects was significantly greater than that of persons of comparable age and

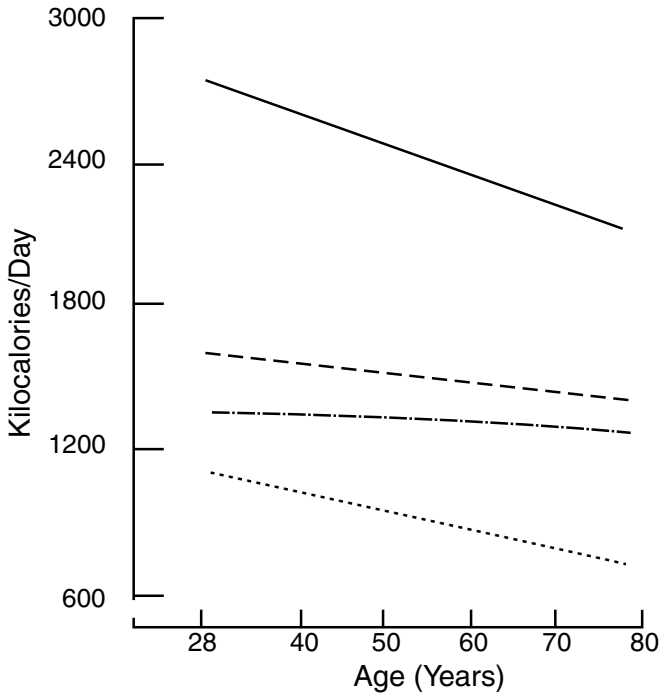

FIGURE 10.4
Energy expenditure and aging. The solid line represents energy expenditure in men, the dashed line indicates basal expenditure in men, the dotted line shows energy expended for activity in men. The resting metabolic rate in women is the dot/dash line. The resting metabolic rate in kcal/minute is the ordinate and age in years is the abscissa. Adapted from Feldman, E.B., In: *Essentials of Clinical Nutrition,* F.A. Davis, Philadelphia, 1988, ch. 9 and Rudman, D., Feller, A.G., Nagrai, H.S., et al. *N Engl J Med,* 323: 11; 1991.

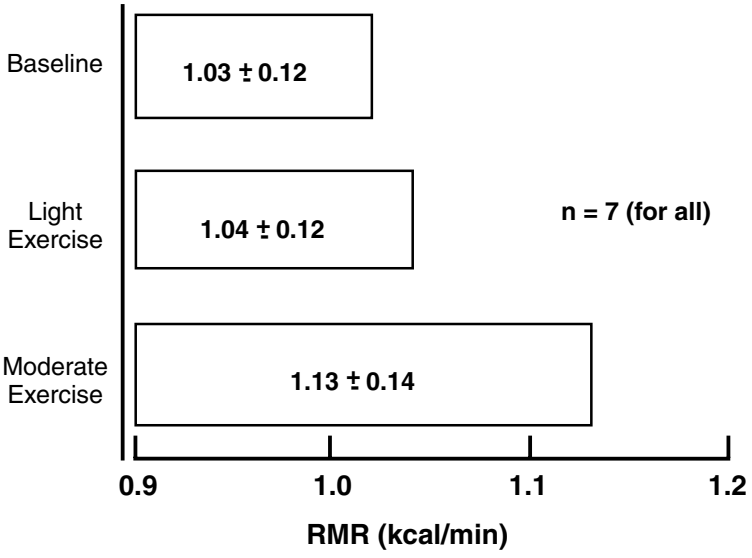

FIGURE 10.5
Exercise and the resting metabolic rate in older persons. The length of the top bar represents the resting metabolic rate in kcalories/minute. The upper bar is the control, the middle bar shows effects of light exercise, and the lowest bar shows the effect of moderate exercise. Adapted from Poehlman, E.T., Gardner, A.W., Goran, M.I., *Betabolism,* 41: 041; 1992.

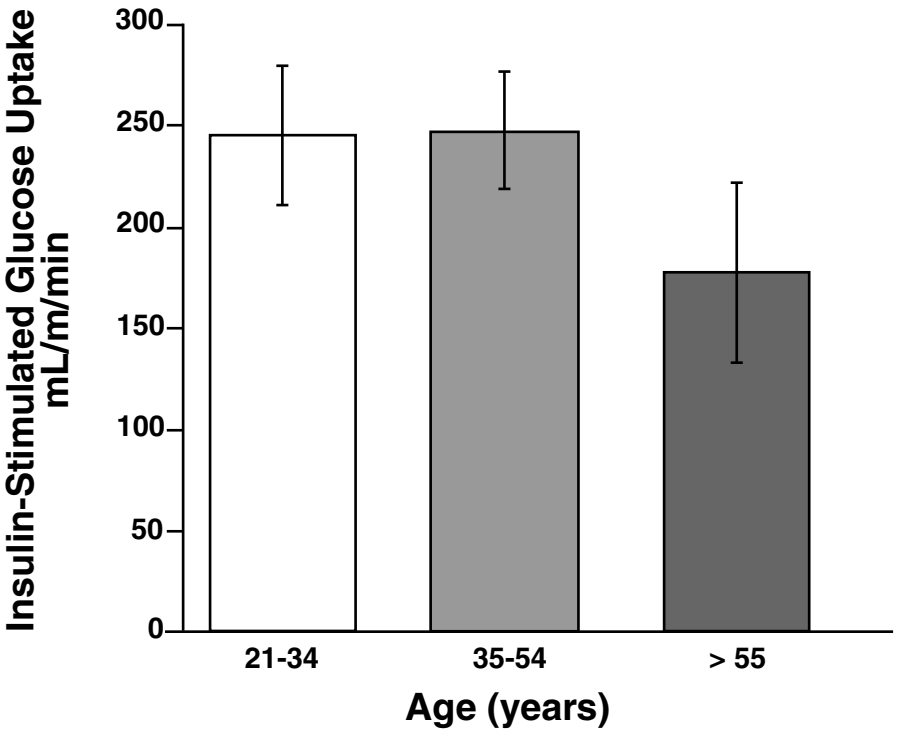

FIGURE 10.6
The effect of age on glucose uptake. The height of the bar represents the mean insulin-stimulated glucose uptake. The error bars represent 2.5 standard deviations from the mean. The lesser glucose uptake in those over age 55 differs significantly from the other two age groups ($p<0.01$). Adapted from Rosenthal, M., Doberne, L., Greenfield, M., et al. *J. Am. Geriatr. Soc.* 30: 562; 1982.

BMI who did not exercise regularly, and was similar to that of young subjects who did not exercise regularly.

An exercise program is important to prevent or limit obesity, diabetes mellitus, and increases in blood pressure, lessen bone loss, and provide a favorable blood lipid profile, increasing HDL-cholesterol and decreasing triglycerides.

To compensate for decreased energy requirements and prevent excessive weight gain, overweight, and obesity, the energy intake of the elderly usually needs to decrease. Older subjects who limit their energy intake, however, must consume more nutrient-dense foods in order to meet protein and micronutrient needs. They should limit their intakes of energy-dense foods such as fats and sweets, and take in adequate amounts of protein-rich foods. A one-a-day multivitamin supplement designed for older adults may be indicated when decreased energy intake is prescribed.

Vitamin B_{12}

Vitamin B_{12} status in the elderly is impaired by achlorhydria and bacterial overgrowth that binds this vitamin, inhibiting absorption. Achlorhydria affects 10 to 30% of the geriatric population, and associated atrophic gastritis further decreases the absorption of vitamin B_{12} from food. The absorption of synthetic B_{12} is not adversely affected. This has led some nutritionists to recommend markedly increasing the level of oral intake for older adults from the RDA of 2.6 to 25 μg/day. This increased amount may be found in some

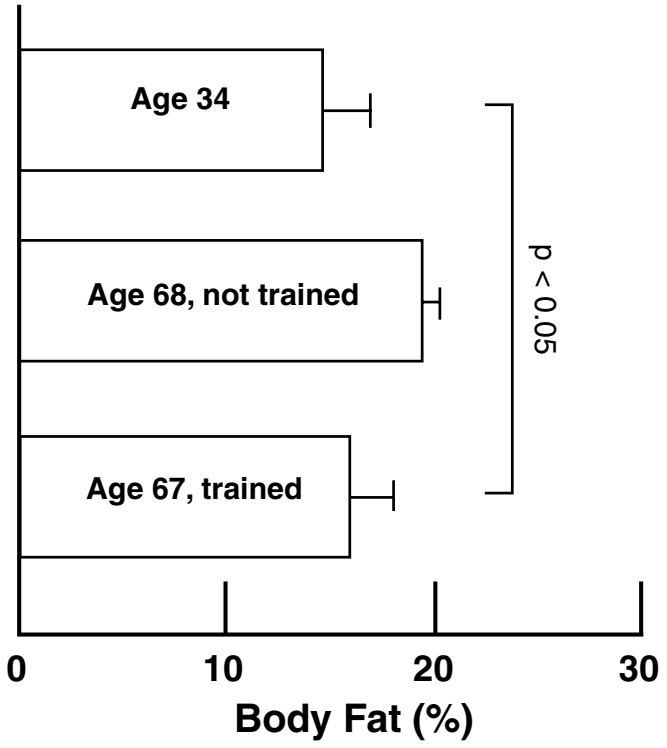

FIGURE 10.7
The effect of aging and physical training on body fat. The length of the top bar indicates values for % body fat in young people, the middle bar represents these values in old people, not physically trained, and the bar at the bottom represents the values in old people who are physically trained. Young people differ significantly from old untrained, and old physically trained differ from old untrained. Adapted from Hollenbeck, C. et al. *J. Am. Geriatr. Soc.* 33: 273; 1985.

vitamin supplements formulated for the older age group. The body's handling of vitamin B_{12} is reviewed in the section on Anemia.

Vitamin D

Vitamin D status in the elderly is impaired by multiple factors that decrease:

- Dietary intake
- Exposure to the sun
- Skin synthesis
- Hepatic and renal hydroxylation
- Receptors in the gastrointestinal tract
- Absorption

Skin synthesis of vitamin D by the elderly is only 30-40% of that of children and young adults.[28] The resulting decreases in vitamin D stores in the body lead to an increase in parathyroid hormone and an increase in bone remodeling and bone loss. These factors are discussed in the section on Skeletal Disorders.

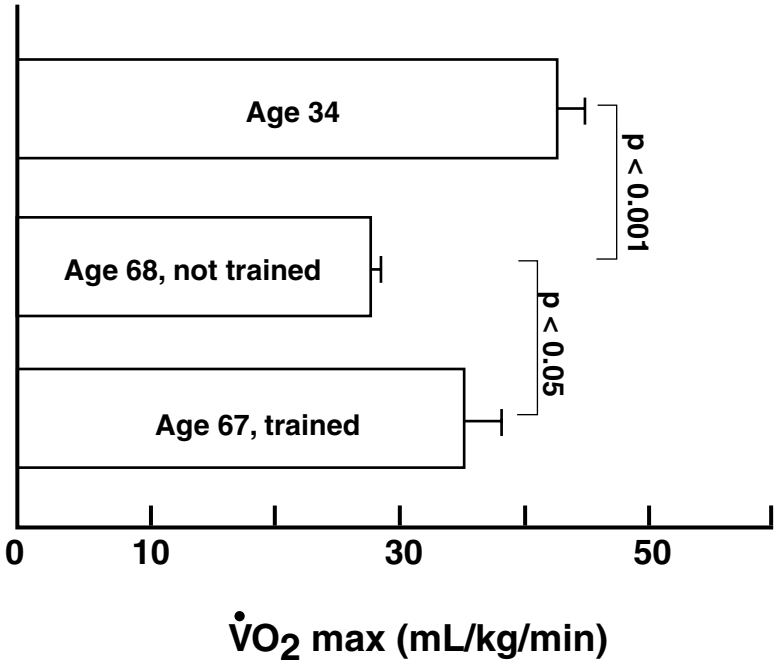

FIGURE 10.8
The effect of aging and physical training on aerobic capacity. The length of the top bar indicates values for maximum oxygen consumption in young people. The middle bar represents these values in old persons not physically trained, and lowest the bar represents the values in old people who are physically trained. Young people differ significantly from old untrained, and old physically trained differ from old untrained. Adapted from Hollenbeck, C. et al. *J. Am. Geriatr. Soc.* 33: 273; 1985.

Multivitamin/Mineral Supplement

A daily multivitamin supplement suitable for the older age group may be indicated to meet general micronutrient needs (vitamins, minerals). This is especially true for small, old people, and whenever energy intake to meet energy expenditure is less than 1300 kcal/day.

Anorexia in the Elderly

Anorexia and weight loss are common in the elderly, especially in patients suffering from medical or mental illness.[29] With normal aging, men and women may decrease their energy intake as they are less active physically and as their resting metabolic rate declines (Figure 10.4). The feeding drive (hunger) may decrease, and satiety may occur more readily. This physiological change with aging, however, may be the precursor of pathological anorexia and weight loss that most commonly is due to depression. Physiological and disease-related anorexia may be mediated by changes in a variety of hormones or cytokines. In order to prevent cachexia, with resultant morbidity and mortality, early recognition by nutritional screening, and aggressive management is needed. Management can include

the use of enteral supplements and, if necessary, tube feedings or parenteral nutrition. The underlying medical or psychiatric disorder must also be diagnosed and treated.

Various interventions have been proposed to improve appetite and metabolism in the elderly. Among these is the use of growth hormone supplements. Growth hormone has been shown to have some favorable effects on function, yet it is not without risk and is quite expensive.[23]

Other studies in men comparing subjects with average ages 24 and 70 years showed that aging may be associated with a significant impairment in the ability to control food intake following overeating or undereating. These findings may explain the vulnerability of older persons to unexplained weight loss.[30]

Nutritional Deficiencies in the Elderly

Various recent surveys have shown that 40% of the aged have intakes lower than two-thirds of the RDA for energy and that intakes of calcium, iron, vitamins A, E, and D, water soluble vitamins, and zinc are low.[1] Deficient intakes are especially prevalent in some ethnic groups and older individuals with low income. Osteopenia and iron deficiency anemia are common, and are discussed in the respective sections of this handbook.

Homebound and Institutionalized Elderly

Malnutrition is common in elderly nursing home residents. Of special concern are intakes of calcium, vitamin A, thiamin, riboflavin, and iron. Recommendations to decrease this prevalence include improving the eating environment, searching for early signs of undernutrition, finding treatable causes of poor food intake (depression, dental problems) with appropriate modifications of the diet, and controlling infection.[31] Predictors or mortality within six months were low levels of hemoglobin, cholesterol, and albumin. Socialization improves eating behavior. Spacing meals at five-hour intervals, using multiple smaller meals and snacks, providing a good breakfast, having food at the proper temperature, and attention to adequate light all can improve food intake and meal enjoyment.[32]

Congregate and home delivery feeding programs are crucial for homebound elderly. Water is a major concern in nursing home subjects. Thirst mechanisms are impaired in many elderly, and water needs to be provided and intake insured, especially in hot climates and in hot weather.

Patients should not be over-sedated and should be encouraged to be active, even if bed- or chair-bound. A study of frail, institutionalized 90-year-olds showed that high-resistance weight training lead to significant gains in muscle strength, size, and functional mobility.[33]

The Hospitalized Patient

The severity of nutritional deficits correlates with increased risk of subsequent morbid events in the hospitalized elderly.[34] Risk factors for malnutrition in hospitalized elderly

patients should be evaluated promptly on or after admission. These risk factors include a history of inadequate food intake or unexplained, rapid weight loss, body weight or other anthropometric measurements that show depletion, and low serum albumin.

With acute illness, food and water intake may cease. In the presence of hypercatabolism from diseases, especially inflammatory or infectious disease, nutrient needs are increased. Injuries or surgery may have similar effects. The elderly have fewer nutritional reserves, especially if they are already undernourished; attention to feeding is vital. Any deficits may be enhanced by the food deprivation resulting from tests or treatments that withhold meals.

A study in a veterans' hospital of non-terminally ill hospitalized patients indicated that many elderly patients were maintained on inadequate energy intakes that may have contributed to an eightfold increased risk of mortality in this group. These patients with low nutrient intake also exhibited significantly lower serum cholesterol and serum albumin levels on discharge than other patients.[33] The investigators recommend that greater efforts should be made to prevent the development of protein–energy undernutrition during hospitalization. Caregivers should be aware that the food may be unpalatable or unacceptable by some ethnic groups, and this adds to the difficulty of adequate patient nourishment. Illness or medication-related nausea, vomiting, or diarrhea will exacerbate these difficulties.

Enteral supplements or total enteral or parenteral nutrition should be considered when appropriate. An energy-rich, protein-rich beverage (one to two 8-oz servings daily) can improve the outcome of patients with hip fracture and chronic obstructive pulmonary disease, and be associated with diminished falling in frail elderly. Consultation with a dietitian can help immeasurably.

Conclusion

The older population differs from younger adults not only by age but also by health status. The elderly group is not a homogeneous population, and their many different health and social problems impact their nutritional status.[35] Optimal nutrient intake not only meets their needs but prevents some chronic diseases and ameliorates others. Attention must be paid to environmental, psychological, and pathophysiological parameters in evaluating nutritional status and interventions. While there is no panacea for the aged, nor a "fountain of youth," much can be done to recognize their nutritional needs and improve their nutritional health.

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