Chapter 7

NUTRITION AND FITNESS PROBLEMS: PREVENTION AND SERVICES

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Chapter 7

NUTRITION AND FITNESS PROBLEMS: PREVENTION AND SERVICES[1]

Introduction

Adolescence is a period of biological and social change, and because of the changes that they undergo (e.g., in their size, body composition, body functions, physical abilities, and life styles) and other individual factors, adolescents as a group and as individuals have special nutritional and, possibly, fitness needs. Nutrition and physical activity during adolescence can influence the process of physical growth and development. Evidence concerning the impact of adolescent dietary patterns on the occurrence of chronic diseases in adulthood is very limited, but there is some evidence to suggest that dietary patterns are important factors in the occurrence of some major chronic diseases (e.g., atherosclerotic cardiovascular diseases and hypertension, certain forms of cancer, obesity, non-insulin-dependent diabetes, and dental caries) and that dietary modifications can reduce the risk of some of these diseases (152).

The changing nutritional needs and physical abilities of adolescents as a group are addressed in this chapter, as are the nutritional and other needs of certain subgroups of adolescents (e.g., adolescents with diabetes, adolescents with physical disabilities). Also described in this chapter are selected Federal programs related to the nutritional health and physical fitness status of U.S. adolescents. The chapter ends with conclusions and implications for public policy.

Background on Adolescent Nutrition and Fitness

Adolescents' Nutritional and Physical Fitness Needs

Definitional Issues

Good nutrition is a somewhat elusive concept not easily defined or determined. It is generally agreed, however, that good nutrition embraces the principles of sufficiency, variety, balance, and moderation (59a). Especially in large population groups, research tools cannot capture or interpret all the interrelated aspects of food intakes and nutritional outcomes; most studies instead focus on substitute measures (e.g., specific nutrient consumption or dietary attitudes).

Physical fitness is defined in various ways. In the not too distant past, a person with obvious motor (or athletic abilities)--defined in terms of muscle strength, agility, speed, and power—was considered ''physically fit. ' Recently, however, the concept of physical fitness has been undergoing a major change. According to a 1987 American Academy of Pediatrics statement, physical fitness is now considered to include five components: 1) muscle strength, 2) muscle endurance, 3) flexibility, 4) body composition (i.e., ratio of lean body mass to fat), and 5) cardiorespiratory endurance (4). Many available studies focus on proxy measures of fitness, such as performance on standardized tests of fitness.

Several major Federal sources of data on nutritional status, food and nutrient consumption, and other information related to adolescent nutrition are identified in box 7-A.

Nutritional Needs

The human body requires for health the intake of water, amino acids from protein, vitamins, minerals, fatty acids, and sources of calories (protein, carbohydrate, and fat) (226) (see box 7-B).

A physiologic diet provides intakes of each essential nutrient between the two thresholds of minimal requirement and maximal tolerance (186). The *minimal requirement is* defined as the *smallest* quantity of an essential nutrient that "maintains normal mass, chemical composition, morphology, and physiologic functions of the body and prevents any clinical or biochemical sign of the correspond-

[1]This chapter is not an exhaustive compendium of all adolescent nutrition and fitness issues. Instead, its purpose is to focus on what appear to be *the* major problems associated with nutrition and fitness affecting many American adolescents.

[2]The focus of this OTA Report, for reasons noted in Vol. I, Summa-y *and Policy Implications,* is on 10- through 18-year-olds. Some of the data presented in this chapter are for other age groupings, because data foil 0- through 18-year-olds are not readily available.

Box 7-A—Federal Data Collection Efforts Related to Adolescent Nutrition

Several federally sponsored national surveys[1] gather information on health and nutritional status measurements,[2] food and nutrient consumption measurements, food composition measurements, dietary knowledge and attitude assessments, food supply determinations, sociodemographic and economic measurements, and other relevant data. A number of the surveys sponsored by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture are discussed below. Several of the surveys are components of the National Nutritional Monitoring System, a Federal assessment system that allows continuous nutrition monitoring through complementing, periodic surveys.

U.S. Department of Health and Human Services (DHHS):[3]

- *National Health and Nutrition Examination Survey (NHANES): NHANES is* one component of the National Nutrition Monitoring System. This survey, conducted by the National Center for Health Statistics (NCHS) in DHHS, obtains health-related data by means of direct physical examination, clinical and laboratory tests, and related measurement procedures (232). A major goal of NHANES I (1971-74) was to measure and monitor indicators of the nutritional status of the America people through dietary intake data, biochemical tests, physical measurements, and clinical assessments for evidence of nutritional deficiency. The target population was the civilian, noninstitutionalized U.S. population ages 1 through 74. *NHANES II (1976-80)* had a nutrition component that was nearly identical to the NHANES I. Neither NHANES I nor NHANES II had an adequate adolescent sample. *NHANES* III *is* now in progress. It is collecting some adolescent-specific data, but results are not expected until 1994.
- *Hispanic HANES (1982-84): NCHS* conducted this survey on about 76 percent of the Hispanic adult population (187).
- National Health lnterview Survey (NHIS): This survey, conducted by NCHS, uses personal household interviews to collect data on personal and demographic characteristics, utilization of health resources, and a variety of health topics from a sample of the civilian, noninstitutionalized U.S. population. It will include a special supplement on adolescent health in 1991, 1995, and 2000.
- *Total Diet Study: This* study, by the Food and Drug Administration, gathers information on intakes of pesticides, toxic substances, radionuclides and industrial chemicals, as well as or intakes of iodine, iron, sodium, potassium, copper, magnesium, and zinc, for males and females ages 6 to 11 months, 2 years, 14 to 16 years, 25 to 30 years, and 60 to 65 years.
- *Youth Risk Behavior Surveillance System (YRBSS)* (to be implemented in 1991, 1995, and 2000): This system, recently developed by the Centers for Disease Control in DHHS, will monitor the prevalence of

[1]For a listing of Federal nutrition monitoring and surveillance activities, see *Nutrition* Monitoring *in the United States: The Directory of Federal Nutrition Monitoring Activities (243).*

[2]In general, the validity and reliability of results of dietary and of nutritional status assessments vary (methods may be well-tested but are limited *(58)). Also, errors* of interpretation of dietary intake data are common *(18).*

[3]Further details *on* the DHHS system *are* provided in a report on the National Nutritional Monitoring System (256).

ing deficiency state' (186). In children and adolescents, the minimal requirement also must meet an additional criterion: it must maintain an optimal rate of growth (186). The *maximal tolerance* for an essential nutrient is an important consideration for individuals taking dietary supplements, which may be harmful at certain levels. Factors that influence the minimal requirement and maximal threshold for a nutrient include rate of growth, age, exercise, chemical composition of the diet, presence of certain diseases or physical conditions (e.g., diabetes, pregnancy), and intake of prescription drugs (186).

Nutritional needs during adolescence correlate closely with biological maturity (140). Adolescents should consume diets providing more total nutrients than younger children (131,203), because adolescents typically have a larger body and different body composition (e.g., a different ratio of lean body mass to fat). Adolescents experience gains in height and weight that alter their nutritional needs (see table 7-l). Females typically experience a pubertal height spurt between ages 10 and 13, and males experience a height spurt between ages 12 and 15 (200). This growth requires nutrients as structural materials. Changes in physiologic function that occur during

priority risk behaviors among samples of school-aged adolescents by collecting data from a periodic school-based survey combined with special supplemental data from NHIS on youth risk behavior.

U.S. Department of Agriculture (USDA):

- *Nationwide Food Consumption Survey (NFCS): This survey is* one component of the National Nutrition Monitoring System. Conducted by USDA's Human Nutrition Information Service every 10 years, NFCS collects information on the general and low-income U.S. population ages O to 75 years and older (213a). The most recent survey, conducted in 1987-88, included the collection of information on foods used by households and eaten by individuals.
- *Continuing Survey of Food Intakes by Individuals (GSFII): This survey, like NFCS,* is part of the National Nutritional Monitoring System. It is conducted by USDA's Human Nutrition Information Service. Initiated in 1985, it is designed to measure levels and changes in the food and nutrient content and nutritional adequacy of U.S. diets on a continuing basis (213a). In 1985 and 1986, the CSFII included all-income and low-income samples of women 19 to 50 years of age and their children 1 to 5 years of age. In 1985, the survey also included men 19 to 50 years of age. The CSFII was not conducted in 1987 and 1988. The 1989, 1990, and 1991 samples included men, women, and children of all ages. All CSFII samples are drawn from households in the 48 coterminus States and include a basic survey (households with incomes at any level) and a low-income survey (households with incomes at or below 130 percent of the Federal poverty level). The kinds and amounts of food ingested at home and away from home by individual household members are reported for 3 consecutive days using a l-day recall in an in-person interview and a 2-day diary.
- *Diet and Health Know/edge Survey (DHKS):* This survey, begun in 1989 as a followup to CSFII, targets "food managers" in households participating in CSFII. Its purpose is to link an individual's knowledge and attitudes about diet and health to his or her actual dietary behavior.
- *National Evaluation of School Nutrition Programs: This survey,* conducted only occasionally, provides information on U.S. adolescents' eating patterns and use of school nutrition programs.

Federally sponsored national surveys have several positive features:

- the surveys provide population-based parameters of current nutritional status,
- the surveys identify some groups at risk and their nutritional problems; and
- the surveys contribute useful population-based information for national planning purposes.

On the other hand, federally sponsored national surveys have a number of limitations including the following:

- Neither NHANES nor NFCS provides data on energy expenditures and fitness status.
- Subgroup sample sizes are not large enough to permit analyses and cross-tabulations using several variables (e.g., income, race, and sex); that is, adolescents with combinations of problems are not sufficiently targeted.
- Because of high nonresponse rates among very low-income, non-English-speaking people and because adolescents living in institutional settings are not included in the surveys, some problems may be underestimated.
- Nutritional status data are collected only periodically.

adolescence also alter adolescents' nutritional requirements. U.S. females, for example, typically begin menstruating at age 12 1/2. Females who start menstruating have an increased requirement for iron due to menstrual losses (200,211). Changes in lifestyle, especially in physical activity, may also affect adolescents' nutrient needs (142). Male or female adolescents who regularly participate in vigorous physical activity, for example, increase their energy needs.

Nutritional needs for male and female adolescents of the same age are typically quite different because of factors that include differences in body composition and function (90). But even adolescents of the same sex and age may have different nutritional needs. Adolescents mature at different rates, sometimes as a consequence of genetic endowment and sometimes as a result of environmental factors (e.g., chronic undernutrition slows height and weight growth and slightly delays puberty). Furthermore, as discussed later, some adolescents have diseases or special conditions (e.g., diabetes, thyroid conditions, or pregnancy) that alter their nutritional needs by changing the absorption, metabolism, or excretion of particular nutrients (212).

Box 7-B—Biological Functions of Dietary Substances

Protein—Dietary protein provides a mixture of amino acids to replace the body's continuous degradation of these substances and is also a metabolic fuel for energy. Sufficient protein intake is important for body growth, hair growth, blood and organ mass, muscle development, and proper balance of hormones and body fluids.

Vitamins

Vitamin A—A group of compounds essential for vision, growth, cellular differentiation and proliferation, reproduction, and integrity of the immune system.

Vitamin D—Essential for proper formation of the skeleton and for mineral equilibrium.

Vitamin E—Inhibits the oxidation of essential cell constituents and prevents the formation of toxic oxidation products. Primary deficiency of vitamin E is not found in otherwise healthy humans because of the wide distribution of the vitamin in foods, but secondary deficiency (which may result from intestinal malabsorption) is associated with reproductive failure, muscular dystrophy, and neurological abnormalities.

Vitamin K—Essential for the formation of proteins involved in the regulation of blood clotting, and for the biosynthesis of some other proteins found in the plasma, bone, and kidney.

Vitamin C—Required for the formation and synthesis of collagen (an abundant protein of connective tissue). Deficiency may affect immune responses, wound healing, iron absorption, and allergic reactions. Often vitamin C deficiency results in scurvy, a serious disease in which the weakening of collagenous structures leads to capillary hemorrhaging.

Thiamin (B-1)-Involved in the breakdown of carbohydrates. Deficiency can lead to beriberi, a disease affecting the cardiovascular and nervous systems and characterized by symptoms including mental confusion, muscle weakness, enlarged heart, and congestive heart failure.

Riboflavin (B-2)-Participates in a variety of oxidation-reduction reactions and essential to the structure of some enzymes. Among the symptoms of deficiency are sore throat, excess blood and fluid in the mucous membranes, and angular stomatitis.

Niacin-Also involved in oxidation-reduction reactions. Deficiency is associated with skin rashes, swelling and reddening of the tongue, dermatosis, diarrhea, and dementia.

Vitamin B-6--Important in the metabolism of amino acids. Deficiency leads to dermatitis and depression in adults and seizure in infants.

Folate-Designates a compound that plays an important role in amino acid metabolism and nucleic acid synthesis. Deficiency leads to impaired cell division and alterations of protein synthesis.

Vitamin B-12—Essential to metabolism. Deficiency can cause pallor, weight loss, diarrhea, optic neuritis, and mental changes.

An important dietary standard used in the United States is the recommended dietary allowances (RDAs), established by the Food and Nutrition Board of the National Academy of Sciences (NAS) (153). The 1989 RDAs for protein, vitamins, and minerals for U.S. males and females ages 11 to 14, ages 15 to 18, and ages 19 to 24 are specified in table 7-2. RDAs are recommendations for daily dietary intakes of specific nutrients, based on nutritional studies and expert judgment.[3] They are neither minimal requirements nor necessarily optional levels of intake. Rather, they are "the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy people" (153).[4]

[3]In principle, RDAs are based on various ~& of evidence: 1) studies of subjects maintained on diets containing low or deficient levels of a nutrient, followed by correction of the deficit with measured amounts of the nutrient; 2) nutrient balance studies that measure nutrient status in relation to intake; 3) biochemical measurements of tissue saturation or adequacy of molecular function in relation to nutrient intake; 4) nutrient intakes of fully breastfed infants and of apparently healthy people from their food supply; 5epidemiological observations of nutrient status in populations in relation to intake; and 6) in some cases, extrapolation of data from animal experiments. In practice, there are only limited data on which estimates of nutrient requirements *Call be* based (153).

[4]RDAs apply to healthy persons only and do not cover special nutritional needs arising from metabolic disorders, chronic diseases, or other medical conditions or drug therapies (153).

Minerals

Calcium—Essentia.l for bone mineral formation. Bone undergoes constant resorption and formation throughout life. In childhood and adolescence, dietary calcium helps to build strong bones; in adults, when bone resorption exceeds formation, it slows the rate of bone loss.

Phosphorus—An essential component of all cell protoplasm, aiding in biochemical synthesis and energy transfer. Phosphorus is a constituent of nervous tissue and bone.

Magnesium-Modulates numerous biochemical and physiological processes. Deficiency may cause growth failure, behavioral disturbances, weakness, tremor, seizures or cardiac arrhythmias.

Iron—A constituent of blood and a number of enzymes. Anemia and reduced resistance to infection are among the symptoms of deficiency.

Zinc-A constituent of enzymes involved in most major metabolic pathways, Zinc intake affects appetite, growth, skin, and the immune system.

Iodine—Essential part of the thyroid hormones. Deficiency can cause swelling of the thyroid gland (goiter), and excessive intake can cause depression of thyroid activity.

Lipids

Fats—Fats are an important energy source and help to facilitate the intestinal absorption of vitamins A, E, and D. Saturated and monounsaturated fats, however, are not essential to the diet because they can be synthesized by the body. Polyunsaturated fats are essential components of the diet, functioning as precursors to important structural lipids such as those found in cell membranes.

Cholesterol—Cholesterol is an important component of all cell membranes and a precursor to steroid hormones and bile acids in the liver, but is not essential to the diet because it can be synthesized by the body.

salt---serves as the primary regulator of extracellular body fluid volume, It is also important in regulating acid-base balance and the membrane potential of cells, and is involved in active transport across cell membranes.

Calories—A calorie is a unit of quantity of heat, used to express the energy value of food. Energy requirements vary according to body size and composition, and level of physical activity. The level of energy intake from food balances energy expenditures and allows for necessary or desirable levels of physical activity. In children and pregnant or lactating women energy is also needed for the deposition of tissues or secretion of milk. If calorie intake is consistently above or below an individual's requirement, changes in body weight and composition will result.

SOURCES: Office of Technology Assessment 1991, based on the following sources: National Academy of Sciences, National Research Council, *Recommended Dietary Allowances,* **10th ed. (Washington DC: National Academy Press, 1989); E. Braunwald, K.J. Isselbacher, R.G. Petersdorf, et al.** (eds.), *Harrison's Principles of Internal Medicine,* **11th ed. (New York, NY: McGraw-Hill Book Co., 1988).**

In practice, there are only limited data on which estimates of nutrient requirements can be based (153). Traditionally, RDAs have been established for essential nutrients only when there are sufficient data to make reliable recommendations. For several nutrients for which there is insufficient information on which to base an RDA, the NAS Food and Nutrition Board publishes estimated safe and adequate ranges of daily intakes, as shown in table 7-3.

In addition to listing RDAs for protein, vitamins, and minerals, the NAS publication *Recommended Dietary Allowances* lists recommended daily energy intake levels (caloric intake) for persons of median height and weight (153). Recommended energy intakes for U.S. males and females ages 11 to 24 of median heights and weights, by age and sex, are shown in table 7-4. The principal dietary sources of energy are carbohydrates, fat, and protein (153). Energy needs vary from person to person. An individual's energy requirements depend on how much energy the individual expends at rest, in physical activity, and as a result of the body's adaptive response to heat (153). These, in turn, are affected by variables that include age,[5] sex, body size and composition, genetic factors, energy intake, physiologic state (e.g., growth, pregnancy, lactation), coexisting pathological conditions, and ambi-

[5]Resting energy expenditure is closely correlated with lean body mass, and this varies by age. Activity patterns also vary by age.

Table 7-I—Weight and Height of U.S. Males and Females Ages 10 to 18[a]

	Males, by percentile					
	Weight, in kg (lb)			Height, in cm (in)		
Age	5th	50th	95th	5th	50th	95th
10	24,33	31.44 (69.2)	45.27	127.7	137.5 (54.1)	148.1
11	26.80	35.30 (77.7)	51.47	132.6	143.3 (56.4)	154.9
12	29,85	39.78 (87.5)	58.09	137.6	149.7 (58.9)	162.3
13	33.64	44.95 (98.9)	65.02	142.9	156.5 (61.6)	169.8
14	38,22	50.77 (111.7)	72.13	148.8	163.1 (64.2)	176.7
15	43.11	56.71 (124.8)	79.12	155.2	169.0 (66.5)	181.9
16	47.74	62.10 (136.6)	85.62	161.1	173.5 (68.3)	185.4
17	51.50	66.31 (145.9)	91.31	164.9	176.2 (69.4)	187.3
18	53.97	68.88 (151.5)	95.76	165.7	176.8 (69.6)	187.6

	Females, by percentile					
	Weight, in kg (lb)			Height, in cm (in)		
Age	5th	50th	95th	5th	50th	95th
10	24.36	32.55 (71.6)	47.17	127.5	138.3 (54.4)	149.5
11	27.24	36.95 (81.3)	54.00	133.5	144.8 (57.0)	156.2
12	30.52	41.53 (91.4)	60.81	139.8	151.5 (59.6)	162.7
13	34.14	46.10 (101 .4)	67.30	145.2	157.1 (61.9)	168.1
14	37.76	50.28 (1 10.6)	73.08	148.7	160.4 (63.1)	171.3
15	40.99	53.68 (1 18.1)	77.78	150.5	161.8 (63.7)	172.8
16	43.41	55.89 (123.0)	80.99	151.6	162.4 (63.9)	173.3
17	44.74	56.69 (124.7)	82.46	152.7	163.1 (64.2)	173.5
18	45.26	56.62 (124.6)	82.47	153.6	163.7 (64.4)	173.6

[a]The data in this table were collected from nationality respective samples of individuals in three studies conducted by the National Center for Health Statistics of DHHS between 1962 and 1974. It is not intended that the figures in this table necessarily be considered standards of normal growth and development.

SOURCE: Adapted from P.V.V.Hamill, T.A. Drizd, C.L. Johnson, et al., "Physical Growth: National Center for Health Statistics," *American Journal of Clinical Nutrition* 32:607-609, *1979,* cited in National Academy of Sciences, National Research Council, *Diet and Health: Implications for Reducing Chronic Disease Risk* (Washington, DC: National Academy Press, 1989). Reprinted by permission.

Table 7-2—NAS Recommended Dietary Allowances (RDAs) for Protein, Vitamins, and Minerals for U.S. Males and Females Ages 11 to 24, 1989[a]

Nutrient and unit of measurement	RDAs for males (by age)			RDAs for females (by age)		
	11-14	15-18	19-24[b]	11-14	15-18	19-24[b]
Protein, gm[c]	45	59	58	46	44	46
Vitamins						
Vitamin A, micrograms RE[d]	1,000	1,000	1,000	800	800	800
Vitamin D, micrograms	10	10	10	10	10	10
Vitamin E, mg	10	10	10	8	8	8
Vitamin K, micrograms	45	65	70	45	55	60
Vitamin C, mg	50	60	60	50	60	60
Thiamin, mg	1.3	1.5	1.5	1.1	1.1	1,1
Riboflavin, mg	1.5	1.8	1.7	1.3	1.3	1.3
Niacin, mg NE[e]	17	20	19	15	15	15
Vitamin B-6, mg	1.7	2.0	2.0	1.4	1.5	1.6
Folate, micrograms	150	200	200	150	180	180
Vitamin B-12, micrograms	2.0	2.0	2.0	2.0	2.0	2.0
Minerals						
Calcium, mg	1,200	1,200	1,200	1,200	1,200	1,200
Phosphorus, mg	1,200	1,200	1,200	1,200	1,200	1,200
Magnesium, mg	270	400	350	280	300	280
Iron, mg	12	12	10	15	15	15
Zinc, mg	15	15	15	12	12	12
Iodine, micrograms	150	150	150	150	150	150
Selenium, micrograms	40	50	70	45	50	55

[a]Nutritional requirements vary among individuals as a consequence of numerous genetic and environmental circumstances: RDAs are intended to provide for the needs of most healthy individuals living in the United States under normal environmental stresses (186).
[b]The focus of this OTA Report is on 10- through 18-year-olds. RDAs for 19- to 24-year-olds are provided in this table for the purpose of comparison.
[c]Healthy adults require nine essential amino acids in varying amounts each day. Dietary protein provides a mixture of amino acids for endogenous protein synthesis and is also a metabolic fuel for energy (186).
[d]RE = retinol equivalents. One RE is equal to 1 microgram of retinol or 6 micrograms of beta-carotene.
[e]NE = niacin equivalent. One NE is equal to 1 mg of niacin or 60 mg of dietary tryptophan.

SOURCE: Adapted from National Academy of Sciences, National Research Council, *Recommended Dietary Allowances*, 10th ed. (Washington, DC: National Academy Press, 1989). Reprinted by permission,

Table 7-3—NAS Estimated Ranges of Safe and Adequate Daily Dietary Intakes of Additional Vitamins and Minerals for U.S. Adolescents Ages 11 and Over[a]

Vitamin or mineral	Estimated range of safe and adequate daily dietary intake
Vitamins	
Biotin	30 to 100 micrograms
Pantothenic acid	4 to 7 mg
Trace elements[b]	
Copper	1.5 to 2.5 mg
Manganese	2.0 to 5.0 mg
Fluoride	1.5 to 2.5 mg
Chromium	50 to 200 micrograms
Molybdenum	75 to 250 micrograms

[a]For vitamins and minerals for which there is insufficient information on which to base an RDA, NAS publishes estimated ranges of safe and adequate daily dietary intakes.
[b]According to NAS, since the toxic levels for many trace elements may be only several times usual intakes, the upper levels for the trace elements given in this table should not be habitually exceeded.

SOURCE: Adapted from National Academy of Sciences, National Research Council, *Recommended Dietary Allowances*, 10th ed. (Washington, DC: National Academy Press, 1989), p. 284. Reprinted by permission.

ent temperature (153). While RDAs for protein, vitamin s, and minerals are high enough to meet an upper level requirement encompassing individual variability, the recommended energy allowance reflects the *average* population requirement for each age group (153) and will not be sufficient for an individual who regularly engages in strenuous physical activity. Raising the recommended energy intake level to accommodate individuals with an upper level requirement, however, would be inappropriate because it could lead to obesity in persons with average requirements. Noting the great variability in the timing and magnitude of the adolescent growth spurt and in adolescent activity patterns, NAS emphasizes that its recommended energy intake levels for adolescents can be adjusted individually to take such variability into account (153).

From birth to age 10, the energy needs of males and females are not very different (153). After age 10, separate allowances are made for males and

Table 7-4—NAS Recommended Energy Intakes for Males and Females Ages 11 to 24 of Median Weights and Heights, 1989a

	Males				Females			
			Energy intakes				Energy intakes	
Age[b]	Median weight (kg)	Median height (cm)	Calories per kg of body weight	Total calories per day	Median weight (kg)	Median height (cm)	Calories per kg of body weight	Total calories per day[c]
Age 11-14	45	157	55	2,500	46	157	47	2,200
Age 15-18	66	176	45	3,000	55	163	40	2,200
Age 19-24	72	177	40	2,900	58	164	38	2,200

[a]Energy requirements of individuals are affected by several variables, including level of physical activity, age, sex, body size and composition, genetic factors, physiologic state (e.g., growth, pregnancy, lactation), coexisting pathological conditions, and ambient temperature. Recommended energy allowances, in contrast to RDAs for other nutrients (see table 7-2), are intended to meet the average needs of individuals.

[b]The focus of this OTA Report is on 10- through 18-year-olds. Recommended energy intakes for 19- to 24-yea r-olds are provided in this table for the purpose of comparison.

[c]For pregnant females and for females who are breastfeeding, the recommended energy intakes are higher (300 calories more Per day for pregnant females in the second and third trimesters of pregnancy and 500 calories more per day for lactating females in the first year).

SOURCE: Adapted from National Academy of Sciences, National Research Council, Recommended Dietary *Allowances*, 10th ed. (Washington, DC: National Academy Press, 1989), p. 33. Reprinted by permission.

females because of differences in the age of puberty, evolving activity patterns, and body composition. On average, energy needs for adolescent males are higher than for females. Pregnant and lactating females have higher food energy needs than other females, as shown in table 7-4.

Data on the role of diet as a causal or contributing factor in chronic diseases have led some groups to issue dietary recommendations derived through approaches other than those used in developing RDAs for specific nutrients (153). Broad nutritional guidelines that provide guidance beyond that provided by RDAs were issued in the NAS report Diet *and Health.. Implications for Reducing Chronic Disease Risk (152), in The U.S. Surgeon General's Report on Nutrition and Health (242),* and in *Nutrition and Your Health: Dietary Guidelines for Americans* published by the US. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS) (227). Those guidelines are summarized in box 7-C.

Among other things, these guidelines suggest restricting intakes of fat, saturated fat, cholesterol, sodium, sugar, and alcohol. Populations with high fat diets have more heart disease, certain types of cancer, and obesity (226). A diet low in saturated fatty acids and cholesterol can help maintain a desirable level of blood cholesterol, possibly reducing the risk for heart disease (226). Eating a diet with less salt (which contains sodium) may help some people reduce their risk of developing hypertension (high blood pressure). Sugars supply calories but are limited in essential nutrients and may increase the risk of tooth decay. Drinking alcohol is linked with a variety of chronic and other health problems (e.g., liver disease, accidental injuries).[6]

The guidelines in box 7-C also suggest that diets include plenty of vegetables, fruits, and grain products. Vegetable and fruits are good sources of vitamins A and C, folic acid, fiber and minerals (226). Breads and cereals provide B vitamins, iron, protein, and dietary fiber. Over the last decade, several organizations have recommended increasing the intake of complex carbohydrates or dietary fiber (153). The consumption of a fiber-rich diet promotes normal elimination and may have other beneficial effects (e.g., reducing blood cholesterol levels, preventing colon cancer and diabetes) (153).

Finally, it should be noted that USDA and DHHS' *Dietary Guidelines for Americans* recommends maintaining a healthy weight (227). Being too fat or too lean (a less common problem in the United States) increases the risk of various health problems. Available knowledge also suggests that whether one's weight is ' 'healthy' depends on how much of one's body weight is fat, where in the body the fat is located, and whether one has weight-related medical problems or a family history of such problems ***(226).***

[6]Adolescents' dental health status is discussed in ch. 8, ' 'Dental **and Oral Health Problems: Prevention and Services,** ' in this volume; use of alcohol is discussed in ch. 12, ''Alcohol, Tobacco, and Drug Abuse: Prevention and Services, in this volume.

Box 7-C—Broad Nutritional Guidelines That Provide Guidance Beyond Recommended Daily Allowances (RDAs)

National Academy of Sciences' Diet and Health Report (1989):

This report made recommendations for quantities of nutrients and numbers of suggested servings from some food groups, specifically:

- Limit intake of fat to less than *30* percent of total calories.
- Limit intake of saturated fatty acids to less than 10 percent of total calories.
- Limit cholesterol intake to under 300 mg daily.
- Limit salt intake to under 6 grams daily.
- Maintain protein at moderate levels, not more than twice recommended daily allowance (R-DA).
- For those who drink alcoholic beverages, limit intake to less than 1 oz of pure alcohol per day. [1]
- Maintain optimal intake of fluoride.
- Avoid the use of dietary supplements in levels greater than RDA.
- Have 5+ servings of vegetable and fruit combinations, especially green and yellow vegetables and citrus fruits.
- Have 6+ daily servings of a combination of breads, cereals, legumes, and other starches and complex carbohydrates.

U.S. Surgeon General's Report on Nutrition and Health (1988):

This report endorsed USDA's Dietary *Guidelines for Americans* (those that were current at the time) and also recommended the following:

- that fluoridated community water systems, or other appropriate sources of fluoride be used to prevent tooth decay;[2]
- that those who are particularly vulnerable to dental caries should limit their consumption and frequency of foods high in sugar;[2]
- that adolescent females should increase consumption of foods high in calcium, including low-fat dairy products; and
- that adolescents and women of childbearing age, especially those in low-income families, be encouraged to consume foods that are good sources of iron.

USDA and DHHS' Dietary Guidelines for Americans (October 1990):

- Eat a variety of foods.
- Maintain healthy weight.
- Choose a diet low in fat, saturated fat, and cholesterol.
- Choose a diet with plenty of vegetables, fruits, and grain products.
- Use sugars in moderation.
- Use salt and sodium in moderation.
- If you drink alcoholic beverages, do so in moderation. [1]

The published guidelines provide more information on each guideline, including details on what the guideline means, how it is important to health, and some tips on using the guideline.

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[1] The consumption of alcohol by U.S. adolescents is discussed in ch. 12, "Alcohol, Tobacco, and Drug Abuse: Prevention and Services," in this volume.

[2] See ch. 8, "Dental and Oral Health Problems: Prevention and Services," in this volume for a discussion of the importance of fluoride to adolescents' dental health and other topics related to adolescents' dental health.

SOURCES: National Academy of Sciences, National Research Council, *Diet and Health: Implications for Reducing Chronic Disease* (Washington DC: National Academy Press, 1989); U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General, *Surgeon General's Report on Nutrition and Health* (Washington, DC: U.S. Government Printing Office, 1988); and U.S. Department of Agriculture and U.S. Department of Health and Human Services, *Nutrition and Your Health: Dietary Guidelines for Americans,* Home and Garden Bulletin, No. 232 (Hyattsville, MD: 1990).

Researchers are developing more precise ways to measure healthy weight.[7]

Physical Fitness and Activity Needs

Numerous recent studies have suggested that physical fitness and/or physical activity[8] have, or potentially have, positive impacts on health and longevity (22,22a,33,33a,106a,171,174b,241). It is important to note, however, that these studies have had methodological flaws and have almost been conducted with adult samples. During adolescence, physical activity is thought to influence growth and development of skeletal bone, muscle, and fat (142). There appears to be a reciprocal relationship between physical activity and obesity or overweight (see below).

Adolescents' Nutrition and Fitness Problems

A lack of data on contemporary adolescents and a paucity of systematic research on the impact of varying levels of nutrients and physical activity and fitness on health (including adolescent health) (254a) make conclusions about the nutrition and fitness problems of U.S. adolescents difficult to draw. Some survey data suggest that if one uses available nutritional and fitness *guidelines as* a standard, many U.S. adolescents have inadequate diets and engage in low levels of physical activity. Not coincidentally, a substantial minority are also overweight or obese. These problems may occur more often in some groups of adolescents, especially low-income adolescents or those in particular racial or ethnic groups.[9] Recent national data regarding the incidence or prevalence of these problems among U.S. adolescents are not available (see box 7-A), and national information about specific groups of adolescents (e.g., racial or ethnic minority adolescents, low-income adolescents) is practically nonexistent.

Nutritional Deficiencies

Essential nutrients are proteins, minerals, carbohydrates, fat, and vitamins that are necessary for growth, normal functioning, and maintaining life; they must be supplied by food, because they cannot be synthesized by the body (box 7-B). Table 7-5 shows U.S. adolescents' intake of food energy, protein, vitamins, and minerals in 1977-78 as a percentage of the 1980 RDAs.[10]

USDA's 1977-78 Nationwide Food Consumption Survey found that most U.S. adolescents got more than enough protein (see table 7-5). More recent data also confirm that intakes of protein by U.S. adolescents typically meet or exceed the RDA (1 11). USDA's 1977-78 Nationwide Food Consumption Survey also found that, on average, U.S. adolescents' intakes of vitamins A, B 12, and C, thiamin, riboflavin, and niacin, were sufficient or more than sufficient. On the other hand, USDA's 1977-78 Nationwide Food Consumption Survey (224) found that U.S. adolescents' *energy intakes* (calories consumed) in the late 1970s were, on average, lower than the RDA levels.

The data in table 7-5 suggest that the nutrients U.S. adolescents are most likely to be getting insufficient quantities of include vitamin B-6, *iron* and *calcium*. Females ages 9 to 18 tended to consume less iron and calcium than males, but males, too, consumed less than the 1980 RDA. The RDA for *iron in 1989 was* lower than in 1980, but recent data support the finding that iron is one of the nutrients most likely to be deficient in U.S. adoles-

[7] *Overweight* is sometimes defined as body mass index (BMI)—i.e., weight in kilograms divided by height in meters squared—greater than or equal to the 85th percentile of a similar population group. *Obesity*, a more serious problem, is defined in various ways. One definition is BMI greater than or equal to the 95th percentile of a similar population group. Another definition is weight at least 20 percent over "normal weight." Measuring triceps skinfolds is another way of measuring obesity.

[8] Physical *fitness* is an *attribute* that should be distinguished from physical *activity*, which is a *behavior*. Physical activity has been found to be an important determinant of physical fitness. To some extent, therefore, physical fitness can be considered to be an objective *marker* for habitual physical activity (and vice versa), but physical fitness and physical activity are not the same thing (22a).

[9] The health problems of low-income adolescents and racial and ethnic minority adolescents are discussed further in ch. 18, "Issues in the Delivery of Services to Selected Groups of Adolescents," in Vol. III. Also discussed in that chapter is the general paucity of data and research on low-income and racial and ethnic minority adolescents.

[10] The first edition of the NAS publication *Recommended Dietary Allowances* was published in 1943. Since then, nine revised editions have appeared, the most recent in 1989. The 1980 RDAs are similar to the 1989 RDAs, but there are some differences. In 1980, for example, the RDA for iron was 18 mg per day as opposed to 15 mg per day in 1989 (150). For a discussion of other differences, see the 1989 NAS publication *Recommended Dietary Allowances (153).*

Table 7-5—Average Daily Nutrient Intake as a Percentage of the 1980 RDAs Among U.S. Adolescents Ages 9 to 18, 1977-78[a,b]

Nutrient	Male		Female	
	Vegetarian (N= 20)	Nonvegetarian (N= 3,462)	Vegetarian (N= 31)	Nonvegetarian (N= 3,600)
Food energy[c]	98%	86%	91%	82%
Protein	203	193	170	160
Vitamins				
Vitamin A	182	123	121	112
Thiamin	166	121	143	134
Riboflavin	171	149	118	111
Niacin[d]	150	122	118	111
Vitamin B6	123	94	81	72
Vitamin B12	191	205	142	148
Vitamin C	225	173	172	150
Minerals				
Calcium	107	97	87	74
Iron	121	91	90	76
Magnesium	97	80	115	103
Phosphorus	151	133	129	115

[a]The 1980 RDAs (150) are similar to the 1989 RDAs (153) in many respects, but there are some differences. For example, the 1980 RDA for iron was 18 mg., while the 1989 RDA for iron was 15 mg. See text for discussion.
[b]The percentages in this table are basedon data from the U.S. Department of Agriculture's 1977-1978 Nationwide Food Consumption Survey (224).
[c]Recommended energy intake levels are levels to meet average needs, unlike RDAs for other nutrients, which are believed to meet the needs of the vast majority of healthy individuals.
dRDA is for preformed niacin rather than niacin equivalents.

SOURCE: Adapted from National Academy of Sciences, National Research Council, *Diet and Health: Implications for Reducing Chronic Disease Risk* (Washington, DC: National Academy Press, 1989). Reprinted by permission.

cents' diets, especially among females (122,142). Females' iron needs are particularly high. In addition, exercise may increase the need for iron (128), and iron deficiency during physical training is more common in females than males (see section on female adolescent athletes below).

In 1989, the NAS Food and Nutrition Board's Subcommittee on the Tenth Edition of the RDAs urged that special attention be paid to *calcium* intakes throughout childhood to age 25 to reduce the risk of osteoporosis later in life (153). However, another NAS committee, the Committee on Diet and Health, found that the evidence was not sufficient for drawing conclusions about the influence of dietary patterns on osteoporosis (152). As opposed to the effects of exercise on iron stores, exercise increases the retention of calcium in the body (23,98), as measured by the mineral content in bones; peak bone mineral density has been found to be enhanced by large calcium intakes and large energy expenditures (102).

According to data from other studies, levels of vitamin C, folic acid, thiamin, and riboflavin are low in some adolescents (47,123,191,228,23 1,234). Levels of manganese and copper are unknown because food composition data are incomplete (152,168). Physical activity may deplete zinc stores, but the evidence is unclear (52).

For most U.S. adolescents, vitamin and mineral deficits are subclinical and do not require professional intervention (59a). In the few cases where deficiency is commonly observed (e.g., iron deficiency in females), treatment with supplements may be necessary.

Inadequate Dietary Fiber[11]

Data on intakes of dietary fiber by U.S. adolescents are incomplete, but some observers have suggested that intakes are probably lower than recommended (2,5). On the other hand, *Healthy People 2000* noted that one expert panel (of the Life Sciences Research Office of the Federation of American Societies for Experimental Biology) indicated that levels of dietary fiber appropriate for adults may not be appropriate for children (no ages specified, and so *Healthy People 2000* did not make

[11]*Dietary fibers* are mainly indigestible complex carbohydrates in plant cell walls and various gums, mucilages, and algal polysaccharides (153).

Box 7-D—Healthy People 2000 Objectives Pertaining to Adolescents' Physical Activity and Nutrition

Healthy People 2000 is the Nation's most prominent statement on health promotion and disease prevention objectives for the U.S. population (241). This report, published by the U.S. Department of Health and Human Services, contained a number of objectives for the year 2000 pertaining to adolescents' nutrition and physical activity and fitness. The report also provided baseline data when they were available (see below). In addition to the health status, risk reduction, services, and protection objectives listed below, *Healthy People 2000* enumerated objectives for personnel needs, surveillance and data systems, and research (241). These latter objectives were not specific to adolescents, but meeting them would be important to meeting the health status objectives for adolescents.

Nutrition Objectives for the Year 2000

Health Status and Risk Reduction Objectives

- Reduce dietary fat intake to an average of 30 percent of calories or less and average saturated fat intake to less than 10 percent of calories among people ages 2 and older (no baseline data cited for adolescents or children).
- Increase calcium intake so at least 50 percent of youth ages 12 through 24 and 50 percent of pregnant and lactating women consume three or more servings daily of foods rich in calcium (no baseline data cited for adolescents).
- Decrease salt and sodium intake so at least 65 percent of home meal preparers prepare foods without adding salt, at least 80 percent of people avoid using salt at the table (baseline: 54 percent of women aged 19 through 50 who served as the main meal preparer did not use salt in food preparation; no baseline data cited for adolescents' use of salt).

Services and Protection Objectives:

- Increase to at least 5,000 brand names[1] the availability of processed food products that are reduced in fat and saturated fat (baseline: 2,500 items reduced in fat in 1986).
- Increase to at least 90 percent the proportion of restaurants and institutional food service operations that offer identifiable low-fat, low-calorie food choices, consistent with the *Dietary Guidelines for Americans* (baseline: about 70 percent of fast food and family restaurant chains with 350 or more units had at least one low-fat, low-calorie item on their menu in 1989).
- Increase to at least 90 percent the proportion of school lunch and breakfast services and child care food services with menus that are consistent with the nutrition principles in the *Dietary Guidelines for Americans* (baseline data available in 1993).
- Increase to at least 75 percent the proportion of the Nation's schools that provide nutrition education from preschool through 12th grade, preferably as part of quality school health education (baseline data available in 1991).
- Increase to at least 75 percent the proportion of primary care providers who provide nutrition assessment and counseling and/or referral to qualified nutritionists or dietitians (baseline: physicians provided diet counseling for an estimated 40 to 50 percent of patients in 1988).[2]

Physical Activity and Fitness Objectives for the Year 2000

Health Status and Risk Reduction Objectives:

- Increase to at least 75 percent the proportion of children and adolescents aged 6 through 17 who engage in vigorous physical activity that promotes the development and maintenance of cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion (baseline: 66 percent for youth aged 10 through 17 in 19843).
- Reduce to no more than 15 percent the proportion of people aged 6 and older who engage in no leisure-time physical activity (no baseline data available for adolescents or children).
- Increase to at least 40 percent the proportion of people aged 6 and older who regularly perform physical activities that enhance and maintain-muscular strength, muscular endurance, and flexibility (no baseline data available for any age group).

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[1] A brand item is defined as a particular flavor and/or size of a specific brand and is typically the consumer unit of purchase (241).

[2] This objective and the baseline data cited are not specific to adolescents. For a discussion of primary care providers' behaviors with adolescents, see ch. 15, "Major Issues in the Delivery of Primary and Comprehensive Services to Adolescents," in Vol. III.

[3] The source cited for this value was the National Children and Youth Fitness Study I.

Services and Protection Objectives:

- Increase to at least 50 percent the proportion of children and adolescents in 1st through 12th grade who participate in daily school physical education (baseline: 36 percent in 1984-86).
- Increase to at least 50 percent the proportion of school physical education class time that students spend being physically active, preferably engaged in lifetime physical activities (baseline: students spent an estimated 27 percent of class time being physically active in 1983).
- Increase to at least 50 percent the proportion of primary care providers who routinely assess and counsel their patients regarding the frequency, duration, type, and intensity of each patient's physical activity practices (baseline: physicians provided exercise counseling for about 30 percent of sedentary patients in 1988).
- Increase community availability and accessibility of physical activity and fitness facilities.[4]

Combination Nutrition and Physical Activity and Fitness Objectives for the Year 2000

Health Status and Risk Reduction Objectives:

- Reduce overweight to a prevalence of no more than 15 percent among adolescents ages 12 through 19 (baseline: 15 percent for adolescents ages 12 through 19 in 1976-80).[5]
- Increase to at least 50 percent the proportion of overweight people aged 12 and older who have adopted sound dietary practices combined with regular physical activity to attain an appropriate body weight (no baseline provided for adolescents),

[4]These recommendations were not adolescent-specific.

[5]The values used for adolescents were **"the gender-specific 85th percentile values of the 1976-80 National Health and Nutrition Examination Survey (NHANES II) corrected for sample variation" (241).**

SOURCE: U.S. Department of Health and Human Services, Public Health Service, Office of the Assistant Secretary for Health *Healthy People 2000: National Health Promotion and Disease Prevention Objectives,* **DHHS Pub. No. (PHS)91-50213 (Washington, DC: U.S. Government Printing Office, 1991).**

recommendations on dietary fiber for children or adolescents (box 7-D) (241).

Excessive Consumption of Fat, Cholesterol, Sodium, and Low-Nutrient Density Foods

The diets of most U.S. adolescents in national surveys fail to meet the recommendations of the NAS report *Diet and Health (see* box 7-C) because they are excessive in total fat, saturated fat, cholesterol, and sodium (46,64,1 11,153,159,189).

It is not surprising to find that adolescents' diets are high in fat and cholesterol. NAS reports that food patterns have changed significantly in the United States (152). Between 1909 and 1985 the percentage of calories available in the food supply from fats increased from 32 to 43 percent (152). NAS recommended that children over 2 years old should consume no more than 30 percent of calories in fat. Recent studies have found that school meals are often very high in fat (37,70,164). Fast-food meals or snacks consumed by adolescents are often high in total and saturated fat, cholesterol, sodium, and sugar (135). Table 7-6 shows the nutritional values of seven sample fast-food meals.

Approximately 25 percent of total calories consumed by U.S. adolescents, almost regardless of

Photo credit: Benjamin Smith

Current data on the food consumption patterns and nutritional status of U.S. adolescents, especially subgroups of adolescents such as racial and ethnic minorities and low-income adolescents, are limited. The most recent comprehensive information about what U.S. adolescents eat is from 1977-78. These data suggest that adolescents' diets contain sufficient amounts of most essential vitamins and minerals and more than enough protein, but not enough total calories, vitamin B6, iron, and calcium. But more recent information suggests that adolescents' diets may be too high in fat, cholesterol, and sodium.

income, sex, or race (142), come from high calorie foods that are relatively low in protein, vitamins, and minerals ("low nutrient density" foods). Snacking, or foods consumed ''outside of traditional meals, " provides 20 to 35 percent of adolescents' total energy intakes (46,145,224), but several studies show that the nutrient density is usually lower for snacks than for meals (57). Because recent data are not available, and data from the late 1970s suggest that adolescents generally consume sufficient proteins, vitamins, and minerals (with the exception of vitamin B6, calcium, and iron) (see table 7-5), it is not clear how much of a nutritional problem—beyond fat intake-snacking represents.

Low Levels of Physical Activity

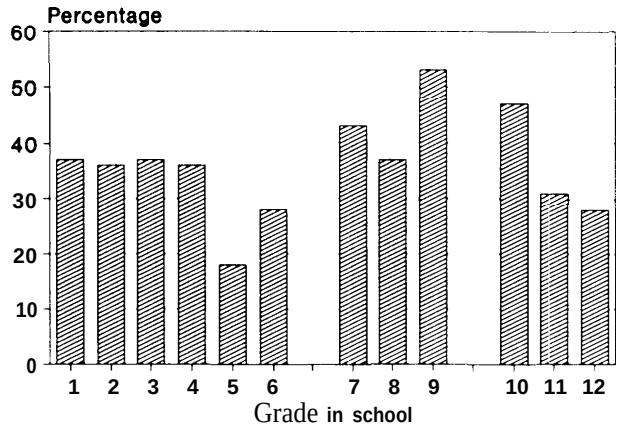
Like their nutritional needs, the physical abilities of adolescents differ from those of younger children. The changes that occur with puberty involve not only increased linear growth and mass but also physiological changes that improve physical and athletic ability. The onset of puberty is associated with an increase in aerobic and anaerobic power (97) and tolerance of exercise in the heat (13) and in the cold (202).

As noted above, there is considerable concern about levels of physical activity among U.S. adolescents on average (91a,174a,241). Detailed, accurate studies have not been carried out to show trends in activity patterns or the effects of age on activity during adolescence, but low levels of physical activity throughout adolescence have been discerned from recent surveys and semiquantitative measures of fitness (173,182).

Enrollment and participation in daily physical education classes decrease somewhat in late adolescence. Figure 7-1, based on results from the National Children and Youth Fitness Studies,[12] shows the percentage of U.S. students in 1st through 12th grades enrolled in daily physical education classes in 1984-86 (182,183, 241). Only about 20 percent of the time is spent in moderate or vigorous activity during a class (15).

Results from the National Children and Youth Fitness Studies indicate that 59percent of 5th to 12th graders reported engaging in appropriate physical activity year round (182).[13] Of the time these adolescents spent in physical activity outside of school physical education classes (84 percent of their average weekly minutes of participation in physical activities), nearly 47 percent of students reported engaging in appropriate activities that could be carried over into adulthood (182).

Figure 7-l—Percentage of U.S. Students in 1st Through 12th Grade Receiving Daily Physical Education, 1984-86



SOURCE: U.S. Department of Health and Human Services, Public Health Service, Office of the Assistant Secretary for Health, *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*, DHHS Pub. No. (PHS)91-50213 (Washington, DC: U.S. Government Printing Office, 1991), based on the National Children and Youth Fitness Study I (students in 5th through 12th grade) and the National Children and Youth Fitness Study II (students in Ist through 4th grade).

Results from the National Children and Youth Fitness Studies also indicate that U.S. children and adolescents' physical fitness is related to their mothers' physical activity and inversely to the amount of time children watch television (182). Studies of adults show that adult women of lower socioeconomic status engage in less fitness-related activity than women of higher socioeconomic status (68), and that exercise levels are similar among members of the same family (63). Taken together, these observations suggest that low-income adolescents may be less likely to be engaging in fitness-related activities. Lower participation by lower socioeconomic status individuals may be more a matter of opportunity than inclination; thus, schools could play an important role in providing occasions

[12]The National Children and Youth Fitness Studies (NCYFS) were surveys of 5th to 12th grade students (NCYFS I) and 1 st through 4th grade students (NCYFS II) (182,183,241).

[13]*Appropriate physical activity* was defined in this survey as physical activity involving large muscle groups at an intensity requiring 60 percent or greater of an individual's cardiovascular capacity engaged in at least three times per week for at least 20 minutes.

Table 7-6—Nutritional Values of Seven Sample Fast-Food Meals[a]

Meal No	Sample meal	Calories	Total fat (g)	Percent of calories from fat (%)	Approx. tsp of fat[b]	Cholesterol (mg)	Sodium (mg)	Vitamin A IU	Vitamin C IU	Calcium (mg)	Percentage of RDA Vitamin A	Percentage of RDA Vitamin C	Percentage of RDA Calcium
1	Double burger with sauce	625	30	58		105	880	550	7	255			
	Milkshake	410	10	22		35	190	425	3	375			
	French fries (regular size)	240	15	56		15	120	15	8	10			
	Total	**1,275**	**55**	**46**	**14 1/2**	**155**	**1,190**	**990**	**18**	**640**	**15**	**30**	**80**
2	Chicken nuggets (6)	310	20	58		70	700	100	2	15			
	Apple pie	280	15	48		5	400	15	10	10			
	Coffee with cream	65	5	69		20	15	55	—	25			
	Total	**655**	**40**	**55**	**9**	**95**	**1,115**	**170**	**12**	**50**	**2**	**20**	
3	Fish sandwich with cheese and tartar sauce	495	25	45			676	145	4	140			
	Soda (12 oz)	150	0	0			15	—	—	—			
	French fries	240	15	56		13	120	15	8	10			
	Total	**885**	**40**	**53**	**9**	**73**	**881**	**160**	**12**	**150**	**2**	**20**	**9**
4	Beef tacos (2)	390	20	46		50	565	915	—	190			
	Low-fat milk (8 oz)	105	2	17		10	125	500	2	300			
	Total	**495**	**22**	**40**	**5**	**60**	**690**	**1,415**	**2**	**490**	**18**		**61**
5	Single burger	290	13	40		45	435	140	3	60			
	Tossed salad with low-calorie dressing	50	1	18			445	1,590	40	40			
	Low-fat milk	105	2	17		10	125	500	2	300			
	Total	**445**	**16**	**32**	**3 1/2**	**55**	**1,005**	**2,230**	**45**	**400**	**28**	**75**	**50**
6	Baked potato (plain)	150	Tr[c]		0		0	5	—	30	20		
	Margarine (1 pat)	35	4	100		0	45	155	0	—			
	Tossed salad with low-calorie dressing	50	1	18			445	1,590	40	40			
	Low-fat milk	105	2	17		10	125	500	2	300			
	Total	**340**	**7**	**18**	**1 1/2**	**10**	**620**	**2,245**	**72**	**360**	**28**	**20**	**45**
7	Cheese pizza (1 slice)	155	5	29		20	455	410	5	145			
	Tossed salad with low-calorie dressing	50	1	18			445	1,590	40	40			
	Orange juice (8 oz)	110	0	0		0	0	195	95	20			
	Total	**315**	**6**	**17**	**1 1/2**	**20**	**900**	**2,195**	**140**	**205**	**27**	**233**	**26**

[a]Figures shown represent the average nutrient values for similar items of more chains. The nutrient analyses are those of Young et al. (258). The average values as listed may deviate slightly from values published as chain-specific. However, the average values as calculated appear to be fairly representative of what all chains provide.

[b]One teaspoon of fat is equivalent to approximately 4.5g of fat.

[c]Tr denotes trace.

SOURCE: Massachusetts Medical Society, Committee on Nutrition, "Sounding Board: Fast Food Fare: Consumer Guidelines," *New England Journal of Medicine* 321(17):752-756, 1989. Reprinted by permission.

for exercise by lower socioeconomic status adolescents.

A recent study of the effects of television on children and adolescents shows that adolescents spend many hours outside of school watching television—an average of 23 hours per week from 1976 to 1980 (86). Watching television may affect the amount of time adolescents spend engaging in physical activities.[14]

Obesity or Overweight

Depending on the measurement used, the prevalence of overweight and obesity in U.S. adolescents ranges from 15 to 22 percent (86,241).[15] Obesity may have genetic origins (26,3 1,208), but it is also associated with diet and physical activity. The family environment and the community are important in explaining obesity in children and adolescents (166). Family involvement in active lifestyles and moderation in eating patterns is usually critical in preventing and avoiding obesity. Children in obese families expend less energy than those in lean families, possibly because they copy sedentary family lifestyles (10). Obese adolescents have lower than usual levels of physical activity (21), and even when obese adolescents are physically active, they are less so than their leaner peers (30).

Obesity in adolescents may be associated with other factors, such as socioeconomic status, rate of biological maturity, or race. Fatness and sedentary habits are more common in adults of lower socioeconomic status (78). Early maturing females tend to be fatter and are more likely to become obese as adults (79). Black female adolescents appear to be overweight more often than white female adolescents (116,1 17,233). However, this information may be confounded in part when considering that black body composition during adolescence differs from whites; black individuals have a higher bone and muscle mass so that overweight may not always mean overfatness at levels of moderate overweight. The risk of early obesity in Mexican American adolescents, especially for the central or trunkal type of obesity (highly associated with heart disease and diabetes mellitus), is extremely high (117,236).[16] Obesity is prevalent in some American Indian tribes (20a,152), but data on obesity in American Indian adolescents are very limited (20a).

Conclusions that many adolescents are overweight—and that fatness may be increasing among adolescents (53,54,55,87)17—may seem inconsistent with findings that U.S. adolescents' energy intakes are, on average, lower than recommended. It may be that U.S. adolescents are more sedentary than is assumed by NAS when formulating its recommended energy allowances.

Conclusions

Current national data on the food consumption patterns of U.S. adolescents are limited. Available evidence suggests that many U.S. adolescents do not follow the general dietary guidelines set forth in publications such as the NAS report *Diet and Health: Implications for Reducing Chronic Disease Risk (152)* or in USDA and DHHS' *Nutrition and Your Health: Dietary Guidelines for Americans (227) (see* box 7-B). Specifically, it appears that U.S. adolescents tend to consume excessive amounts of fat, saturated fat, cholesterol, sodium, and foods with low nutrient density. Recent studies have found school meals to be very high in fat,

Available evidence from the late 1970s suggests that while U.S. adolescents' diets generally provide enough protein, they tend to be deficient in some specific nutrients (e.g., iron, calcium, and vitamin B6) (152). This same source suggests, however, that, on average, U.S. adolescents consume more than sufficient amounts of other vitamins, minerals, and

[14]See ch. *4,* "Schools and Discretionary Time" in this volume for a discussion of what adolescents do during their time away from school.

[15]As noted earlier, obesity and overweight can be defined in different ways, *Obesity can be* defined as BMI greater than or equal to the 95th percentile of a similar population group (usually by age); or it can be defined as 20 percent or more over "normal" weight, *Overweight can* be defined as BMI greater than or equal to the 85th percentile of a similar population group. Measuring triceps skinfolds is another method of measuring obesity. A matter of contention, the method used to measure the ratio of body fat *does* affect prevalence and incidence rates of obesity in a population (86,91,132,241). Because of the rate of physiological change and consequent effect on fat distribution patterns during childhood and adolescence, some measures may not accurately reflect body fat in adolescents. Also, some studies refer to 'obese' and 'superobese' rather than 'overweight' and "obese' adolescents (86).

[16]These data have not been corrected for socioeconomic status levels; however, certain groups of Hispanics experience relatively high levels poverty. For further discussion, see ch. 18, "Issues in the Delivery of Services to Selected Groups of Adolescents, " in Vol. III.

[17]However, another study which used the same data set as many of these studies but different methods for measuring the amount of body fat did not show any secular increases in BMI in adolescents (91). Inconsistent conclusions maybe due to the different indices of obesity employed, and differences in age distributions and sample designs. However, no study suggests that the prevalence of obesity is decreasing among adolescents (142).

protein. Data on average nutrition in contemporary U.S. adolescents will become available in the mid- 1990s, but smaller regional studies are needed to determine nutritional deficiencies in some groups of adolescents.

Physical activity levels of most adolescents decline throughout adolescence. The best opportunity for physical activity for some adolescents, particularly low socioeconomic status adolescents, may be during school hours. But physical education classes during school currently provide little opportunity for actual physical activity.

Available evidence suggests that from 15 to 22 percent of U.S. adolescents are overweight or obese (86,241). Diets high in fats and low levels of physical activity are factors, in conjunction with the family environment and, possibly, genetic factors. Low-income adolescents and adolescents in some racial or ethnic groups are more likely to be overweight or obese than others.

Consequences of Adolescent Nutrition and Fitness Problems

Malnutrition, low levels of physical activity, obesity, and other nutrition and fitness problems experienced by U.S. adolescents have immediate consequences (e.g., failure to grow, decreased resistance to disease, lack of energy, obesity) and may also have long-term consequences. This section reviews evidence for both the immediate and long-term consequences of nutrition and fitness problems during adolescence.

Immediate Consequences of Nutritional and Fitness Problems During Adolescence

Immediate Consequences of Nutritional Problems--The biological functions of selected dietary substances in humans were reviewed in box 7-B earlier in this chapter. Insufficient caloric intake can lead to death by starvation and insufficient intake of vitamins and minerals can lead to diseases such as scurvy or pellagra. Fortunately, starvation and diseases caused by vitamin and mineral deficiencies are rare in this country (226).

Adolescents whose *caloric intakes are* **too** high may experience weight gain, leading to overweight or obesity. Those whose caloric intakes are low may experience weakness, weight loss, physical inactivity, and less than optimal growth (186).[18] Excessive leanness is associated with health problems and premature death. Meal skipping is associated with lower intakes of several nutrients on a daily basis. Recent data suggest that 5 percent of U.S. adolescents, especially females, are chronic meal skippers (142). This finding may be cause for concern because low calorie diets (e.g., under 1,800 calories) may make it difficult to meet intake standards for some essential nutrients, such as iron and calcium, without supplementation.[19]

As noted in box 7-B, *iron* deficiency may result in anemia, causing decreased physical ability, impaired body temperature regulation, lowered resistance to infection, and alterations in behavior and intellectual performance (49). *Calcium* intake and absorption are necessary for adequate bone growth during adolescence (152). *Zinc* deficiency has not been found to impair the capacity for aerobic exercise in animals (128), but strength may be affected (1 14).

Immediate Consequences of Low Levels of Physical Activity—During adolescence, physical activity can influence growth and development of skeletal bone, muscle, and fat (142). Health values of childhood physical activity include relationships to obesity (see below) and to physical fitness and functional capacity (196). In adults, participation in high-intensity aerobic exercise has been shown to improve self-concept (130) and this may also be true for adolescents.

Immediate Consequences of obesity-----obesity has immediate and delayed effects on social development and health (100,142). Poor body image and a decreased sense of personal worth are common among obese adolescents, especially if obesity dates from childhood (34,59,175). Obesity further encourages the tendency towards physical inactivity (10,142) and is associated with an increased risk of hypertension and high blood cholesterol (see below) (20,54, 71,85,180,246).

[18]Adolescents with the eating disorders anorexia nervosa and bulimia (discussed below) e x p e d i e n c e weight loss and other p threats to their health.

[19]In 1989, the NAS Food and Nutrition Board recommended that individuals eat diets composed of a variety of foods rather than rely on supplementation or fortification (153).

Risk of Chronic Diseases Later in Life

Some nutritional and fitness behaviors during adolescence, though not immediately threatening to the adolescent population, may be associated with chronic diseases later in life.

In a recent comprehensive review of the effects of diet on health, an NAS committee drew the following conclusion:

> A comprehensive review of the epidemiologic, clinical, and laboratory evidence indicates that diet influences the risk of several major chronic diseases. The evidence is very strong for atherosclerotic cardiovascular diseases and hypertension and is highly suggestive for certain forms of cancer (especially cancers of the esophagus, stomach, large bowel, breast, lung, and prostate). Furthermore, certain dietary patterns predispose to dental caries and chronic liver disease, and a positive energy balance produces obesity and increases the risk of non-insulin-dependent diabetes mellitus. However, the evidence is not sufficient for drawing conclusions about the influence of dietary patterns on osteoporosis and chronic renal disease (152).

The NAS committee also cautioned as follows, however:

> Most chronic diseases in which nutritional factors play a role also have genetic and other environmental determinants, but not all the environmental risk factors have been clearly characterized and susceptible genotypes usually have not been identified. Furthermore, the mechanisms of genetic and environmental interactions involved in disease are not fully understood. It is evident that dietary patterns are important factors in the etiology of several major chronic diseases and that dietary modifications can reduce such risks. Nevertheless, for most diseases, it is not yet possible to provide quantitative estimates of the overall risks and benefits (152).

It is important to note that the NAS committee did not specifically review the effects of adolescents' dietary patterns on health during adulthood. There is in general very little information on such effects. While more research on the impact of adolescent dietary patterns on adolescents' immediate and future health is clearly needed, the available research on diet and chronic disease suggests that adolescents might be well advised to follow prudent dietary recommendations and should receive continuing education about links between diet and health as such information becomes available.

Risk of Obesity—Though most obese adolescents do not become obese adults, it is difficult to predict (except for the most obese) who will persist in their obesity (242). It appears, however, that the risk of continued adult obesity rises the longer an adolescent remains obese (85). Continued obesity is especially likely to be associated with increased risks of later hypertension, high serum cholesterol and coronary artery disease, adult-onset diabetes mellitus, gall bladder disease, an increase in certain forms of cancer, and other medical problems (85,133, 237).

Risk of Coronary Artery Disease-Coronary artery disease in adults is highly associated with high cholesterol levels—particularly high low-density-lipoprotein (LDL) levels and low high-density-lipoprotein (HDL) levels—physical inactivity, and high blood pressure (139,206,251). The Pathobiological Determinants of Atherosclerosis in Youth (PDAY) and the Bogalusa Heart studies have recently shown that high LDL and low HDL levels in adolescence are associated with artery-narrowing plaque (139) and that high cholesterol levels may follow an adolescent into adulthood (251).

Recently, an expert panel on blood cholesterol levels in children and adolescents at the National Cholesterol Education Program of the National Institutes of Health suggested selective cholesterol screening of some children and adolescents (i.e., those who have a family history of premature cardiovascular disease or at least one parent with high blood cholesterol) (237). But in one study, the predictive value of the occurrence of high cholesterol in adolescence for high cholesterol in adulthood is questioned; of children with cholesterol concentrations exceeding the 75th percentile, 75 percent of the females as adults and 56 percent of males as adults did not qualify for intervention using the National Cholesterol Education Program criteria (118).

There is no evidence that fitness during adolescence has a direct effect on adult health, but establishing lifetime activities (e.g., walking, running, and cycling) during adolescence may encourage continued adult participation in physical activity (196). Increased physical activity in adults has been associated with an overall decreased risk of coronary heart disease (22,146,162,163,171,197).

Risk of Diabetes--Diabetes is the most common of the serious metabolic diseases (69). Type I

(insulin-dependent) diabetes usually begins in adolescence. Type 11 (non-insulin-dependent) diabetes usually begins in middle life or beyond.

The development of Type I diabetes occurs when an environmental event (e.g., a viral infection) triggers an autoimmune reaction in a genetically susceptible individual (69).

The development of Type II diabetes is less well understood (69). The disease runs in families, however, and the typical patient is overweight. As noted above, an NAS committee concluded that a positive energy balance (i.e., too many calories) produces obesity and thus increases the risk of Type II diabetes (152).

Risk of Cancer—Excess dietary fat and low intakes of plant foods and vitamin C are the dietary factors most strongly linked to increased risk of some cancers[20] (152). Generally, increased weight relative to height is associated with increased risk of cancer (195). Caloric expenditure or some other factor associated with physical activity in recreation or employment may be associated with decreased risk of some cancers (73,76,82,245).

Risk of Osteoporosis--Begin too thin is linked with osteoporosis in women and thinness is associated with poor nutrient (e.g., calcium) intakes (226). However, the relationship of dietary calcium to osteoporosis is uncertain (152,226). It does appear, however, that higher intakes of calcium and iron by women, especially during adolescence and early adulthood can increase bone mass and delay the onset of fractures later in life. The level of bone mass achieved at skeletal maturity (generally in the mid-twenties) is a major factor modifying the risk for fractures (152).

Conclusions

The consequences of adolescents' nutrition and fitness problems may directly affect individuals during adolescence or later in life. Some adolescents experience immediate effects, such as poor bone growth due to calcium deficiency, lack of energy due to iron-deficiency anemia, impaired resistance to infection, or obesity due to a combination of genetics, diet, and sedentary behavior.

Little research has been directed toward the effects of adolescent dietary and physical activity patterns on adult chronic disease, but some evidence suggests that the ultimate consequences of a long-term pattern of poor nutrition and low levels of physical activity may be life-threatening. As a consequence, the recent consensus document, *Hea1thy People* 2000, made the recommendations shown in box 7-D.

Adolescents With Particular Nutritional and Fitness Problems

Some adolescents have special nutritional and fitness problems. As discussed below, adolescents who are pregnant or lactating need increased energy intakes and other nutrients. Adolescent athletes also have special nutritional needs and subsequent problems. Other adolescents with special needs include adolescents with eating disorders such as anorexia and bulimia and adolescents with serious chronic physical or mental conditions and disabilities who may have either difficulty making proper nutritional choices, decreased mobility, or decreased access to facilities that provide exercise assistance.

Pregnant Adolescents[21]

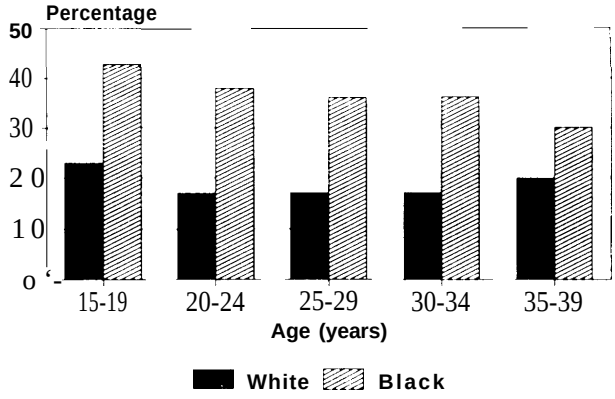
The diets of pregnant younger adolescents are often deficient in energy, calcium, and iron. Special problems with nutritional implications include gestational diabetes, pregnancy-induced hypertension, inadequate prepregnancy weight, inadequate weight gain during pregnancy, and iron-deficiency anemia (24).

Anemia during pregnancy is associated with premature delivery, low birth weight, and fetal death (80,148). The Centers for Disease Control's (CDC) 1987 Pregnancy Nutrition Surveillance System gathered hematologic data (which define anemia) on 63,709 low-income pregnant women from ages 15 to 39 (230). CDC found that the prevalence of anemia during the third trimester of pregnancy was higher in pregnant adolescents (ages 15 to 19) than in other age groups, and for all age groups, black women had a higher prevalence than white women (see figure 7-2).

[20]Available evidence from epidemiologic and animal research suggests that a high fat intake is associated with increased risk of cancers of the colon, prostate, and breast (152). Vitamin C may protect against stomach cancer (1 52). NAS found the evidence for protective effects of dietary fiber inconsistent (152).

[21]For further discussion, see ch. 10, "Pregnancy and Parenting: Prevention and Services," in this volume.

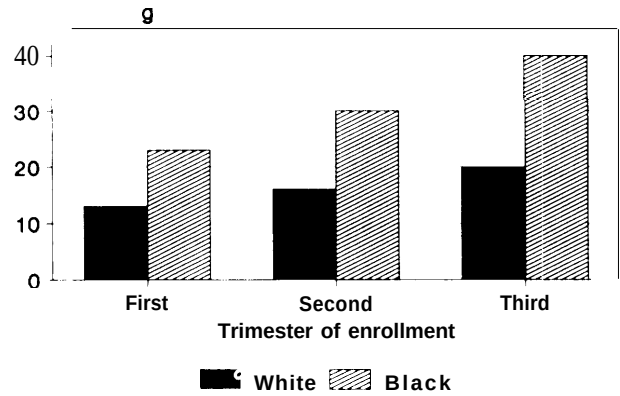
Figure 7-2—Prevalence of Anemia Among U.S. Women During the Third Trimester of Pregnancy, by Race and Age, 1987[a]



[a]Data are 1987 data from the Centers for Disease Control's pregnancy Nutrition Surveillance System.

SOURCE: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, "Anemia During Pregnancy in Low-Income Women, United States, 1987," Morbidity *and Mortality Weekly Report* 39(5):73-76, Feb. 9, 1990.

Figure 7-3-Prevalence of Anemia Among U.S. Women During the Third Trimester of Pregnancy, by Race and Trimester of Enrollment in Public Health and Nutrition Programs, 1987[a]



[a]Data are *1987 data* from the Centers for Disease Control's pregnancy Nutrition Surveillance System.

SOURCE: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, "Anemia During Pregnancy in Low-Income Women, United States, 1987," *Morbidity* arrd *Mortality Week/y Report* 39(5):73-76, Feb. 9, 1990,

According to the CDC study, there is some evidence that participation in public nutrition programs (e.g., the Special Supplemental Food Program for Women, Infants, and Children (WIC)[22]) may improve iron nutrition status and reduce the prevalence of anemia in all age groups of low-income pregnant women (see figure 7-3). The WIC program focuses on low-income pregnant and lactating women and on children under age 5. Only 3 percent of those participating in WIC are pregnant, breastfeeding, or postpartum females under age 18.[23]

Adolescent Athletes

Participating in activities that require a certain weight or body type may in some cases lead adolescents to engage in unhealthful behaviors, For example, activities that require thinness for either aesthetic or performance purposes (e.g., wrestling, gymnastics, dance) may cause adolescents to become undernourished, bulimic, anorexic, or amenorrheic (females), and affect testosterone levels (males) (136). Activities that require greater body mass may lead adolescents to use steroids or become susceptible to fraudulent health food claims (29,66). It is not clear to what extent coaches or physical education teachers currently work with adolescents so that they avoid unhealthful practices and obtain adequate levels of essential energy and nutrients.

Female Athletes-Female athletes may become amenorrheic, which can be detrimental to bone health; consequently these females can experience a higher prevalence of scoliosis (249) and stress fractures (17,121). They are also inclined toward vegetarianism (201), resulting in weight loss, and excessively low-fat fiber-rich diets which increase fecal loss of estrogens and reduce circulating estrogens (84,94). The quality of their diet itself' could help induce amenorrhea by altering reproductive hormone levels. Female athletes, more than males, are also likely to be iron deficient (158,178).

Male Athletes--Surveys of adolescents attending high school show an increasing consumption of illegal anabolic steroids[24] to increase muscle mass and strength for athletic competition (29). The use of anabolic steroids in adult strength-trained athletes affects blood lipid profiles; there is a 55-percent decline in HDL-cholesterol and a 25-percent in-

[22]See the section below on Federal programs pertaining to adolescent nutrition and fitness for a discussion of other Federal nutrition programs. Also see ch. 10, "Pregnancy and Parenting: Prevention and Services," in this volume for discussion of Federal programs available to pregnant adolescents.

[23]See ch. 19, "The Role of Federal Agencies in Adolescent Health," in Vol. III for more discussion of Federal agencies' emphasis on adolescents.

[24]The Anti-Drug Abuse Act of 1988 (Public Law 100-690) made unapproved use of anabolic steroids illegal.

Photo credit: Katherine Criss

Participating in activities that require a certain weight or body type may in some cases lead adolescents to engage in unhealthful behaviors such as having diets that are too low in essential nutrients.

crease in total cholesterol, indicating a possible higher risk for cardiovascular disease (95,250). These drugs also impair the metabolism of glucose (41,83) and favor net accretion of body protein, especially as muscle mass (66). Immediate effects such as acne, baldness, reduced libido, breast growth, impaired sexual function (257), and affective and psychotic symptoms (170) may present more persuasive arguments against their use by adolescent males as opposed to the more long-term effects such as cardiovascular disease.

Adolescents have much higher rates of sports injuries than younger children (75, 179).[25] Older adolescents (ages 16 to 19) experience more sports injuries requiring treatment than do other age groups (50). Overall, according to one survey of adolescents, males experience the most (almost 75 percent) sports-related injuries (129). Females, however, experience more injuries related to specifc activities and sports than males participating in the same activity or sport at a similar rate (9,169). According to Bar-Or, adolescent athletes and their coaches should be warned of the risk for low bone mineral stores (irrespective of calcium intake), fractures, and hypothermia or hyperthermia while exercising in cold or hot temperatures (16). The American Academy of Pediatrics Committee on Sports Medicine and Committee on School Health recommends that all coaches should be certified (4). Only 16 percent of high schools nationwide have a certified athletic trainer or comparable professional on staff (42).

Adolescents With Eating Disorders

Two serious eating disorders that afflict U.S. adolescents are anorexia nervosa and bulimia. Anorexia nervosa is a mental disorder characterized by an intense fear of becoming obese and a refusal to eat, leading to a significant weight loss (at least 25 percent of body weight) (6). Bulimia is a mental disorder characterized by a compulsion to binge and then purge the body by self-induced vomiting or use of laxatives (6). Adolescents with bulimia, most of whom are females, may experience weight fluctuations of more than 10 pounds.

Anorexia nervosa and bulimia present serious threats to adolescents' physical health, including dehydration, hormonal imbalance, and depletion of important minerals (1 1,25,77,92,99,106,112), Without treatment, including psychological counseling, medical treatment, and dietetic advice, some adolescents with anorexia may die. Bulimia can have serious consequences for adolescents' later physical development.

One recent survey suggests that the prevalence of anorexia among U.S. females ages 15 to 19 is 0.5 percent (126). The prevalence of bulimia in the U.S. population is estimated to be 2 percent (143). Adolescents with anorexia nervosa or bulimia need psychological counseling and medical treatment. Adults who teach, coach, or train adolescents should recognize signs of the eating disorders in their charges and refer those at risk for treatment. Student health services in schools should similarly be able to assist students with these problems.

[25] See ch. 5, "Accidental Injuries: Prevention and Services," in this volume.

Table 7-7—Examples of Chronic Diseases and Conditions With Nutrition and Fitness Implications Among U.S. Children Ages O to 20, 1980

Disorder	Prevalence per 1,000 children ages O to 20 years	Nutrition and fitness implications
Arthritis	2.20	Feeding difficulties, obesity, diet-drug interactions, mobility inhibited, possibly altered growth
Asthma	38.00	Mobility may be inhibited
Central nervous system injury	2.15	Feeding and mobility difficulties
Cerebral palsy	2.50	Feeding and mobility difficulties
Chronic renal failure	0.08	Therapeutic diets required, wasting and delayed growth common
Cleft lip or palate	1.50	Feeding difficulties if not repaired
Congenital heart disease	7.00	Therapeutic diets may be required if severe, mobility affected, diet-drug interactions, growth retardation
Cystic fibrosis	0.20	Therapeutic diets needed, diet-drug interactions, growth retardation
Diabetes mellitus	1.80	Therapeutic diets needed, diet-drug interactions, possible growth retardation, exercise must be planned
Down's syndrome	1.10	Feeding difficulties if severe, obesity, growth retardation
Leukemia	0.11	Anorexia at some stages, diet-drug interactions, growth retardation
Mental retardation	25.00	Feeding difficulties if severe, obesity, emaciation, growth retardation
Muscular dystrophy	0.06	Special forms and routes of feeding required, diet-drug interactions, feeding and mobility difficulties, growth retardation
Spina bifida	0.40	Therapeutic diets required, obesity, mobility problems
Phenylketonuria	0.10	Therapeutic diets required, growth retardation
Blindness	0.60	Feeding difficulties, obesity, mobility problems

SOURCE: Adapted from S.L. Gortmaker and W. Sappenfield, "Chronic Childhood Disorders: Prevalence and Impact," *Pediatric Clinics of North America 31*:3-18, *1984.* Reprinted by permission.

Adolescents With Chronic Conditions and Physical Disabilities

Serious chronic conditions and disabilities often have nutritional or fitness consequences for adolescents (see table 7-7).[26] Chronic conditions and disabilities that are indirectly associated with hypoactivity (abnormally low levels of activity) include massive obesity, asthma, diabetes, blindness, Down's syndrome, and mental retardation of other types (14,194,199,209).

Adolescents with disabilities that preclude walking tend to be fatter and less active than normal adolescents. Low physical activity may explain the lower aerobic ability and greater fatness found in blind adolescents (194). Although near normal aerobic fitness can be achieved, most blind adolescents lack sighted guides and adequate facilities to allow independent exercise (194). There are limited opportunities for adolescents with physical and developmental disabilities to engage in fitness-related activities, although there is considerable evidence that such activity would benefit such adolescents (160).

Nutrition counseling and interventions can help minimize or eliminate preventable causes of poor growth. Unfortunately, schools and school food services often lack technical skills or money to implement special health, food, and educational services often needed by disabled adolescents (93). The role of nutrition could be stressed in the care of disabled and chronically ill adolescents by, for example, including a nutritionist on the health care team or emphasizing nutrition in physical training programs.

[26] See ch. 6, "Chronic Physical Illnesses: Prevention and Services," in this volume for a discussion of the difficulties faced by many adolescents with serious chronic conditions and disabilities.

Photo credit: Jill Slater

Typically, physical fitness opportunities for children and adolescents with physical disabilities are limited. These early adolescents at the Kentucky School for the Deaf belong to a soccer team.

Phenylketonuria—Phenylketonuria is a genetic disorder of amino acid metabolism that is characterized by the inability to metabolize the amino acid phenylalanine (156,219). Although no abnormalities are apparent at birth, blood levels of phenylalanine rise rapidly after protein feedings are begun, and if diagnosis and dietary treatment is not begun within 30 days of birth, severe mental retardation will result (181).

Phenylalanine-restricted diets are known to enhance normal intellectual development in children with phenylketonuria. Studies suggest that continuation of such therapeutic diets throughout adolescence could maintain a child's intellectual achievement (38,124).

Juvenile-Onset Diabetes—As noted earlier, there are two major types of diabetes. Type I (insulin-dependent) diabetes typically has its onset in childhood or adolescence. Age 14 is the peak age for incidence of disease (69).

Insulin is required for treatment of all type I patients (69). In addition, adolescents with type I diabetes must follow a specified dietary regimen. Therapeutic diets, in conjunction with exercise and drug therapy, control some of the complications of type I diabetes (such as insulin shock, diabetic ketoacidosis, coma, and hypoglycemic reactions) (74). In adolescents, as well as adults, dietary cooperation is sometimes enhanced if the patient is occasionally allowed a special treat (e.g., a dessert ordinarily forbidden) with the understanding that resumption of the diet will begin the next day (69). Studies suggest that overweight diabetic adolescents could improve their carbohydrate metabolism by exercising regularly (144,176).

Adolescents **With Mental Retardation or Developmental Disabilities**

Mental retardation may be associated with secondary malnutrition, due to difficulties in feeding, or to inadequate care (12). Thus, the nutritional status of mentally retarded adolescents, living both in and outside of institutions, is of concern. According to teachers and parents, participation of mentally retarded adolescents in physical fitness programs has good psychological effects (199).

Emotionally Ill Adolescents

Some emotional disorders, or their treatments, have nutritional implications (e.g., some antidepressant drugs can affect the appetite). Nutritional guidance could be integrated into settings for mental health services provision. In adults, participation in high-intensity aerobic exercise has been shown to improve self-concept (130) and reduce depression (213). The possibility that aerobic exercise could be a beneficial addition to programs for troubled adolescents should be explored.

Conclusions

Certain populations of adolescents have special nutritional and fitness needs which may require attention by the adolescents themselves, their families, and the professionals around them. Heightened awareness of the importance of nutrition and fitness to the overall health of these adolescents (e.g., through nutrition education or physical education for the adolescents, or training programs for family and professionals) and providing opportunities to achieve nutrition and fitness goals (e.g., food programs or access to physical activity facilities) could help alleviate or prevent some problems experienced by these adolescents.

Prevention and Treatment of Nutrition and Fitness Problems

Adolescents' Nutritional Choices

The National Adolescent Student Health Survey in 1987 found that 37 percent of 8th and 10th graders ate breakfast every day (the survey period was the "previous week' '), 51 percent ate lunch every day,

and 68 percent ate dinner every day (7). In contrast, 16 percent *never* ate breakfast during the past week, 6 percent never ate lunch, and 1 percent never ate dinner. Females ate fewer meals in a week than males, and 10th grade females ate fewer meals than 8th grade females. The survey found that most (89 percent) of the surveyed 8th and 10th grade students who reported eating breakfast ate their breakfast at home, though some (7 percent) ate at school (7). Those who ate lunch, however, typically obtained it at school (72 percent v. 19 percent bringing lunch from home). Fewer 10th graders than 8th graders brought lunch from home (13 percent v. 19 percent) though more ate lunch someplace other than at school (13 percent v. 4 percent).

The National Adolescent Student Health Survey also showed that most 8th and 10th grade students snack (only 12 percent ate no snacks the day before), and further, that most (61 percent) of the snacks consumed were 'junk food' (chips, soda, candy, ice cream, or cake) rather than nutritious snacks (fruits, vegetables, nuts, juice, milk, yogurt, or cheese) (7). Male and female snacking behaviors were about the same.

As adolescents grow older, competing demands on their interests and energy and potent social forces (including peer pressures, busy schedules, and sports concerns) rise in importance (1 19,125,136,198,204, 253), while the importance that adolescents attach to nutrition may decline (125). In one study, 45 percent of junior high school students felt that nutrition is ''very important, ' as compared with 36 percent of senior high school students (125). Interestingly, nutrition decreased in importance at the same time that perceived control over nutritional choices increased. Fifty-six percent of junior high school students reported that they themselves have the most influence over what they eat, as compared with 74 percent of senior high school students (125).

Adolescents sometimes emphasize factors other than health or nutrition in making food choices (44). For example, weight was of great concern among adolescents surveyed in 1989, especially females; nearly half of all 11th and 12th grade students surveyed had been on a diet at least once, and the vast majority who had dieted did so for cosmetic rather than health reasons (125). Societal stresses on the cosmetic aspects of fitness are extreme and lead some adolescents to attempt to control weight and appear fit by restrictive (and potentially harmful) dieting (34) rather than by a combination of diet and physical activity. Increasingly, female adolescents are concerned about their weight at younger ages (113).

Influencing Adolescents' Nutritional Choices

Health Education

In 1985, only 12 States had mandated nutrition as a core content area in school health education (241). But, of the 80 percent of 8th and 10th graders surveyed in 1987 who had at least one health education class, 74 percent had received nutritional instruction in that class (7); this finding suggests that there is substantial dissemination of at least some nutrition information. In addition, community-based programs can reach targeted adolescent populations (e.g., pregnant adolescents not in school). USDA's Food and Nutrition Service has prepared nutrition advice and information, which is available for groups with special nutritional needs (222). Food and nutrition-related services in rural areas could be expanded and links with already existing services could be explored (e.g., the Cooperative Extension Service of USDA has offices in almost every county which is supported by a State office) (222). State health departments provide nutrition education materials, nutrition counseling, and nutrition consultation to targeted populations and to programs developed for them.

But increasing knowledge about proper nutrition alone does not necessarily improve eating habits. Although 67 percent of 11th and 12th grade students reported that saturated fat and cholesterol should not be eaten in excess, this knowledge had only a slight influence on consumption of foods high in these constituents (125). The manner in which the information is presented may influence its impact. For example, adolescents regard nutrition education curricula that neglect food preferences and other motivational factors as boring and irrelevant (33). Other school-based health promotion activities have been effective, however. For example, one school-based approach resulted in the short-term reduction of cardiovascular disease risk factors in 10th graders by modifying diet and exercise (1 10).

Marketing science experts recognize that adolescents have special wants, and they tailor appeals to the youth market to meet them (81). Appropriate motivation and modifications in the social environment help to persuade adolescents and adults to give

more priority to healthful food choices when they decide what to eat (253).

Food Labels

Data from the National Adolescent Student Health Survey in 1987 suggest that adolescents in the 8th and 10th grades are able to apply basic skills in solving nutrition-related consumer problems but lack certain specialized consumer information which would permit them to make wise food choices (7). Further, only 27 percent had previously received any education or instruction during school in interpreting food labels. The current national debate on the content of food labels (108,149) highlights the importance of information in making informed nutritional choices. In addition to recommending Federal regulations regarding nutrition labeling, a recent Institute of Medicine report calls for regulations that would require fast-food restaurants to provide nutrition information to consumers (149).

Menus in Schools and Institutions

Many schools incorporate the principles of USDA and DHHS *Dietary Guidelines for Americans (227) in their* meal planning (241). Nevertheless, it has been reported that school meals are high in fat (37,70,164). Modifying school menus appears to command some public support (216). One study successfully altered the diets of students by modifying the menu and the way foods were prepared (the polyunsaturated-to-saturated fat ratio of the diet of students who were served fat-modified diets increased significantly) (61).

Low-income adolescents in participating schools can receive breakfast and lunch at school free or at a reduced price (see section below on Federal programs). USDA prepares recipes for schools to use in planning their meals. Evaluations of these meal programs have shown that they have a positive overall effect on the nutritional intake of the participants (216), although as noted above, they may be high in fat.

Conclusions

Nutrition education, either as a component of school health education curricula or more targeted outreach programs, is available from a number of sources and most adolescents appear to receive some nutrition education, at least while they are in school. There is little information about the effect of nutrition education on adolescent dietary behaviors, though some studies show that there are effective interventions. Providing nutritional foods in meals provided by schools may provide as much benefit to adolescents as nutrition education does.

Influencing Adolescents' Physical Activity Levels

Physical Education in Schools

As noted above, students attend physical education classes in decreasing numbers throughout adolescence. Further, these classes do not provide much opportunity for physical activity (20 percent of class time) (13). The emphasis in physical education classes is on competitive sports rather than on activities and skills that can be more easily carried over to later years (e.g., swimming, tennis, and cycling) (13,196). Although there is little *adolescent specific* information on the effects of not participating in so-called ''lifetime" physical activity during adolescence, there is a general consensus that adolescents could benefit from additional physical activity (e.g., 3,241).

Community Facilities for Physical Activities

Several observers have suggested that every adolescent should have access to public facilities and community programs that encourage safe, beneficial, enjoyable physical activity (177,184). Many adults believe that greater availability of exercise facilities would help them become more involved in regular exercise (241). To OTA's knowledge, adolescents have not been asked about their recreational needs or preferences. A 1986 survey of municipal and county park and recreation departments found that the average number of citizens per managed acre was well within the standards set by the National Recreation and Park Association (138). But the numbers of trails (for hiking, jogging, bicycling, or cross-country skiing), pools, tennis courts, and basketball courts per citizen are below those suggested by the National Recreation and Park Association (138), and the DHHS publication *Healthy People 2000* recommends that communities establish additional opportunities for engaging in physical activity (box 7-D) (241).

Conclusions

Opportunities for adolescents to participate safely in physical activity are hampered by the current construction of school physical education classes, the lack of certified physical education teachers and

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Photo credits: Education Week (top photo); Benjamin Smith (bottom photo)

Some observers concerned about adolescent health have noted that opportunities for physical activity during adolescence tend to emphasize competitive sports (top) rather than activities and skills that can be more easily carried over to later years (bottom).

coaches, and the lack of community facilities for physical activity.

Interventions To Prevent or Reduce Adolescent Obesity

The effectiveness of specific treatment interventions to help obese adolescents appears to be dependent on a multiple approach that includes diet, exercise, behavioral techniques, and the support of families, communities, or peers (93a,97a,247). Further, some interventions to prevent obesity take an environmentally based approach meant to narrow the range of adolescents' food choices (61,97a).

Powerful predictors of success in fitness and obesity control include afterschool activities of adolescents at home and in the community (165). When parents and children participate in obesity control programs together and incorporate all program elements (e.g., behavior modification practices), they can be fairly effective (28). An example of a family-based program is Shapedown, which involves behavior modification, physical activity, modest reduction in food intake, and attention to the families' and adolescents' views of themselves (141a).

Clinical treatment of obesity has been found to be effective when it includes the traditional emphasis on increased physical activity with modest decreases in energy inputs combined with behavioral techniques (62), including self-monitoring diet and exercise, control of stimuli that precede eating, and reward of desirable behaviors.

One review of various treatment schemes for pediatric obesity suggests that the most effective school-based programs include exercise, nutrition, and behavior modification (248). Five elements are important for school-based programs: physical education programs, classroom education, the school lunchroom, the school health office, and liaison with home and community programs. Obese adolescents need help in setting realistic targets for fatness and weight loss (57,59,97a). Support programs using younger and older peers, with frequent reinforcement of progress from teachers, physical education instructors, school nurses, and others are also important (207).

Major Federal Programs Related to Nutrition and Fitness

U.S. Department of Agriculture

USDA is the Federal agency with major responsibility for Federal nutritional programs, including the collection of data on topics listed in box 7-A and the provision of food services for low-income people.

USDA's Human Nutrition Information Service conducts and interprets applied research in food and nutrition. Its responsibilities include monitoring food and nutrient content of American diets, assessing dietary status and trends in food consumption, understanding food choice influences, maintaining the national nutrient data bank on the nutrient content of foods, and developing information and techniques for making informed food choices.

USDA's Food and Nutrition Service administers the Federal Food Stamp Program and Child Nutrition Programs (including National School Lunch and Breakfast Programs, the Summer Food Service Program, the Special Supplemental Food Program for Women, Infants, and Children[27] and the Child Care Food Program).

The Food Stamp Program is a program that provides low-income individuals and families with children with noncash transfers which can be used only for food. Eligibility is based on family income. The amount of the benefit for each family is calculated based on a number of family-dependent factors (e.g., work and child care expenses) and on the cost of the Thrifty Food Plan (based on an inexpensive, but nutritionally sound diet). For those participating, the program has been associated with significant improvements in dietary intake (217). But, according to USDA's 1977-78 Nationwide Food Consumption Survey,[28] only 12 percent of low-income households spending at the full food stamp allotment obtained 100 percent of their recommended dietary allowances, and only a third obtained at least 80 percent (217).

Adolescents ages 15 to 17 make up 34 percent of the participants in the Food Stamp Program, but all eligible adolescents may not benefit. In 1979, less than 60 percent of all poor households participated in the Food Stamp Program (216).

Other food programs directly affecting adolescents are the School Breakfast and School Lunch programs, which provide meals for low-income school children free or at a reduced price depending on family income. The programs have been shown to increase the amount of food consumed by participants, as a supplement for family meals rather than as a substitute (216). A 1981 USDA study found that students from families qualifying for free or reduced-price meals were dependent on the National School Lunch Program for between 34 and 49 percent of their daily nutrient intake (217).

Forty-three percent of individuals in the National School Lunch Program and 24 percent in the School Breakfast Program are adolescents ages 13 to 18, (see table 7-8). In 1983,92 percent of all elementary and secondary schools participated in the National School Lunch Program (214), but the School Breakfast Program was available in only about a third of all schools (215). Schools that participate in the School Breakfast Program are generally located in low-income areas (215).

U.S. Department of Health and Human Services

Within DHHS, nutrition research and monitoring are principally conducted by two Public Health Service agencies: the Centers for Disease Control and the National Institutes of Health (see below). These make up the Department's major effort related to the nutrition of adolescents. Other nutrition-related services are provided to adolescents by the Bureau of Maternal and Child Health in the Health Resources and Services Administration of DHHS,[29] by the Indian Health Service, and by the Office of Human Development Services. The Office of the Assistant Secretary for Health compiles DHHS' Health Objectives for the Year 2000 (found in the recent DHHS publication, *Healthy People 2000),* which include nutrition- and physical activity-related policy objectives (box 7-D).

[27]The Special Supplement Food Program for Women, Infants, and Children (WIC) was mentioned in an earlier section about pregnant adolescents.

[28]Data from the 1987.88 Nationwide Food Consumption Survey were not available as of mid-1991.

[29]The Bureau of Maternal and Child Health provides nutritional support principally in the form of block grants to States for the prOviSiOn Of nutritional services. Also, funds for training public health nutritionists and research and program development projects are disseminated through the special programs of regional and national significance (SPRANS) program.

Table 7-8-Participation in the National School Breakfast and National **School Lunch Programs, 1983-84 School Year**

	Number of students participating in the program at least once per week (thousands)	Participation rate	Number of students participating on an average day (ADP) (thousands)	Average daily participation (ADP) rate
School Breakfast Program[a]				
All students	3,609	24.2?!	2,733	18.3%
Meal price status				
Free	2,564	53.9	2,107	44.3
Reduced	222	20,6	157	14.6
Full	823	9.0	469	5.1
Grade level				
1-3	1,316	31.3	1,049	25.0
4-6	1,337	31.5	1,027	24.2
7-9	614	17.4	425	12.0
10-12	342	11.6	232	7.8
School Lunch Program				
All students	30,078	77.570	25,550	65.9%0
Meal price status				
Free	9,763	96.2	9,319	91.8
Reduced	1,816	91.4	1,658	83.4
Full	18,497	69.4	14*574	54.7
Grade level				
1-3	8,327	87.9	6,916	73.0
4-6	8,535	85.0	7,644	76.1
7-9	7,373	76.0	6,230	64.2
10-12	5,841	61.0	4,761	49.7

[a]A student is a participant in the School Breakfast Program (School Lunch Program) if he or she selects one or more breakfasts (lunches) during a week. The *participation rate* is the number of participants divided by the total number of students in schools that offer the program. The number of students participating on an average day (ADP) is calculated as one-fifth the reported number of meals served in a week. The ADP rate is the ADP divided by the total number of students in schools that offer the program.

SOURCE: U.S. Department of Agriculture, Food and Nutrition Service, Office of Analysis and Evaluation, "Characteristics of the National School Lunch and School Breakfast Program Participants," Washington, DC, January 1988.

Centers for Disease Control

CDC works to promote sound nutritional habits through comprehensive school health programs. CDC's efforts include: 1) building consensus regarding priority nutrition intervention issues for the purpose of developing national guidelines; 2) collaborating with USDA to ensure that these guidelines incorporate the perspective of the Nutrition Education and Training Program and National School Lunch and Breakfast Programs; and 3) reviewing State policies relevant to nutrition intervention in schools and to school breakfast and lunch programs.

In addition, as noted earlier, CDC is developing the Youth Risk Behavior Surveillance System (YRBSS) to monitor trends in the prevalence of priority risk behaviors among youth at the national and State levels (see box 7-A). CDC also supported the 1987 National Adolescent Student Health Survey (7). The National Center for Health Statistics in CDC conducts the National Health and Nutrition Examination Survey (NHANES) and the National Health Interview Survey (NHIS) (see box 7-A), which collect nutrition and health data on adolescents.

National Institutes of Health

National Heart, Lung, and Blood Institute (NHLBI)--In April 1991, NHLBI issued the Panel Draft Report of the National Cholesterol Education Program, which called for all Americans over 2 years of age to adopt a low saturated fat, low cholesterol diet. Also, NHLBI is conducting a multicenter monitoring project to compare risk factors, such as hyperlipidemia and blood pressure, in black and white adolescent females.

National Cancer Institute (NCI)--NCI is supporting, through a collaboration between NCI and the American Cancer Society, a school-based nutrition education project to improve adolescent health. A curriculum for intermediate and secondary school students is being pilot tested in four regions. A companion manual for food service providers is also being tested as an aid in making school lunch

programs consistent with USDA and DHHS' *Dietary Guidelines for Americans (227).*

Conclusions and Policy Implications

Conclusions about U.S. adolescents' nutritional and fitness status are difficult to draw for several reasons. Current national data on U.S. adolescents' nutrition and fitness are not available. Research on nutrition and on fitness is hampered by inconsistent outcome measures and other methodological problems (225).

Extrapolating from available information, OTA concludes that the most prevalent nutritional problems among today's adolescents are overweight or obesity, iron deficiency anemia, and eating disorders. Obesity is often associated with low levels of physical activity and poor self esteem. Obese adolescents may be at increased risk of heart disease, hypertension, diabetes (particularly if obesity is continued during adulthood) and certain cancers. For female adolescents, especially female athletes and females who are pregnant, iron deficiency anemia is a particular problem, because it decreases physical ability, resistance to infection, and intellectual performance. During pregnancy, anemia can also affect the health status of the fetus (low birthweight, premature delivery, and fetal death). Calcium, another mineral often deficient in adolescent diets, is important for achieving peak bone growth. Female adolescents with anorexia nervosa or bulimia are at great risk of experiencing health problems and even death.

Some evidence suggests that the diets of American adolescents are high in fat and sodium. High-fat diets can contribute to obesity in the short term, and, if such diets persist, to the occurrence of some cancers (e.g., colon and breast), coronary heart disease, and non-insulin-dependent diabetes later in life (152). Some adolescents with physical disabilities or chronic diseases (e.g., diabetes) require special attention to meet their nutritional and physical activity needs. Some diseases and medications can affect the absorption of nutrients, and sometimes, therapeutic diets can help control diseases (e.g., diabetes). The availability of special health, food, and education services in schools and school food services for these adolescents is often limited.

U.S. adolescents' ability to make good nutritional choices and decisions about physical activity for themselves may be influenced by the information

Photo credit: Benjamin Smith, Washington, DC

Very often, adolescents have little control over the food available to them. Congress could support efforts to provide better nutritional choices to adolescents.

provided to adolescents (or lack of it) about the foods they eat and the effects of physical activity. Nutritional information about school menus and fast food meals may not be routinely available to adolescents (although some fast food restaurants make or plan to make nutritional information more accessible at point of purchase). Many health education classes include nutrition education as a component, but it is not clear that these classes alone significantly influence the eating habits of adolescents. Some evidence suggests that education curricula that take adolescents' preferences into account may be better received than curricula that do not. Most adolescents get breakfast and lunch from home or school, so food choices (at least for these two meals) may be dependent on whoever buys the groceries or plans the menus. There have been several calls to improve the nutritional content of school (37) and ''fast food' (27a) meals.

Access to fitness-promoting activities is apparently a problem for adolescents. Enrollment in physical education classes declines somewhat during the adolescent years; in any event, school-based physical education classes appear to provide little opportunity for actual physical activity.

For adolescents in general, there is little information about the specific benefits of physical activity; for example, there is no research to suggest that physical activity during adolescence leads to continued activity as an adult. It is clear, however, that increased physical activity could help overweight

adolescents reduce their weight and thereby reduce the immediate psychological consequences of obesity and the potential risk of future chronic diseases.

Specific policy options regarding adolescents' nutrition, physical activity, and physical fitness are listed in Volume I.

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