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Nutrition Monitoring in the United States

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Nutrition monitoring has been defined as "an ongoing description of nutrition conditions in the population, with particular attention to subgroups defined in socioeconomic terms, for purposes of planning, analyzing the effects of policies and programs on nutrition problems, and predicting future trends."[1] The nutrition monitoring program in the United States has evolved over the past century to meet data needs for nutrition policy and nutrition research. This section provides a brief review of the evolution of the nutrition monitoring program, summarizes the program's monitoring and surveillance activities during the past decade, and describes the links between nutrition monitoring, nutrition research, and nutrition policy.

Goal of the Nutrition Monitoring Program

The name of the National Nutrition Monitoring System (NNMS) was changed to the National Nutrition Monitoring and Related Research Program (NNMRRP) with the passage of the National Nutrition Monitoring and Related Research Act of 1990 (P.L. 101-445).[2-5] The goal of the nutrition monitoring program is to have a coordinated, comprehensive system that provides information about the dietary and nutritional status of the U.S. population, conditions that affect the dietary and nutritional status of individuals, and relationships between diet and health.

The program is composed of interconnected federal and state activities that provide information about the relationship between food and health. A general conceptual model representing this relationship is shown in Figure 15.1 and is comprised of five measurement components: nutrition and related health measurements; food and nutrient consumption; knowledge, attitudes, and behavior assessments; food composition and nutrient data bases; and food supply determinations.

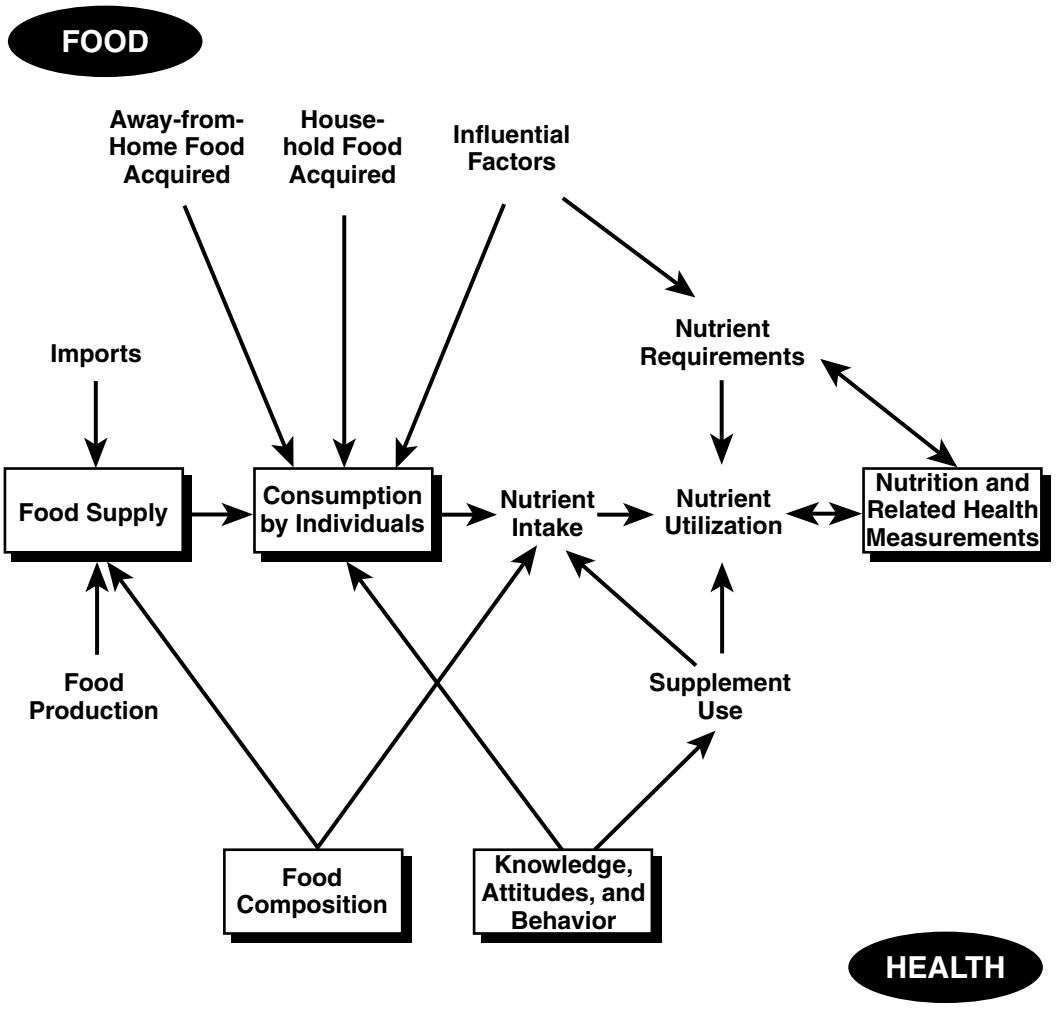

FIGURE 15.1
Food and health relationships. Source: Adapted from U.S. Department of Health and Human Services and U.S. Department of Agriculture. Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program. 1993.

Uses of Nutrition Monitoring Data

The nutrition monitoring program provides information for public policy decisions and scientific research (Table 15.1). Monitoring and surveillance data are used to identify high-risk population groups to plan public health intervention programs and target food assistance awareness efforts, establish the national health agenda and evaluate progress towards achieving national health objectives,[6,7] establish guidelines for the prevention, detection, and management of nutritional conditions,[8-14] and evaluate the impact of nutrition initiatives for military feeding systems.[15] Data are also used to monitor food production and marketing programs and their impact on the food supply.[7,16]

TABLE 15.1

Uses of Nutrition Monitoring Data[1]

Public Policy
Monitoring and Surveillance
Identify high-risk groups and geographical areas with nutrition related problems
Assess progress toward achieving the nutrition and health objectives in *Healthy People 2000 and 2010*[6,7]
Recommend guidelines for the prevention, detection, and management of nutrition and health conditions
Evaluate the effectiveness of nutritional initiatives for military feeding systems
Evaluate changes in agricultural policy, food production and marketing, that may affect the nutritional quality and healthfulness of the U.S. food supply
Develop reference standards for nutritional status
Programmatic
Develop nutrition education and dietary guidance (e.g., Dietary Guidelines for Americans and 5 A Day
Plan and evaluate food assistance programs
Plan and assess nutrition intervention programs and public health programs
Regulatory
Develop food labeling policies
Document the need for and monitor food fortification policies
Establish food safety guidelines
Scientific Research
Establish nutrient requirements through the lifecycle (Recommended Dietary Allowances and Dietary Reference Intakes)
Study diet-health relationships and the relationship of knowledge and attitudes to dietary and health behavior
Foster and conduct national and international nutrition monitoring research
Conduct food composition analysis
Study the economic aspects of food consumption and food security

[1] Adapted from the U.S. Department of Health and Human Services and U.S. Department of Agriculture. Ten-Year Comprehensive Plan for the National Nutrition and Related Research Program. 1993.

One example of the use of nutrition monitoring data for the development of population reference standards is the U.S. Growth Charts. Data from the third National Health and Nutrition Examination Survey (NHANES III) were used to develop the revised U.S. Growth Charts which were released in 2000.[17] The revised standards include charts for infants through 19 years of age, as well as a new chart for body mass index (BMI) by age.[17] The charts are included in the Anthro module of the computer software package EpiInfo, providing both z-scores and percentiles for each chart. NHANES trend data on anthropometric measures in children have been used by the U.S. Consumer Product Safety Commission to evaluate the need to revise standards for consumer items such as infant safety seats.[18]

Nutrition monitoring data are also used to estimate food insecurity in the U.S. Food security refers to assured access to nutritionally adequate and safe foods "without resorting to emergency food supplies, scavenging, stealing, and other coping strategies."[19] Efforts spearheaded by the private sector and academia began to pave the way toward a scientific basis for defining and measuring food insecurity and hunger in the mid-1980s.[20-22] Although national surveys such as NHANES and the USDA's food consumption surveys used questions related to a food security construct as early as 1977,[23-27] the Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program called for the development of a standard measure of food insecurity.[4] Research

and refinement led to an 18-item food security scale that was first included as a supplement to the 1995 Current Population Survey.[23] Using the scale, it is estimated that the prevalence of food security in U.S. households is approximately 88%.[28] A number of nationally representative surveys of the U.S. population have begun to incorporate this standard measure, and a number of state and local surveys are including an abbreviated short form.[29] Policy documents like *Healthy People 2010*[7] and the U.S. Action Plan on Food Security[30] use the food security measure to assess progress, and the scale can also be used as a yardstick by which to evaluate federal food and nutrition assistance programs with respect to welfare reform.

Programmatic uses of nutrition monitoring data include developing and promoting nutrition education activities and programs such as the Dietary Guidelines for Americans[31] and 5 A Day for Better Health,[32] public health programs such as the National Cholesterol Education Program[8] and the National High Blood Pressure Education Program,[9] and federally supported food assistance programs such as the Food Stamp Program and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).[33,34]

Regulatory uses of nutrition monitoring data include developing food fortification,[35,36] food safety,[16] and food labeling policies to inform consumers.[37] Nutrition monitoring data have been used by regulatory agencies to examine U.S. food fortification policies[35,36] and to provide dietary exposure estimates for nutrient and non-nutrient food components.[16] For example, dietary intake and serum data collected in NHANES III were used to assess folate status and the relationship between serum determinations, diet, and other nutrition and health variables prior to folate food fortification rulemaking by the Food and Drug Administration (FDA).[36,38]

Scientific research uses of nutrition monitoring data range from revising the standards of human nutrient requirements[39-41] to studying the relationship between diet, nutrition, and health. National data on the population's dietary intakes and serum nutrient levels have been used extensively for the investigation of nutrient requirements throughout the lifecycle and for the development of the Dietary Reference Intakes by the National Academy of Sciences (NAS).[39,40] Continued research to develop nutrition status indicators will be important for future monitoring efforts.

Nutrition monitoring data are essential to identify food and nutrition research priorities of significance to public health.[6,7,13,14,42,43] National nutrition data have been used for scientific reviews such as The Surgeon General's Report on Nutrition and Health[13] and the NAS report on Diet and Health: Implications for Reducing Chronic Disease Risk.[14] Such scientific reviews often form the basis for the development of nutrition policies. Other research is focused on studying the relationships between knowledge and attitudes to dietary and health behavior, the economic aspects of food consumption and food security, and food composition analysis.

The increased prevalence of overweight and obesity in the U.S. is the current focus of public health nutrition efforts. Using standardized international health-based definitions for men and women aged 20 to 74 years, the age-adjusted prevalence of overweight (BMI > = 25) was 59%, and obesity (BMI > = 30.0) was 20% in NHANES III (1988-94), compared to 51 and 12%, respectively, in NHANES II (1976-80).[7,44] This increasing trend has also been observed for adolescents, children, and preschoolers.[45,46] Using the 95th percentile of BMI from NHANES II as the definition of overweight and the 85th to 95th percentile as the definition of risk for overweight, 11% of children and adolescents were overweight and another 14% were at risk for overweight during 1988 to 1994.[45] The prevalence of overweight in children and adolescents increased from about 5% in the 1960s and 1970s.[45]

NHANES III anthropometry data serve as the baseline measures for the *Healthy People 2010* weight objectives.[7] Future NHANES data will be used to track progress in reducing the prevalence of overweight and obesity. The NIH Obesity Initiative is aimed at public

health efforts to reduce overweight and foster collaborative research to better understand the etiology and prevention of obesity.[10,47] National and state nutrition monitoring data on dietary intake, physical activity patterns, weight loss efforts, and consumer knowledge, attitudes, and behaviors will be important for public health education and research efforts to reduce the prevalence of overweight and obesity in the U.S.

History of the Nutrition Monitoring Program: Milestones and Publications

Informally, the nutrition monitoring system had its genesis at the end of the 19th century. Early studies on food and nutrition were begun by Dr. W. O. Atwater in the 1890s.[48] These small-scale studies aimed to help the working class achieve good diets at a low cost. The first national survey, the Consumer Purchases Study of 1936-37, provided a comprehensive picture of household food consumption and indicated that one-third of the nation's families had diets that were poor by nutritional standards. In the late 1960s, concerns about the nutritional status of the U.S. population re-emerged as a result of widespread hunger. Not only was Congress concerned about the extent to which people were affected by hunger, but also by the Federal government's inability to document the problem because of a lack of nutrition monitoring coordination. A 1977 act of congress required the U.S. Department of Agriculture (USDA) and the U.S. Department of Health, Education, and Welfare (currently Department of Health and Human Services [HHS]) to develop plans to coordinate the two largest components of the monitoring program, DHHS's National Health and Nutrition Examination Survey and USDA's Nationwide Food Consumption Survey (NFCS).[49] It also mandated the development of a reporting system to translate the findings from these two national surveys and other monitoring activities into periodic reports to Congress on the nutritional status of the American population. A 1986 report, the first progress report on nutrition monitoring, provided an overview of the dietary and nutritional status of the population and recommendations for improvements in the monitoring program.[50] In 1989, the report was updated by an expert panel.[51]

In 1988, the Interagency Committee on Nutrition Monitoring (ICNM) was established to provide a formal mechanism for improving the planning, coordination, and communication among agencies.[52] As a first step, the Directory of Federal Nutrition Monitoring Activities was published in 1989.[53] It was updated and expanded in 1992 to include state surveillance efforts,[54] and in 1998 it became available on the Internet.[55] The most recent version was published on the Internet in 2000.[56] The publication is used extensively as a resource for finding nutrition monitoring data sources, contact persons, and published references.

The *National Nutrition Monitoring and Related Research Act* of 1990 (P.L. 101-445)[3] established several mechanisms to ensure the collaboration and coordination of federal agencies as well as state and local governments involved in nutrition monitoring. Under the act, the Secretaries of DHHS and USDA have joint responsibility for implementation of the coordinated program and the transmission of required reports to Congress via the President. The ICNM was formalized and became the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR), which currently includes 22 agencies that contribute to or use national nutrition monitoring data. The IBNMRR serves as the central coordination point for federal nutrition monitoring activities. The board coordinates the preparation of the annual budget report on nutrition monitoring and biennial reports on progress and policy implications of scientific findings to the President and Congress, and the periodic scientific reports that describe the nutritional and related health status of the

population to Congress. In 1993 and 1995, respectively, the Board published Chartbook I: Selected Findings from the National Nutrition Monitoring and Related Research Program[57] and the Third Report on Nutrition Monitoring in the United States.[58]

Three staff working groups (Survey Comparability, Food Composition Data, and Federal-State Relations and Information Dissemination and Exchange [Federal-STRIDE]) were established under the board to improve communication and coordination among member agencies on high-priority issues. After the welfare reform law was enacted in 1996, a fourth group — the Welfare Reform, Nutrition, and Data Needs Working Group — was established to determine whether federal surveys and surveillance systems represented by the IBNMRR could capture the effects of welfare reform on nutrition, hunger, and health status, identify gaps in data collections, encourage use of comparable data collection among surveys, serve as a repository on national nutrition survey efforts related to welfare reform, and foster collaborative research on nutrition and welfare reform. The group has been quite active and now includes federal as well as non-federal members.

The act also established the National Nutrition Monitoring Advisory Council (NNMAC) to provide scientific and technical guidance to the IBNMRR. The council includes nine members (five appointed by the President and four by Congress) with expertise in the areas of public health, nutrition monitoring research, and food production and distribution.

Finally, the 1990 act called for the development of a Ten-Year Comprehensive Plan.[59] The plan includes three primary goals: to provide for a comprehensive National Nutrition Monitoring and Related Research Program (NMRRP) through continuous and coordinated data collection, improve the comparability and quality of data across NNMRRP, and improve the research base for nutrition monitoring. These national goals are complemented by state and local objectives to strengthen data collection capacity, improve the quality of state and local data, and improve methodologies to enhance comparability of NNMRRP data across national, state, and local levels. Table 15.2 includes a summary of the nutrition monitoring program's history.

TABLE 15.2

Milestones and Publications of the National Nutrition Monitoring and Related Research Program

1977	*Food and Agriculture Act* (P.L. 95-113) passed
1978	Proposal for a comprehensive nutritional status monitoring system submitted to Congress
1986	First progress report on Nutrition Monitoring in the United States published
1988	Interagency Committee on Nutrition Monitoring formed
1989	Second progress report on Nutrition Monitoring in the United States and The Directory of Federal Nutrition Monitoring Activities published
1990	*National Nutrition Monitoring and Related Research Act* (P.L. 101-445) passed
1991	Interagency Board for Nutrition Monitoring and Related Research established through incorporation and expansion of the ICNM
	Proposed Ten-Year Comprehensive Plan for the Nutrition Monitoring and Related Research Program published for comment
1992	National Nutrition Monitoring Advisory Council formed
	The Directory of Federal and State Nutrition Monitoring Activities published
1993	Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program published
	Chartbook I: Selected Findings from the National Nutrition Monitoring and Related Research Program published
1995	Third progress report on Nutrition Monitoring in the U.S. published
1998	The Directory of Federal and State Nutrition Monitoring and Related Research Activities published
2000	The Directory of Federal and State Nutrition Monitoring and Related Research Activities revised and published

Nutrition Monitoring Measurement Components

The NNMRRP aims to study the relationship between food and health through data collection in five measurement component areas. Since the 1930s, more than 40 surveys and surveillance systems have evolved in response to the information needs of federal agencies and other nutrition monitoring data users. Chronological listings of past nutrition monitoring surveys and activities have been published.[4,5,59-61] Subsumed under each area is a host of studies, surveys, surveillance programs, and related research. Table 15.3 summarizes the major activities since 1990 by measurement area. Brief descriptions of surveys and surveillance systems are summarized below and have been described in detail elsewhere.[4,5,53-58,60,62] The Directory of Federal and State Nutrition Monitoring and Related Research Activities includes additional information. As an Internet publication, each survey synopsis contained in the directory includes a hypertext link for more information on each activity (http://www.cdc.gov/nchs/data/direc-99.pdf).

Nutrition and Related Health Measurements

Nutrition and related health data have a wide variety of policy, research, health and nutrition education, medical care practices, and reference standards applications. The cornerstone of this NNMRRP measurement component, NHANES, provides national data on the nutritional status, dietary intake, and numerous health indices of the U.S. population.[3-5,58,60-64] It also provides national population reference distributions, national prevalences of diseases and risk factors, and trends in nutritional and health status over time. NHANES followup studies allow epidemiologic investigations of the relationships of nutrition and health to risk of death and disability. The current NHANES (1999+) has a continuous annual design, and oversampling of Mexican Americans, blacks, older persons, adolescents, and pregnant females in the first three years.

The National Health Interview Survey provides information about self-reported health conditions annually and about special nutrition and health topics periodically, such as vitamin/mineral supplement usage, youth risk behavior, food program participation, diet and nutrition knowledge, cancer, and disability and food preparation. Other special topical modules relate to tracking of our nation's health and nutrition objectives.

Recently, a number of health care provider record-based surveys were merged and expanded into one integrated survey called the National Health Care Survey. Data on alternative health care settings, such as ambulatory surgical centers, hospital outpatient departments, emergency rooms, hospices, and home health agencies, are being collected through this system. The survey provides information on the availability and utilization of dietary and nutritional services in these types of agencies. For hospital outpatient visits, information is obtained about physician-reported hypertension and obesity, and counseling services for diet, weight reduction, and cholesterol reduction. The survey also provides information on hospitalizations resulting from nutrition-related diseases.

A number of other surveys and surveillance systems, primarily conducted by the Centers for Disease Control and Prevention (CDC), also contribute nutrition-related health information, particularly for low-income pregnant women, infants, and children who participate in publicly funded health, nutrition, and food assistance programs.[62,65,66] These surveillance systems provide data representative of the population in participating states and include physical measures such as height, weight, hemoglobin, and hematocrit.

TABLE 15.3

Federal Nutrition Monitoring Surveys and Surveillance Activities Since 1990

Date (initiated)	Dept.	Survey	Sample Size and Target U.S. Population
Nutrition and Related Health Measurements			
Continuous (1915)	HHS	National Vital Registration System	All births and deaths in the total U.S. population
Annual (1957)	HHS	National Health Interview Survey (NHIS)	Civilian, noninstitutionalized household population (N = 103,477 individuals and N = 39,832 households in 1997)
1985, 1990, 1998	HHS	National Health Interview Survey on Health Promotion and Disease Prevention	Civilian, noninstitutionalized household population in the U.S., ages 18+ y (N = 41,104 households in 1990)
1987, 1992	HHS	National Health Interview Survey on Cancer Epidemiology and Cancer Control	Civilian, noninstitutionalized household population ages 18+ y in the U.S. (N = 12,000 households in 1992)
1991	HHS	1991 National Health Interview Survey on Health Promotion and Disease Prevention	Civilian, noninstitutionalized, household population of the United States, ages 18+ y (N = 43,732 households)
1992–1993	HHS	National Health Interview Survey on Youth Behavior Supplement	Youth ages 12-21 y (N = 10,645 households)
1994	HHS	National Health Interview Survey on Disability	Civilian, noninstitutionalized household population (N = 107,469 households)
1993, 1995	HHS	National Health Interview Survey Year 2000 Objectives Supplement	Civilian, noninstitutionalized household population in U.S., ages 18+ y (N = 17,317 households in 1995)
1990, 1995 (1973)	HHS	National Survey of Family Growth	Women, 15-44 y (N = 10,847 households in 1995)
Continuous (1973)	HHS	Pregnancy Nutrition Surveillance System (PNSS)	Low-income, high-risk pregnant women participating in programs in 18 states, the Navajo Nation, and the Intertribal Council of AZ (N = 599,000 records in 1995)
Continuous (1973)	HHS	Pediatric Nutrition Surveillance System (PedNSS)	Low-income, high-risk children, birth-17 y in participating programs in 43 states and DC, Puerto Rico, and 6 Indian reservations (N = 8,800,000 records in 1995)
1988–1990	HHS	National Maternal and Infant Health Survey	Women, hospitals, and prenatal care providers associated with live births (N = 9953), still births (N = 3309), and infant deaths (N = 5332)
1988–1994	HHS	Third National Health and Nutrition Examination Survey (NHANES III). Followup study is under consideration	U.S. noninstitutionalized, civilian population, 2+ mo; Oversampling of blacks and Mexican-Americans, children 0-5 y, and individuals 60+ y (N = 33,994 individuals interviewed; N = 31,311 individuals examined)
1989–1993	HHS	National Health and Nutrition Examination III Supplemental Nutrition Survey of Older Americans	NHANES III (1988-91) examinees 50+ years (N = 2602 completed NHANES III dietary recall (DR) and 1st SNS interview; N = 2519 completed NHANES III DR and 2nd SNS interview; N = 2261 completed NHANES III DR and 2 SNS interviews)

1990–1991	HHS	Survey of Heights and Weights of American Indian School Children	American Indian school children, ages 5-18 y (N = 9464 children in 1990-91 school year)
1991–1992	HHS	Navajo Health and Nutrition Survey	Persons ages 12+ y residing on or near the Navajo reservation in AZ, NM, and CO (N = 985 examined)
1991–1992	HHS	Longitudinal Followup to the National Maternal and Infant Health Survey	Participants of the 1988 NMIHS (N = 9400 mothers of 3 yr olds; N = 1000 women who had infant deaths; N = 1000 women who had late fetal deaths in 1988
1992	HHS	NHANES I Epidemiologic Followup Study	Individuals examined in NHANES I, 25-74 y at baseline, 1971-74 (N = 9281, 1992 cohort)
Continuous (1992)	HHS	NHANES II Mortality Followup Survey	Individuals examined in NHANES II, 30-74 y at baseline, 1976-80 (N = 9252)
Continuous (1992)	HHS	Hispanic HANES (HHANES) Mortality Followup Survey (in progress)	Individuals interviewed in HHANES, 20-74 y at baseline, 1982-84 (N = NA)
Annual (1992)	HHS	National Health Care Survey (integrates: National Home and Hospice Care Survey (1992-94; 1996), National Nursing Home Survey (since 1973-74) and Followup (1995, 1997), National Hospital Discharge Survey (since 1965), National Ambulatory Medical Care Survey (since 1973), National Hospital Ambulatory Medical Care Survey (1992), and National Survey of Ambulatory Surgery (1994-96)	Record-based health care provider surveys including: visits to hospital emergency and outpatients departments of non-Federal, short-stay, general and specialty hospitals and ambulatory surgical centers; office visits to non-Federal, office-based physicians; and home health agencies and nursing homes (N = 11,396 for 1996 NHHCS; N = 9556 for 1995 NNHS; N = 282,525 for 1995 NHDS; N = 32,978 for 1996 NAMCS; N = 52,194 for 1996 NHAMCS; N = 125,751 for 1996 NSAS)
Continuous (1992)	HHS	NHANES III Mortality Followup Survey	Individuals interviewed and examined in NHANES III, 20+ y at baseline, 1988-94 (N = NA)
1996–1999	HHS	Demonstration Sites for PedNSS and PNSS	Low-income, high risk women, infants, and children that participate in government food assistance programs and participate in PedNSS and PNSS (N = minimum of 1000 children in WIC for PedNSS; N = minimum of 300 women in WIC for PNSS)
1999+	HHS	National Health and Nutrition Examination Survey	Civilian, noninstitutionalized individuals. Oversampling of blacks, Mexican-Americans, adolescents, older persons, and pregnant women in the first 3 years. (N = NA)
Food and Nutrient Consumption			
Continuous (1917)	DOD	Nutritional Evaluation of Military Feeding Systems and Military Populations	Enlisted personnel of the Army, Navy, Marine Corps, and Air Force (N = 20-240 depending on study focus)
Annual supplement (1995)	BLS; CB; USDA	Current Population Survey, Supplement on Food Security	Civilian, noninstitutionalized U.S. population (N = approx. 59,500 for CPS)

TABLE 15.3 *(Continued)*

Federal Nutrition Monitoring Surveys and Surveillance Activities Since 1990

Date (initiated)	Dept.	Survey	Sample Size and Target U.S. Population
Continuous (1980)	DOL	Consumer Expenditure Survey	Civilian, noninstitutionalized, population and a portion of the institutionalized population (N = 5000 in quarterly interview survey of consumer unites; N = 6000 diary surveys of consumer unites kept for 2 consecutive 1-week periods)
Continuous (1983)	DOC	Survey of Income and Program Participation (SIPP)	Civilian, noninstitutionalized population of the U.S. (N = 11,600-36,800 households in a continuous series of panels)
1994, 1996 (1984)	USDA	Study of WIC Participants and Program Characteristics	WIC participants using mail surveys of State and local WIC agencies, record abstractions at local WIC service sites and, in 1988, interviews with participants (N = 7,000,000+ individuals in 1996)
1988–1994	HHS	NHANES III and Supplemental Nutrition Survey of Older Americans	See NHANES III listing above. Individuals ages 50+ y examined in NHANES III with telephones (See listing above for N)
1989–1991, annual 1994–1996, annual (1985-1986)	USDA	Continuing Survey of Food Intakes by Individuals (CSFII) (Intake of Pyramid Servings and Servings database 1994-1996)	Females 19-50 y and their children 1-5 y and males 19-50 y residing in households in 48 conterminous States in 1985-86, individuals of all ages residing in households in 48 conterminous States in 1989-91, and nationwide in 1994-96; oversampling of individuals in low-income households; individuals 2+ y from CSFII 1994-96 (N = 15,303 in 1994-96)
1989-91	HHS	Strong Heart Dietary Survey	American Indian adults ages 45-74 y in SD, OK, and AZ (N = 888)
1991–1992	DOC	Development of a National Seafood Consumption Survey Model	Individuals residing in eligible households and recreational/subsistence fishermen (N = —)
1992	USDA	School Nutrition Dietary Assessment Study	School-age children in grades 1-12 in 48 conterminous States and D.C. (N = 380 school districts; N = 607 schools; N = 4489 students)
1992	USDA	Adult Day Care Program Study	Adult day care centers and adults participating in the Child and Adult Care Food Program (N = 282 CACFP Centers; N = 282 non-CACFP Centers; N = 942 participating adults)
1994–1995	USDA	WIC Infant Feeding Practices Study	Nationally representative sample of WIC mothers and infants living in the 48 contiguous States, the District of Columbia and the 33 WIC agencies on Indian reservations (N = 971)
1995	USDA	Early Childhood and Child Care Study	Child care sponsors, providers, and children participating in the CACFP (N = 566 sponsors; N = 1962 providers; N = 1951 households; N = 2174 child-day observations)
1997–1998	USDA	Supplemental Children's Survey	Noninstitutionalized children 0-9 y in households in the U.S.; oversampling of low-income households (N = approx 5000)
1998	USDA	School Nutrition Dietary Assessment Study II	School-age children in grades 1-12 in 48 conterminous States and D.C. (N = approx 1152 schools)
1999+	HHS	National Health and Nutrition Examination Survey	Civilian, noninstitutionalized individuals. Oversampling of blacks, Mexican-Americans, adolescents, older persons, and pregnant women in the first 3 years (N = approx 3200)

Knowledge, Attitudes, and Behavior Assessments

Continuous (1984)	HHS	Behavioral Risk Factor Surveillance System	Individuals 18+ y residing in households with telephones in participating States (N = approx 2039 per state in all 50 states for 1995)
1990, 1994 (1982)	HHS	Health and Diet Survey	Civilian, noninstitutionalized individuals in households w/telephones, 18+ y (N = 5005 in 1995)
1989–1991 1994–1996	USDA	Diet and Health Knowledge Survey	Main meal-planner/preparers in households participating in 1989-91 and 1994-96 CSFII (N = 5765 for 1994-96)
Annual (1990)	HHS	Youth Risk Behavior Survey (YRBS)	Youths attending school in grades 9-12 and 12-21 y of age in households in 50 States, D.C., Puerto Rico, and Virgin Islands (N = approx 12,000 for the National surveys and N = approx 2000 for the State and local surveys)
1990	HHS	Cholesterol Awareness Survey — Physicians' Survey	Physicians practicing in the conterminous U.S. (N = 1,604)
1990–1991	HHS	Nationwide Survey of Nurses' and Dietitians' Knowledge, Attitudes, and Behavior Regarding Cardiovascular Risk Factors	Registered nurses and registered dietitians currently active in their professions (N = 7200 registered nurses; N = 1621 occupational health nurses oversample; N = 1782 registered dietitians)
1990–1991	HHS	Nutrition Label Format Studies	Primary food shoppers, ages 18+ y (N = 2676)
1991	HHS	Weight Loss Practices Survey	Individuals currently trying to lose weight, ages 18+ y, in households with telephones (N = 1232 current dieters; N = 205 African American oversample; N = 218 nondieting controls)
1991	HHS	5 A Day for Better Health Baseline Survey	Individuals ages 18+ y with telephones (N = approx. 2059)
1992–1993; 1998	HHS	Consumer Food Handling Practices and Awareness of Microbiological Hazards Screener	Individuals in households w/telephones, 18+ y (N = 1620)
1993–1994	HHS	Infant Feeding Practices Survey	New mothers and healthy, full-term infants 0-1 y (N = 1200)
1994–1995	USDA	WIC Infant Feeding Practices Survey	Prenatal and postnatal women and their infants participating in the WIC program (N = 971)

Food Composition and Nutrient Databases

Continuous (1892)	USDA	National Nutrient Data Bank Food Composition Laboratory	(N = —)
Annual (1961)	HHS	Total Diet Study	Representative diets of specific age-sex groups (N = —)
1991–1993, 1993–1994, 1995–1996 (1977)	HHS	Food Label and Package Survey	(N = 1250 food brands)

TABLE 15.3 *(Continued)*

Federal Nutrition Monitoring Surveys and Surveillance Activities Since 1990

Date (initiated)	Dept.	Survey	Sample Size and Target U.S. Population
Continuous (1977)	USDA	Survey Nutrient Data Base for CSFII 1989-91, 1994-96; NHANES III 1988-94	(N = —)
1988–1994	HHS	Technical Support Information for the NHANES III, 1988-94 Dietary Interview Data Files	(N = —)
1994–1996	USDA	CSFII 1994-96 Technical Support Files Food Coding Database Recipe Database Survey Nutrient Database and Related Files	(N = —)
Food Supply Determinations			
Annual (1909)	DOC	Fisheries of the United States	(N = —)
Annual (1909)		U.S. Food and Nutrition Supply Series:	(N = —)
	USDA	Estimates of Food Available	
	USDA	Estimates of Nutrients	
Continuous (1985)	USDA	A.C. Nielsen SCANTRACK	(N = 3000 supermarkets since 1988)

Abbreviations: ARS, Agricultural Research Service; ASPE, Assistant Secretary for Planning and Evaluation; BLS, Bureau of Labor Statistics; CACFP, Child and Adult Care Food Program; CB, Census Bureau; CDC, Centers for Disease Control and Prevention; DOC, Department of Commerce; DOD, Department of Defense; DOL, Department of Labor; FDA, Food and Drug Administration; ERS, Economic Research Service; FNS, Food and Nutrition Service; HHS, Department of Health and Human Services; HNIS, Human Nutrition Information Service*; HRSA, Health Resources Services Administration; IHS, Indian Health Service; NCCDPHP, National Center for Chronic Disease Prevention and Health Promotion; NCHS, National Center for Health Statistics; NCI, National Cancer Institute; NHLBI, National Heart, Lung, and Blood Institute; NIH, National Institutes of Health; NA — not applicable; NMFS, National Marine Fisheries Service; NOAA, National Oceanic and Atmospheric Administration; SSA, Social Security Administration; ASARUM, U.S. Army Research Institute of Environmental Medicine; USDA, U.S. Department of Agriculture.

* HNIS was integrated into ARS in 1994.

— = Not applicable

NA = Not available

The Pediatric Nutrition Surveillance System (PedNSS), sponsored since 1973, is used to monitor simple key indicators of nutritional status among low-income, high-risk infants and children who participate in publicly funded health, nutrition, and food assistance programs.[66] Data can be analyzed at individual, clinic, county, state, and national levels. The Pregnancy Nutrition Surveillance System (PNSS), sponsored since 1978, tracks nutrition-related problems and behavioral risk factors associated with low birth weight among high-risk prenatal women.[66] The PNSS is used to identify preventable nutrition-related problems and behavioral risk factors to target interventions.

Food and Nutrient Consumption

Food consumption measurements include estimates of individuals' intakes of foods and beverages (nonalcoholic and alcoholic) and nutritional supplements. Both CSFII and NHANES provide national estimates of food and nutrient intakes in the general U.S. population and subgroups. These surveys and the FDA Total Diet Study provide the potential to assess pesticide levels in diets.

Periodic assessments of food and nutrient consumption of specific population subgroups not adequately covered in national surveys have been conducted for military populations, Native Americans, children, and low income populations. A 1996 Supplemental Children's Survey was conducted specifically to assess pesticide exposures in the diets of infants and young children. Since 1995, a yearly supplement to the Current Population Survey (CPS), conducted by the U.S. Census Bureau, has been devoted to measuring the extent of food insecurity and hunger among people living in U.S. households.[23,28,67]

Evaluations of USDA nutrition and food assistance programs are routinely conducted. The Adult Day Care Program Study and the Early Childhood and Child Care Study each determined the characteristics and dietary intakes of their participants and the features of day care centers participating in the Child and Adult Care Food Program. A number of studies have been conducted to evaluate the nutrition and health effects of participating in WIC, provide current participant and program characteristics of the WIC program, and describe the infant feeding practices of WIC participants. The School Nutrition Dietary Assessment Study assessed the nutrient content of USDA and non-USDA meals offered in U.S. schools and the contribution of the National School Lunch Program to overall nutrient intake.[68] A follow-up study was conducted to compare changes over time.

Knowledge, Attitudes, and Behavior Assessments

National surveys that measure knowledge, attitudes, and behavior about diet and nutrition and how these relate to health were added to the nutrition monitoring program in 1982. In general, the focus of the Health and Diet Surveys is on people's awareness of relationships between diet and risk for chronic disease, and on health-related knowledge and attitudes. The survey has studied consumer use of food labels, the effectiveness of the National Cholesterol Education Program, and weight loss practices.[69,70] The focus of the Diet and Health Knowledge Survey initiated by USDA in 1989 is on the relationship of individuals' knowledge and attitudes about dietary guidance and food safety to their food choices and nutrient intakes.

Surveys addressing specific topics such as infant feeding practices, weight loss practices and progress toward achieving related national health objectives, and cholesterol awareness of health professionals have been periodically conducted to meet specific data needs. The National Cancer Institute (NCI) conducted the 5 A Day Baseline Survey in collaboration with food industry to assess knowledge, behavior, and attitudes about fruits and

vegetables.[71] NCI also conducted the Cancer Prevention Awareness Survey and the National Knowledge, Attitudes, and Behavior Survey to measure progress on knowledge, attitudes, and behaviors regarding lifestyle and cancer prevention and risk factors. The FDA conducted a study to assess consumer food handling practices and awareness of microbiological hazards, and also conducted a number of studies to evaluate the Nutrition Facts Label features and usability by consumers.[72]

The focus of the Behavioral Risk Factor Surveillance System (BRFSS) is on personal behavior and its relationship to nutritional and health status. BRFSS has been used by state health departments to plan, initiate, and guide health promotion and disease prevention programs, and to monitor their progress over time.[73] The Youth Risk Behavior Survey monitors priority health risk behaviors among adolescents through national, state, and local surveys.[74]

Food Composition and Nutrient Databases

FDA's Total Diet Study provides annual food composition analysis of core foods of the U.S. food supply, and the Food Label and Package Survey, sponsored by a number of agencies, is conducted to monitor labeling practices of U.S. food manufacturers.[75,76] The survey also includes a surveillance program to identify levels of accuracy of selected nutrient declarations compared to values obtained from nutrient analyses of products.

Since 1892, USDA has maintained the National Nutrient Data Bank (NNDB) for the purpose of deriving representative nutrient values for more than 6000 foods and up to 80 components consumed in the U.S.[77] Data are obtained from the food industry, from USDA-initiated analytical contracts, and from the scientific literature. Values from NNDB are released electronically as the USDA Nutrient Data Base for Standard Reference (SR). The SR is updated periodically to reflect changes in the food supply as well as changes in analytical methodology. The SR nutrient data are used as the core of most nutrient databases developed in the U.S. for special purposes, such as those used in the commercially available dietary analysis programs.[77-79] USDA produces the Survey Nutrient Data Base (SNDB), which contains data for 28 food components and energy for each food item for analysis of NHANES and CSFII.[80] The database is periodically updated. The National Food and Nutrient Analysis Program was initiated in 1997 to produce accurate and current food composition data characterizing the U.S. national food supply. This goal is being achieved through stratified random sample collection and chemical assay of commonly eaten foods accounting for the majority of Americans' nutrient intake. The new data will be incorporated into the NNDB.

Many individuals are consuming nutrients from dietary supplements. To enable the estimation of total nutrient intakes and the impact of dietary supplements on nutrition and health, the National Center for Health Statistics (NCHS) has developed and is maintaining a database on dietary supplements for use with national surveys.[81]

Food Supply Determinations

Since the beginning of this century, U.S. food supply estimates have reflected levels of foods and nutrients available for consumption. These data, updated and published annually by USDA as the U.S. Food and Nutrient Supply Series, are used to assess the potential of the U.S. food supply to meet the nutritional needs of the population and changes in

the food supply over time. They are also used to evaluate the effects of technological alterations and marketing changes on the food supply over time, to study the relationships between food and nutrient availability and nutrient-disease associations, and to facilitate management of federal marketing, food assistance, nutrition education, food enrichment and fortification policy. The Fisheries of the United States Survey has been conducted by the National Marine Fisheries Service since 1909 to provide annual estimates of fish and shellfish availability and consumption in the U.S. food system.

Evolution of the Nutrition Monitoring Program

The history of nutrition monitoring in the U.S. is discussed earlier in this section, and notes significant legislative and other events. The current nutrition monitoring program is firmly grounded in USDA and HHS nutrition-related studies and surveys that address pertinent health issues and needs. The future evolution of the program will be based on these and other identified health issues and needs of the population that relate to diet, physical activity, lifestyle, and health. The focus of the program may shift as past health problems are resolved through nutrition education and public policy changes (e.g., food fortification) and as new diet-related health concerns emerge. The studies and surveys within the current monitoring program can be adapted to meet changing needs, and new studies can be added as resources permit. The present and future needs for nutrition monitoring will be defined and clarified based on nutrition-related studies conducted by government, academic, medical, clinical, and private institutions.

Improvements to the nutrition monitoring program will result from research that develops new methodologies and improves existing ones to assess nutrition and health status. New and improved methods may allow more accurate and efficient assessment of food and nutrient intake, assessment of physiological measures of nutrient status, and techniques to relate food and nutrient intake to health status. These improvements will result in more accurate data, and they may result in data that are not comparable to previous data collected with other methods. These newer data may also shift the focus of the nutrition monitoring program.

Changes in Health Needs

Speculation about the future evolution of the nutrition monitoring program requires consideration of the factors that may change the health concerns of the population. Some of the factors are changes in the food supply, in the demographics of the U.S. population, and in individual dietary and other lifestyle behaviors. Innovation to the food supply may alter the nutrient content of existing foods or may result in new food products. In either case, the nutrient intake of the population or of specific population groups may change as these altered or new foods are consumed. Changes in the food supply may result from genetic engineering of plants or animals, changes in agricultural practices, and new manufacturing processes or technologies. Within the past several decades there has been increased access to food from fast-food chains and other restaurants, increased availability of prepared foods from grocery stores that require only microwave heating prior to consumption, and increased consumption of ethnic dishes. Such changes are likely to continue.

Alterations in the demographics of the U.S. population may affect the mean food and nutrient intakes from national surveys, because the surveys reflect the food preferences,

patterns, and practices of the population. The number of Hispanics and blacks in the U.S. population is increasing at a rate faster than the white, non-Hispanic population. The population is also becoming older as the baby boomers and their children age. Changes in income levels and income disparities in the population may result in changes in diet and health outcomes reported from surveys. Income disparities among racial and ethnic groups and among age and gender categories will continue to be important in identifying population groups that are more vulnerable to diet and health-related problems.

Modifications in individual dietary and other lifestyle behavior may lead to changes in health. Consumers are encouraged to follow the Dietary Guidelines for Americans and the Food Guide Pyramid, to read Nutrition Facts Labels, and to be more physically active. These nutrition education efforts may help consumers improve their diets and health outcomes. Consumers may become increasingly knowledgeable of the health effects of overweight and obesity and make attempts to alter their eating patterns and physical activity to lose weight. People are also influenced by the nutrition information they receive from other sources (TV, radio, books, magazines, advertisements). They may begin to take (or alter their intake of) dietary supplements, increase intake of functional foods, or become interested in organic produce, herbal products, or botanicals. Such behavior changes could affect health. Hopefully, consumers will adopt behaviors that will improve their health; however, it is possible that poor dietary advice may have the opposite effect. It is also possible that continued sedentary lifestyles and wide access to food will maintain the current problems of overweight and obesity in the U.S. and the health problems related to them.

Preparing for the Future

In December 1999 the National Academy of Sciences (NAS) organized a public symposium entitled "Nutrition Monitoring in the U.S.: Preparing for the Next Millennium." This session convened nutrition scientists from industry, academia, government, and the public sector along with policy makers to discuss current efforts to streamline and integrate the monitoring program and to identify and highlight future diet, nutrition, and health data needs. Conference participants discussed ways to optimize the utility and relevance of the nutrition monitoring program for organizations whose activities depend on the availability and reliability of the data obtained from the program. The National Nutrition Summit, held in May, 2000 in Washington, D.C., focused on several nutrition monitoring themes including obesity, physical activity, and food security.

Additional activities in progress to prepare the nutrition monitoring program for the future include integration of USDA and NHCS nutrition surveys, improving the comparability and quality of survey methods, and providing state and local nutrition-related data, including data for population subgroups.

Survey Integration

Continuous collection of diet- and nutrition-related data in cross-sectional and longitudinal surveys and surveillance systems is needed to assess the health of the U.S. population and plan nutrition services and educational programs. Efforts are under way to integrate and merge the NHANES and the CSFII by 2002. The survey will include a nationally representative annual sample of black, white, and Mexican-American persons for all income and low income households, and a common dietary data collection and processing system. Federal agencies are currently conducting sample design and dietary survey methodology research, evaluating the extent of seasonal and geographic coverage with the combined annual survey, and designing and implementing the integrated sample to better meet nutrition monitoring data needs and develop a "core" (identical) set of demo-

graphic, socioeconomic, nutrition, and health-related program questions that are essential to estimate and report dietary intakes for the integrated sample. The two departments are also working to operationalize improvements in sample design, dietary methodologies, and questionnaires. The framework for the survey's design will need to provide flexibility and opportunities for modifications over time.

Comparability and Quality of Methods

An integral part of the coordination of nutrition monitoring activities is the use of standardized or comparable methodologies for the collection, quality control, analysis, and reporting of data. Progress has been made in developing indicators for height and weight to assess growth and overweight, household food security, and folic acid status. Standardized indicators are needed for population descriptors, food security, diet, nutritional, and related health status, and knowledge, attitudes, and behavior assessments. As these indicators are developed, they will be incorporated into existing and planned surveillance systems.

Reliable, valid, and cost-effective measures of nutritional status need to be developed and improved, along with appropriate interpretive criteria. Research is needed on appropriate methods (such as questionnaires, interviewing procedures, physical measures, and biological indicators) for subgroups at increased nutritional risk, practical and efficient measures of diet, biochemical, and clinical parameters, and applied statistical methodologies for the collection and interpretation of nutrition monitoring data. Research to develop and standardize questionnaires for valid and reliable estimators of knowledge, attitudes, and behavior will aid in the development of public health strategies at federal, state, and local levels to improve dietary status, promote health, and prevent nutrition-related disease.

State and Local Data

Nutrition monitoring data are needed at the state and local levels, especially as they relate to welfare reform and other policy changes. Continued improvements to the CDC state surveillance systems, the use of comparable methodologies, and supplemental data collection for defined populating groups will be central to meeting state and local data needs in the future. Improvements will be dependent upon the availability of resources to provide technical assistance and data collection capacity to states.

Data for Population Subgroups

Many surveys of the nutrition monitoring program collect data on population subgroups such as low-income people and minorities. However, data are still limited for select subgroups, such as the homeless, Native Americans, and Asian and Pacific Islanders. NCHS is exploring an initiative known as community HANES to study specific population subgroups for whom national estimates cannot be easily, practically, or cost-effectively made.

The Link between Nutrition Monitoring, Research, and Policy

Research, monitoring, and policy are intertwined by a complex set of interrelationships. As shown in Figure 15.2, nutrition monitoring is vital to policymaking and research.[15,60,82] Monitoring provides information and a database for public policy decision making and

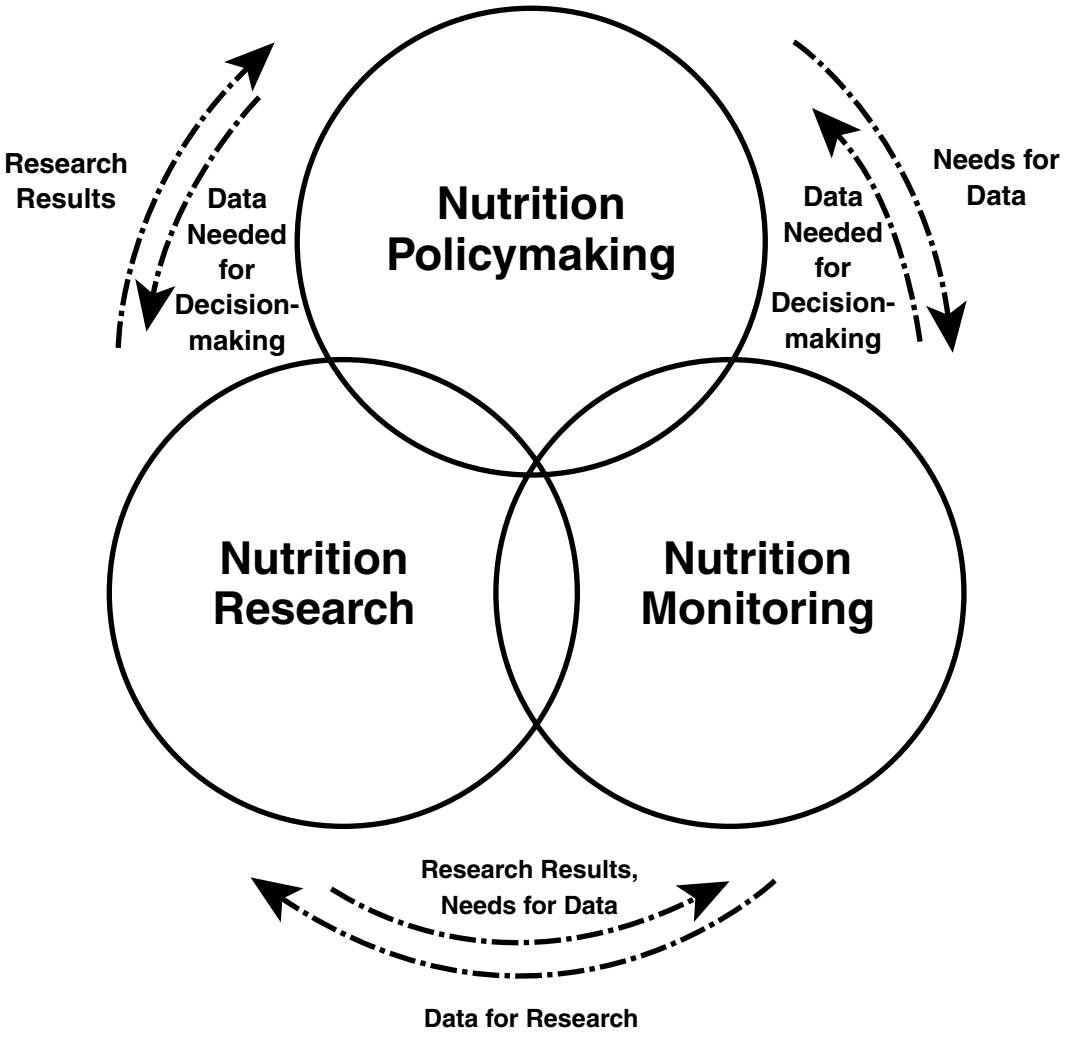

FIGURE 15.2
Overlapping of nutrition monitoring, policy making, and research. Source: Adapted from U.S. Department of Health and Human Services and U.S. Department of Agriculture. Ten-Year Comprehensive Plan for the National Nutrition and Related Research Program. 1993.

establishing research priorities.[42,63,83-85] Nutrition research provides data for policymaking and for identifying nutrition monitoring data needs.[42,63]

The Third Report on Nutrition Monitoring in the United States identified a number of food components of particular public health concern in the U.S. population: food energy, total fat, saturated fatty acids, cholesterol, alcohol, iron, calcium, and sodium. The report also included a range of health issues of particular concern for low-income, high-risk populations including anemia, low birth weight, overweight, high serum total cholesterol, hypertension, osteoporosis, low intakes of a number of nutrients (including folate, calcium, iron, and others), and food insufficiency.[58] Based on these findings, the report also provided recommendations for future nutrition monitoring and nutrition methods research.

To illustrate the link between nutrition monitoring, nutrition research, and nutrition policy, this section explores a current public health issue identified in the Third Report on Nutrition Monitoring in the United States: the relationship of calcium intake and

osteoporosis. All dietary components have unique considerations with respect to determining dietary adequacy and measuring physiological status. The example of calcium and osteoporosis illustrates some of the challenges of measuring both dietary and physiological status, drawing conclusions about the relationship between dietary intake and health, and providing guidance to the public to improve health based on the available data and scientific research.

Dietary Assessment of Calcium Status

Assessment of dietary calcium intake has been routinely included in national food consumption surveys such as NHANES and CSFII. The Adequate Intakes (AIs) for calcium established by IOM are 500 mg/day for ages 1 to 3 years, 800 mg/day for ages 4 to 8 years, 1300 mg/day for ages 9 to 18 years, 1000 mg/day for ages 19 to 50 years, and 1200 mg/day for ages 51 years and over.[58]

Mean total (diet, dietary supplements, antacids) intakes of calcium fall short of AIs, especially for teenage girls, women, and older males (Table 15.4). During 1988 to 1994 mean calcium intakes for females decreased from a peak at 2 to 8 years of age (789 mg/day) to about 776 mg/day for women 50 years of age and older. Calcium intakes for males peaked at 9 to 19 years of age (1016 mg/day) and declined to about 851 mg/day for ages 50 years and over.[86] In issuing its recommendations, the Institute of Medicine indicated that there is a great disparity between recommended calcium values and current dietary

TABLE 15.4

Percent of the U.S. Population Meeting the Adequate Intake (AI) for Calcium, 1988–1994

	Dietary Intake (Food)			Total Intake (Food + Supplements + Antacids)		
Age and Sex	Mean (mg)	Median (mg)	% Meeting AI	Mean (mg)	Median (mg)	% Meeting AI
Males						
2–8 y	868	853	88	875	856	89
9–19 y	1003	989	51	1016	994	52
20–49 y	920	872	60	982	906	64
50+ y	778	717	30	851	762	35
2+ y	895	862	55	945	889	58
Females						
2–8 y	780	767	79	789	773	79
9–19 y	728	721	17	746	729	19
20–49 y	657	624	31	759	672	40
50+ y	610	564	13	776	663	27
2+ y	667	637	29	765	696	36
Total						
2–8 y	826	820	84	833	824	84
9–19 y	865	857	34	881	865	35
20–49 y	786	728	45	868	785	52
50+ y	685	633	21	809	708	30
2+ y	777	738	41	852	785	47

Source: NHANES III.

patterns.[39] Many individuals are not consuming sufficient intakes to meet their requirements and reduce the likelihood that they will develop osteoporosis.

Dairy products provide three-fourths of the dietary calcium intake in U.S. diets, and the dietary intake of calcium parallels what is known about intake of dairy products, i.e., that milk consumption begins to decline for females in their teenage years and remain low throughout life (except perhaps during pregnancy and lactation, when women are advised to drink milk). Milk consumption is also generally low among older men and women. Monitoring data from the 1987-88 NFCS showed that 50% of dietary calcium came from milk and milk products, 20% from milk and cheese as ingredients in mixed dishes, and 30% from all other food groups.[87] Additional USDA data indicate that between 1909 and 1990 dairy products comprised approximately 75% of calcium intake, indicating that the major contributing source has not changed a great deal.[58]

Because information on the use of dietary supplements and antacids was collected in NHANES III, it is possible to estimate the total intake of calcium from all sources. About 17% of the population reported the use of supplemental calcium in the diet in 1988 to 1994.[86] Table 15.4 indicates that these additional non-food sources of calcium in the diet have little overall impact on the percentage of the population meeting the AI for calcium. Overall, children ages 2 to 8 years are most likely to meet the recommended adequate intakes of calcium, with food sources providing the majority of calcium intake. In fact, just approximately 52% of calcium for children ages 2 to 18 years is derived from milk. For children 2 to 5 years, milk contributes almost 60% of calcium, for those 6 to 11 years milk contributes about 54% of calcium, and it contributes 46% of calcium to the diets of 12- to 18-year-olds.[88] Other calcium sources for children ages 2 to 18 include cheese (14%), yeast bread (7%), ice cream/sherbet/frozen yogurt (3%), and cakes/cookies/quickbreads/donuts (2.3%).

Physiological Assessment of Calcium Status

About 99% of body calcium is in the skeleton, and its primary function is structural, i.e., to build and maintain bones and teeth. The remaining body calcium is in blood, extracellular fluid, muscle, and other tissues, where it plays roles in vascular contraction and vasodilation, muscle contraction, nerve transmission, and glandular secretion. Blood levels of calcium remain relatively constant even in people with osteoporosis (decreased bone mass). The calcium is removed from the bone to maintain blood levels. Calcium metabolism and bone metabolism are highly integrated and correlated. Osteoporosis takes many years to develop and is usually not diagnosed until later years, such as when a fracture occurs.

Unfortunately, there have not been large-scale survey methods that are both reliable and cost-efficient for determining physiological calcium status until recently. In NHANES III, bone density was measured for the first time in a nationally representative sample of Americans. Among females 50 years of age and older, osteopenia (less than optimal bone density) at the total femur occurred in 42% of non-Hispanic whites, 37% of Mexican-Americans, and 28% of non-Hispanic blacks. Prevalence estimates for osteoporosis at the total femur in these three groups were 17, 12, and 8%, respectively.[89] Research is focused on developing and interpreting biochemical markers related to bone resorption, bone turnover, and osteoporosis risk.[90-92]

Relating Dietary and Physiological Data

Significant bone accretion occurs during adolescence and early adulthood. The low dietary calcium intakes by many adolescents and adults, particularly females, suggest that they are

not getting the calcium they need to maintain optimal bone health and prevent age-related bone loss. Low peak bone density coupled with inadequate calcium intake in subsequent years may increase the risk of bone fracture in later years. Osteopenia and osteoporosis are both associated with inadequate bone mineral, especially calcium. Fractures resulting from osteoporosis are a major cause of morbidity in post menopausal caucasian females in the U.S. Osteoporosis develops over several decades of life and may not be apparent until a fracture occurs. Although loss of bone mineral is related to dietary intake of calcium, there are also other important considerations with regard to this condition.

The link between dietary calcium intake and bone status (osteoporosis) is not always direct. Dietary intake of calcium may not be a good predictor of physiological calcium status in some population groups or individuals because of the following confounding factors:

Calcium intake:

- Calcium intake collected in national surveys captures only recent (1 to 2 days) dietary intake, whereas osteoporosis takes several decades to develop. NHANES III and NHANES 1999+ did include questions about the historical consumption of milk, although long-term intake is difficult for many people to report accurately.[93,94] In addition, dietary intake surveys tend to underestimate total food and energy intake, so that calcium intake from surveys may be underestimated as well.[95]
- The use of calcium supplements will increase calcium intake and may affect bone health.

Intake of other nutrients:

- If energy intake has not been adequate (as with malnutrition or severe dieting), there may not be sufficient protein or sufficient amounts of other nutrients to help build or maintain bone. Bone is a complex tissue with a steady turnover rate that requires many nutrients. Even if calcium is adequate, the bone may not form properly if other important nutrients are lacking.
- Excess protein intake, especially from animal sources, may lead to increased excretion of calcium in the urine. IOM (1997) points out that while dietary protein intake increases urinary calcium excretion, inadequate protein intakes (34 g/day) are associated with poor general health and poor recovery from osteoporotic hip fractures.
- Dietary phylloquinone (vitamin K-1) or phylloquinone status may be associated with age-related bone loss.[96-98]
- The effects of caffeine on the skeleton are modest at calcium intakes of 800 mg/day or higher.[39]
- The Institute of Medicine[39] reviewed the relationship between salt intake and bone health, and concluded that indirect evidence indicates that dietary salt has a negative effect on the skeleton, although the effect of a change in sodium intake on bone loss and fracture rates has not been reported. IOM (1997) concluded that available evidence does not warrant different calcium intake requirements for individuals according to their salt consumption.

Role of genetics:

- Blacks and Asians experience more lactose intolerance than whites and tend to eat fewer dairy products than whites. Although blacks and Asians tend to have lower calcium intakes than whites, they do not necessarily show an

increase in the prevalence of osteoporosis. In the U.S., older persons of northern European origin have the lowest bone densities and highest fracture risks. About 75% of older blacks have bone densities above the fracture threshold. Thus, it appears that race or genetic background plays a role in the development of osteoporosis.

Physiological status:

- Decreased estrogen production at menopause is associated with accelerated bone loss, particularly from the lumbar spine, for about five years.[99] Estrogen replacement therapy at menopause is one approach to help prevent bone loss and osteoporosis in women for whom no contraindications are present.
- Decreased calcium absorption with age is well recognized and may be due in part to low vitamin D intake. Vitamin D deficiency may play a role in hip fractures of those over 70 years. Older people often have decreased vitamin D intake because most dietary vitamin D comes from vitamin D-fortified milk, a food not preferred by older persons. In addition, older persons have decreased conversion of vitamin D to its active form in the skin. This may be due do decreased vitamin D metabolism, decreased sun exposure (sunlight is required for the conversion), and/or use of sunscreen (which blocks sunlight) to prevent skin cancer.
- Pregnancy and lactation, especially repeated pregnancies and periods of lactation, may create an increased body requirement for calcium, which, if not met, may lead to decreased bone calcium in the mother.
- Some medications interfere with calcium absorption and function.
- Some endocrine disorders may affect calcium balance and status.
- Weight-bearing exercise is very important to maintain bone health. Negative calcium balance may result from immobilization, illness, or lack of exercise.[100,101]

Public Nutrition Policy Regarding Calcium

In addition to the national dietary data, which suggest that calcium intakes are below recommended levels for girls, women, and older adults, and the physiological data regarding the incidence of osteopenia and osteoporosis in the U.S. population, there are also epidemiological data linking age-related osteopenia to lifetime calcium intake. These data support the suspected relationship between dietary calcium intake and bone health. The Third Report on Nutrition Monitoring in the U.S.[58] states,

> Many Americans are not getting the calcium they need to maintain optimal bone health and prevent age-related bone loss. Achieving peak bone mass and maintaining bone mass appear to be related to adequate calcium intake in adolescence and early adulthood. Because of the high rates of bone accretion during adolescence, continued monitoring of calcium intake is important.

The report classifies calcium as a "current public health issue" along with food energy, total fat, saturated fatty acids, cholesterol, alcohol, iron, and sodium and recommends the "development of interpretive criteria to link monitoring data to functional outcomes or health outcomes."

Nutrition monitoring data on calcium intake and calcium-containing foods were used to make scientific recommendations at the 1994 NIH Consensus Conference on Optimal

Calcium Intake.[12] The U.S. policy on calcium is to continue to emphasize the consumption of dairy products through the Dietary Guidelines for Americans[31] and the Food Guide Pyramid, and to suggest alternatives (fish with bones, green leafy vegetables, legumes, calcium-fortified orange juice, calcium supplements) for those who do not consume dairy products (e.g., those who are vegans, lactose intolerant, allergic to milk, those who do not like dairy products, and those whose cultural diets do not include dairy products). The Food Guide Pyramid recommendations are for two servings of dairy products per day for adults 24 years of age and older, and 3 servings per day for children, teenagers, younger adults, and pregnant and lactating women.

Conclusion

The primary goal of the 1990 Ten-Year Comprehensive Plan, "to establish a comprehensive nutrition monitoring and related research program by collecting quality data that are continuous, coordinated, timely, and reliable; using comparable methods for data collection and reporting of results; conducting relevant research; and efficiently and effectively disseminating and exchanging information with data users" is still pertinent a decade later.[39] Nutrition monitoring data are needed to inform both research and policy agendas. It is through this intertwined relationship between monitoring, research, and policy that we can continue to effect change. Given the competing demands for limited national resources and resulting budget limitations, however, the goals for the nutrition monitoring program will continue to be evaluated against other competing national needs. Continued support is necessary to maintain and expand the nutrition monitoring program in the U.S.

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