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**The American Diet: Health and Economic Consequences.** Elizabeth Frazão, Food and Consumer Economics Division, Economic Research Service, U.S. Department of Agriculture. Agriculture Information Bulletin No. 711.

## **Abstract**

Poor diets are associated with 4, including the top 3, of the leading causes of death in the United States: heart disease, cancer, stroke, and diabetes. Poor diets are also associated with other health conditions that contribute to premature mortality or reduced quality of life and productivity. Whereas it is not yet possible to determine the precise extent to which poor diets contribute to these health conditions, and thus determine the true costs associated with poor diets, this report provides information on the incidence, prevalence, and costs associated with health conditions commonly associated with poor diets and inadequate activity. Current dietary patterns are compared with Federal dietary recommendations. Possible reasons for current dietary patterns and USDA's efforts at improving diets are also described.

**Keywords:** Nutrition, diets, health

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## Summary

Four of the 10 leading causes of death in the United States are linked to diet. Heart disease, cancer, stroke, and diabetes account for more than 1.4 million deaths each year, nearly two-thirds of the U.S. total. Diet also plays a role in other health conditions such as overweight, hypertension, and osteoporosis, which can reduce quality of life and productivity and contribute to premature death.

Taken together, these seven diet-related health conditions cost society an estimated \$250 billion each year in medical costs and lost productivity. The extent to which these costs might be reduced by an improved diet cannot be calculated precisely, but some researchers estimate that proper diet might forestall at least 20 percent of the annual deaths from heart disease, cancer, stroke, and diabetes.

Diets high in calories, fat, saturated fat, cholesterol, and salt, and low in such fiber-containing foods as fruit, vegetables, and whole-grain products, are associated with risk of those diseases. While genetic predisposition increases some people's risk for those chronic diseases, behavior within a person's control, such as diet, smoking, and regular exercise can also change the likelihood of contracting them.

**Heart disease** accounted for a third of all deaths in the United States in 1993. And two-thirds of those cases were attributed to coronary heart disease, the type of heart disease commonly associated with poor diet.

Coronary heart disease (CHD) alone caused over 489,000 deaths in 1993, second to all cancers together. CHD costs the United States \$56.3 billion in direct health care costs and lost productivity each year. Health professionals estimate that 20 percent of these deaths could be avoided with changes in one's diet.

CHD is associated with high blood cholesterol levels, overweight, diabetes, and hypertension. Diet, especially a high intake of saturated fat and cholesterol, can raise blood cholesterol levels in some people. Diet can also influence overweight, diabetes, and hypertension.

Over the last two decades, deaths from CHD have fallen about 50 percent. Some of the decline is attributable to reduced consumption of saturated fat and reductions in blood cholesterol levels, although the effect of other factors, such as increased use of cholesterol-lowering drugs, postmenopausal estrogen replacement therapy, and lower-dose oral contraceptives, is not yet known.

**Cancer** caused more than 500,000 deaths in the United States in 1993. More than 1 million new cases are diagnosed each year. According to the American Cancer Society, overall costs for cancer amount to \$104 billion each year in direct medical costs and lost productivity. Diets high in fat and low in fiber-containing foods are associated with increased risk of certain types of cancer, such as colorectal, breast, and prostate cancer. Perhaps a third of all cancer cases could be prevented through dietary measures.

**Stroke** affects more than 500,000 people each year in the United States and, in 1993, killed more than 149,000. The American Heart Association estimates that some 3 million people in the United States suffer from stroke-related disabilities, at an annual cost of nearly \$20 billion. Risk factors include a diet high in saturated fat and cholesterol as well as being overweight or having diabetes or hypertension. Health professionals estimate that at least 20 percent of these deaths could be avoided with changes in one's diet.

**Diabetes** was directly associated with more than 55,000 deaths in 1993 and is implicated in an additional 100,000 deaths each year. It is the leading cause of kidney disease and a risk factor for CHD and stroke. The American Diabetes Association estimates that diabetes affects more than 13 million people in the United States, half of whom are not even aware they have the condition. Total economic cost of diabetes add up to more than \$90 billion annually in direct medical costs and lost productivity. It is estimated that 40 percent of all diabetes can be prevented by controlling overweight.

A number of other health conditions, overweight, hypertension, and osteoporosis, for example, are also influenced by diet. Although not listed as direct causes of death, some of these health conditions contribute to premature deaths and can reduce the quality of life. For example, overweight and hypertension are risk factors for CHD and stroke. Osteoporosis is responsible for 1.5 million bone fractures a year, mostly at the wrist, spine, and hip. Hip fractures alone result in an estimated \$10 billion in annual medical costs.

Despite these findings, most diets today still fall short of meeting Federal recommendations. Some possible reasons why diets still fall short include:

- **Lack of belief.** Many consumers do not believe they can control chronic disease or that changing their diet is very important.
- **Lack of motivation.** Some consumers believe that a "lowfat" diet is more costly and less tasty. Others confess to being confused, and still others erroneously believe their diets are healthy already.
- **Lack of knowledge.** Many consumers have mistaken concepts about the fat content of food items. For example, some erroneously think that lean ground beef is low in fat and that white bread is high in fat.
- **Ineffective changes.** Although women with higher education made greater changes in their diets within the last two decades than did women with less education, these changes did not significantly reduce overall fat intake. Basically, the highly educated women traded fat from one source for another, such as from red meats to dairy products.
- **Health is just one aspect of eating.** People make food choices on the basis of a variety of considerations, such as income, convenience, cultural habits, and psychological satisfaction. Choosing a healthful diet requires changing attitudes, behavior, and eating practices, as well as having a commitment to change.

# The American Diet

## Health and Economic Consequences

Elizabeth Frazão

*“For the two out of three adult Americans who do not smoke and do not drink excessively, one personal choice seems to influence long-term health prospects more than any other: what we eat.”* (The Surgeon General’s Report on Nutrition and Health, U.S. Department of Health and Human Services, 1988).

### Introduction

Scientific evidence increasingly suggests that poor diet plays an important role in the onset of chronic diseases, contributing to increased morbidity, reduced quality of life, and premature mortality. In particular, diets high in calories, total fat, saturated fat, cholesterol, and salt/sodium, and low in fiber-containing foods such as fruit, vegetables, and whole grain products, are associated with increased risk for coronary heart disease, certain types of cancer, stroke, diabetes, overweight, and hypertension. And low intakes of calcium are associated with increased risk of osteoporosis.

Because of the widespread impact that such health conditions have on mortality, illness, disability, and medical costs, there is much interest in preventing or reducing their occurrence. Much research has been devoted to better understanding, identifying, and quantifying the role that diet plays in improving health. This is a complex task, since genetic predisposition and other life-style factors (such as smoking and lack of physical activity) increase some people’s risk for some of these chronic diseases. However, knowledge of the potential impact of diet on chronic disease might aid preventive efforts and improve the quality of life.

Presenting an overall picture of what we know about how diet affects chronic disease and the overall costs associated with these conditions requires bringing together a myriad of information. A brief description of how the current average American diet compares with

the most recent recommendations in USDA/Department of Health and Human Services *Dietary Guidelines*, as well as some explanations as to why American diets are not closer to the recommendations are presented in this report. Existing research on the potential health benefits of changing current dietary patterns is described, together with a description of what the U.S. Department of Agriculture is doing to accelerate improvements in dietary patterns. Future research needs are offered.

### Poor Diets Behind the Leading Causes of Death

Of the 10 leading causes of death in the United States, 4—including the top 3—are associated with diets that are too high in calories, total fat, saturated fat, cholesterol, and salt/sodium, or low in fiber-containing foods. These conditions—heart disease, cancer, stroke, and diabetes—together, account for nearly two-thirds of the deaths occurring each year in the United States (table 1).

Diet also influences other health conditions that, although not listed as a primary cause of death, can reduce the quality of life and contribute to premature mortality—for example, overweight, hypertension, and osteoporosis. Research also suggests that some of the memory loss and confusion associated with aging may stem from vitamin deficiencies and poor nutrition (Jackson, 1993; Rosenberg, 1994). Similarly, preliminary studies suggest a role for antioxidants (see glossary) in the prevention of cataracts and senile degeneration of the retina (the leading cause of blindness in the elderly) (Rosenberg, 1994).

### Diseases of the Heart

According to the National Center for Health Statistics (1993), one-third of all deaths in the United States in 1993 were attributed to diseases of the heart (table 1).



**Table 1—Four of the 10 leading causes of death in the United States are diet related**

Cause of death, 1993	Deaths	Share of all deaths
1. Heart disease	739,860	32.6
*Coronary heart disease	<b>489,970</b>	<b>21.6</b>
2. *Cancer	<b>530,870</b>	<b>23.4</b>
3. *Stroke	<b>149,740</b>	<b>6.6</b>
4. Chronic obstructive pulmonary diseases	101,090	4.5
5. Accidents and adverse effects	88,630	3.9
6. Pneumonia and influenza	81,730	3.6
7. *Diabetes	<b>55,110</b>	<b>2.4</b>
8. HIV infection	38,500	1.7
9. Suicide	31,230	1.4
10. Homicide and legal intervention	25,470	1.1
All causes	2,268,000	100.0

\*Diet-related causes of death.

Source: National Center for Health Statistics. *Annual summary of births, marriages, divorces, and deaths: United States, 1993*. "Monthly Vital Statistics Report", Vol. 42, No. 13. Hyattsville, MD: Public Health Service, 1994.

Of these, 66 percent were attributed to coronary heart disease (also called ischemic heart disease)—the type of heart disease commonly associated with diet.

Coronary heart disease (CHD), alone, caused over 489,000 deaths in 1993, second to all cancers together (table 1). The American Heart Association (1993) estimates there are about 1.5 million heart attacks annually, and that CHD costs the United States \$56.3 billion each year (\$48.3 billion in direct health care costs and \$8 billion in lost productivity) (table 2).

Although genetics plays an important role in an individual's risk of CHD, studies show that environmental factors are also important. The major modifiable risk factors for CHD are high blood cholesterol levels, hypertension, cigarette smoking, and physical inactivity. Diet—especially intake of saturated fat and cholesterol—can influence blood cholesterol levels in some people, an important risk factor for CHD. Diet can also influence other risk factors for CHD, such as overweight and diabetes (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992).

Although CHD currently represents about one-fifth of all deaths in the United States, mortality from CHD has decreased about 50 percent in the last two decades (U.S.

**Table 2—Costs associated with major diet-related health conditions add up**

Diet-related health conditions	Annual cost <sup>1</sup>	Medical costs <sup>2</sup>	Lost output
Coronary heart disease	56,300	48,300	8,000
Cancer	104,000	35,000	69,000
Stroke	19,700	16,900	2,800
Diabetes <sup>3</sup>	40,000	NA	NA
Obesity <sup>4</sup>	2,400	NA	NA
Hypertension <sup>5</sup>	17,400	14,900	2,500
Osteoporosis	10,000+	NA	NA
Total	249,800	NA	NA

NA = Not available.

<sup>1</sup>In most cases this includes direct health care costs and lost productivity resulting from disability.

<sup>2</sup>Includes hospital and nursing services, physician services, and drugs.

<sup>3</sup>Since 55 percent of deaths in people with diabetes are caused by cardiovascular disease, those costs have probably already been included under CHD and stroke (American Diabetes Association, 1993). We estimate that 45 percent of the estimated \$90 billion in total costs associated with diabetes, or \$40 billion, represents additional costs associated with diabetes.

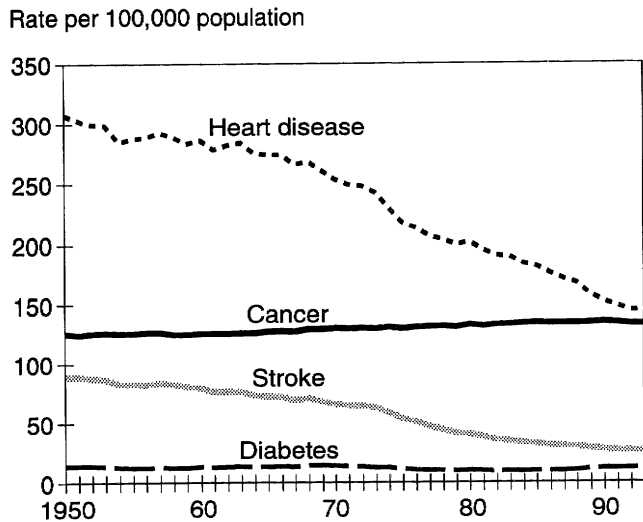
<sup>4</sup>The overall economic costs of \$39.3 billion attributable to obesity include \$11.3 billion for diabetes, \$22.2 billion for cardiovascular disease, \$1.5 billion for hypertension, \$1.9 billion for breast and colon cancer, and \$2.4 billion for gall bladder disease. Only the latter—representing additional costs—are included here.

<sup>5</sup>Includes hypertensive heart disease and hypertensive heart and renal disease (which are included under "Heart disease" as a cause of death) and hypertension with or without renal disease.

Sources: For coronary heart disease, stroke, and hypertension: American Heart Association. *Heart and Stroke Facts: 1994 Statistical Supplement*. Dallas, TX, 1993; for cancer: Brown, Martin L. "The National Economic Burden of Cancer: An Update." Special report, *Journal of the National Cancer Institute*, Vol. 82, No. 23, pp. 1811-14, Dec. 5, 1990; for diabetes: American Diabetes Association. *Diabetes: 1993 Vital Statistics*. Alexandria, VA, 1993; for obesity: Colditz, Graham A. "Economic Costs of Obesity." *American Journal of Clinical Nutrition*. Vol. 55, pp. 503S-7S, 1992; and for osteoporosis: National Osteoporosis Foundation. "Fast Facts on Osteoporosis." Washington, DC, 1994.

Department of Health and Human Services, 1993a), with a nearly 33-percent decrease in the last decade alone (American Heart Association, 1993) (fig. 1). Improved medical care and changes in lifestyles to reduce risk factors have contributed substantially to this decline (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992). For example, blood cholesterol levels have declined an average of about 8 percent between 1960-62 and 1988-91 (Johnson, 1993). Clinical trials suggest that a 1-percent decline in blood cholesterol level is associ-

Figure 1  
**U.S. rates for leading diet-related causes of death, 1950-93<sup>1</sup>**



<sup>1</sup>1993 data are provisional estimates.  
 Source: National Center for Health Statistics, *Monthly Vital Statistics Report*, 1994.

ated with a 2-percent reduction in both fatal and non-fatal CHD (Johnson and others, 1993).<sup>1</sup> Although the observed reduction in average blood cholesterol levels is consistent with the observed reductions in average intake of total fat and saturated fat over the past decades, other non-dietary, cholesterol-lowering behaviors—such as the increased use of cholesterol-lowering drugs, postmenopausal estrogen replacement therapy, and lower-dose oral contraceptives—also were common, making it difficult to determine the isolated effect of changes in dietary patterns (Johnson and others, 1993).

## Cancer

Over 500,000 people died of cancer in the United States in 1993 (table 1). Over 1 million new cases of cancer are diagnosed each year. The age-adjusted

death rate from all cancers has increased slightly since 1950 (fig. 1).<sup>2</sup>

The American Cancer Society (1994) estimates that overall costs for cancer amount to \$104 billion each year, with \$35 billion for direct medical costs, \$12 billion due to lost productivity associated with morbidity, and \$57 billion due to lost productivity associated with premature mortality (table 2) (Brown, 1990).

Although cancer mortality is heavily concentrated among those age 65 years and over—70 percent of all cancer deaths in 1993—economic losses associated with cancer are largest for the younger age groups. For example, Page and Asire (1985) estimated that although individuals age 65 and older accounted for 60 percent of cancer deaths in 1977, they contributed only 11 percent to the value of lost earnings associated with cancer. In contrast, persons 45-64 years of age accounted for 34 percent of all cancer deaths but 62 percent of lost earnings. Persons younger than 45 years made up 6 percent of cancer deaths and accounted for 27 percent of lost earnings.

Even though genetics is an important factor in cancer risk, it is believed that we can greatly reduce the risk for developing certain types of cancer. Epidemiologic studies suggest that cancer is not an inevitable consequence of aging (Wynder and Gori, 1977). Changes in cancer patterns over time—such as the sharp increase in incidence of breast and lung cancer and the decline in stomach cancer in the United States in the past decades—support the hypothesis that environmental and lifestyle factors may play an important role in cancer occurrence (Page and Asire, 1985). This hypothesis is further strengthened by studies showing that when populations migrate, their cancer patterns change in a fairly short time to approximate the patterns prevalent in the new area of residence (Higginson and Muir, 1979; Doll and Peto, 1981; National Research Council, 1982; Page and Asire, 1985).

In an extensive review of the avoidable risks for cancer, Doll and Peto (1981) estimated that cancer death rates in the United States could be reduced by as much as 35 percent by “practicable dietary means.” That estimate included the effects of overnutrition and

<sup>1</sup>However, elevated blood cholesterol levels—as well as risks for many other diseases influenced by diet—are determined to a large extent by nondietary factors. Even among middle-age men, only about half of all coronary heart disease mortality can be attributed to high blood cholesterol levels. Furthermore, the relationship between blood cholesterol levels and CHD mortality is weaker among the elderly, who suffer the majority of CHD deaths (Browner, Westenhouse, and Tice, 1991).

<sup>2</sup>Age-adjusted rates represent weighted averages of the age-specific death rates and show what the level of mortality would be if no changes occurred in the age composition of the population from year to year. Use of age-adjusted rates eliminates the effects associated with the aging of the population, and so age-adjusted rates should be used when making comparisons of relative mortality risks over time and across groups (National Center for Health Statistics, 1993).

overweight (possibly associated with a high intake of fat); of ingestion of naturally occurring carcinogens (such as aflatoxin in moldy peanuts); of carcinogens produced by cooking or storage (such as polycyclic hydrocarbons produced when meat is broiled or smoked); and of cancer-enhancing or cancer-inhibiting substances that affect the formation of carcinogens in the body (such as nitrates and antioxidants).

Diets high in total fat and low in fiber-containing foods are associated with increased risk of certain types of cancer. Three types of cancer, in particular, are believed to be associated with poor diets: colorectal cancer (which accounted for 11 percent of all cancer deaths in 1991), breast cancer (9 percent of all cancer deaths in 1991), and prostate cancer (7 percent of all cancer deaths in 1991) (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992; National Center for Health Statistics, 1993).

However, the precise dietary changes associated with a reduced risk of cancer remain controversial (see more under "Research Needs," p. 17). In an analysis of dietary patterns associated with fat intake, Subar and others (1994) caution that, given the high correlation between fat intake and the intake of certain nutrients and food groups, the reduced risk of cancer attributed to a low fat intake may not necessarily be due to the low fat intake, but may be due to a high intake of something else (such as fruits and vegetables, or vitamin C). Block and others (1992) question whether the search for a single protective agent may have led to an insufficient appreciation of the important protective effect of fruits and vegetables in general against a wide range of human cancers.

## Stroke

Stroke (cerebrovascular disease) affects over 500,000 people each year—averaging nearly one every minute—and killed over 149,000 people in 1993 (table 1). According to the American Heart Association (1993), stroke is the leading cause of serious disability, and accounts for half of all patients hospitalized for acute neurological disease. More than 3 million people in the United States suffer from stroke-related disabilities, at an annual cost of \$19.7 billion (\$16.9 billion in direct medical costs and \$2.8 billion in lost output) (table 2) (American Heart Association, 1993). Risk factors include a diet high in saturated fat and cholesterol as well as overweight, diabetes, and hypertension.

Mortality rates from stroke have fallen by 57 percent in the past two decades (U.S. Department of Health and Human Services, 1993a). Age-adjusted death rates for stroke declined by 32 percent between 1980

and 1990, continuing the downward trend since the 1970's (fig. 1) (U.S. Department of Health and Human Services, 1993c). Some of this improvement is likely associated with improvements in the detection and treatment of hypertension (see below).

## Diabetes

Diabetes is the seventh leading cause of death in the United States, directly responsible for nearly 50,000 deaths in 1991.<sup>3</sup> Mortality from diabetes decreased from the late 1960's throughout the 1970's and remained at a plateau until 1988. The large increase in diabetes mortality between 1988 and 1990 may have resulted from changes in the way many States report causes of death (National Center for Health Statistics, 1993).

However, mortality statistics tend to underreport the true impact of diabetes. The American Diabetes Association (1993) estimates that diabetes contributes to at least an additional 100,000 deaths each year. For example, diabetes is the single leading cause of kidney disease, and a risk factor for CHD and stroke. Studies show that people with diabetes are four times as likely to die from heart disease, and twice as likely to have a stroke as people who do not have diabetes. Diabetes is also the leading cause of blindness, and can cause nerve damage and amputations, as well as birth defects in babies born to diabetic women (American Diabetes Association, 1993).

Diabetes affects 13-14 million people in the United States, half of whom are not even aware they have it. Between 500,000 and 700,000 people are diagnosed with diabetes each year (U.S. Department of Health and Human Services, 1992a, American Diabetes Association, 1993). Prevalence increases with age, with about half of cases in people older than 55. Both prevalence and incidence are higher among blacks and Hispanics than among whites—probably due to a combination of genetic factors and higher prevalence of risk factors such as obesity (American Diabetes Association, 1993).

The American Diabetes Association (1993) estimates that the total economic cost of diabetes—including di-

<sup>3</sup>There are two types of diabetes. Type I, also called insulin-dependent or juvenile-onset diabetes, is characterized by an absolute deficiency of insulin and usually appears before age 40. Type II diabetes, also called noninsulin-dependent or adult-onset diabetes, appears in midlife, most often among overweight or obese adults. Many times it can be controlled by diet and exercise alone. Of the 7.2 million diagnosed cases of diabetes, 90-95 percent are Type II (undiagnosed cases are likely to be Type II, since the severity of Type I symptoms is likely to lead an individual to a doctor, and diagnosis).

rect medical costs and the indirect costs of lost productivity associated with morbidity and premature mortality—add up to more than \$90 billion annually (about half in direct health care costs and half in indirect costs). However, this estimate includes costs associated with cardiovascular disease, responsible for 55 percent of deaths in people with diabetes (table 2).

The only therapeutic interventions known to be effective in non-insulin-dependent diabetes are the maintenance of desirable body weight and exercise (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992; American Diabetes Association, 1993). About 80 percent of people with diabetes Type II are overweight (U.S. Department of Health and Human Services, 1992a).<sup>4</sup> McGinnis and Foege (1993) estimate that half of Type II diabetes cases can be prevented by controlling overweight (perhaps through dietary improvements and exercise).<sup>5</sup>

### Other Health Conditions

Diet also plays a role in three other health conditions prevalent in the United States: overweight, hypertension, and osteoporosis. Although these are not direct causes of death, they are large contributors to premature mortality or to reduced quality of life.

### Overweight

Being overweight is associated with a number of adverse health outcomes, such as elevated blood cholesterol levels, high blood pressure, non-insulin-dependent diabetes, and increased risk for some types of cancer.<sup>6</sup> Being overweight is also an independent risk

<sup>4</sup>Although Type I diabetes patients do not produce enough insulin, Type II diabetes patients produce a reasonable—and even larger than normal—amount of insulin. But, for some reason, their bodies seem to have difficulties using insulin effectively to metabolize glucose. Scientists know that most overweight people have some insulin resistance, that is, their cells are less sensitive to the action of glucose. In some people, the pancreas compensates for this insensitivity by producing sufficiently large amounts of insulin—but those individuals whose pancreas cannot compensate sufficiently then develop Type II diabetes (U.S. Department of Health and Human Services, 1990).

<sup>5</sup>The risk for Type II diabetes is hereditary and increases with age. It also occurs most frequently among the Pima Indians of the Southwestern United States, Hispanics, Asian Americans, and Blacks.

<sup>6</sup>Overweight, here, is defined as a body mass index (BMI, calculated as weight in kilograms divided by height in meters, squared) value of at least 27.8 for men and at least 27.3 for women. These are the sex-specific 85th percentile values of BMI for men and women aged 20 through 29 years from NHANES II, and represent approximately 124 percent of desirable weight for men and 120 percent of desirable weight for women, after appropriate adjustments for clothing and shoes (Kuczmarski and other, 1994).

**Table 3—More people overweight in 1988-91 than in 1976-80**

Classification	Overweight 20- to 74-year-olds			
	1960-62	1971-74	1976-80	1988-91
	<i>Percent</i>			
All	24.3	25.0	25.4	33.3
Men	22.8	23.7	24.1	31.7
Women <sup>1</sup>	25.7	26.0	26.5	34.9
White:				
Men	23.0	23.8	24.2	32.0
Women <sup>1</sup>	23.6	24.0	24.4	33.5
Black:				
Men	22.1	23.9	26.2	31.8
Women <sup>1</sup>	41.6	43.1	44.5	49.2

<sup>1</sup>Excludes pregnant women.

Source: Kuczmarski, Robert J., Katherine M. Flegal, Stephen M. Campbell, and Clifford L. Johnson. "Increasing Prevalence of Overweight Among U.S. Adults." *Journal of the American Medical Association*, Vol. 272, No. 3, pp. 205-11, July 20, 1994.

factor for CHD (U.S. Department of Health and Human Services, 1990). Lee and others (1993) show that, among men, being overweight increases the risk of dying from cardiovascular disease.<sup>7</sup>

Despite efforts to address overweight as a public health problem, and growing consumer interest in weight-loss programs, the prevalence of overweight increased dramatically among adults in the United States in the 1980's (table 3). According to data from phase 1 (1988-91) of the Third National Health and Nutrition Examination Survey (NHANES III), one-third of all adults age 20-74 years are considered to be overweight—nearly 8 percentage points higher since 1976-80 (Johnson, 1993; Kuczmarski and others, 1994).

The prevalence of overweight varies by race, ethnicity, sex, and age. A larger proportion of women (35 percent) are overweight than men (32 percent). Nearly one-half of all adult black and Mexican-American women in the United States are overweight (Kuczmarski and others, 1994). Overweight is associated with excessive intake of calories, high intake of total fat, and low level of physical activity. The economic cost of illness associated with obesity was estimated at more than \$39 billion in 1986, including

<sup>7</sup>Cardiovascular events include CHD and stroke.

\$11.3 billion for diabetes, \$22.2 billion for cardiovascular disease, \$1.5 billion for hypertension, \$1.9 billion for breast and colon cancer, and \$2.4 billion for gall bladder disease (Colditz, 1992) (table 2).

The increased prevalence of overweight is surprising in view of the observed declining trend in average consumption of total fat (measured as a proportion of total calories obtained from total fat) over the same time period (see below, "Choose a diet low in fat, saturated fat, and cholesterol"). However, 1988-91 intake data from NHANES III show an increase in total caloric intakes for persons 12 years and older compared with 1976-80 (Centers for Disease Control and Prevention, 1994). Although some of the increase in caloric intake may be due to improvements in the collection of dietary data, the increased prevalence of overweight suggests that at least part of it represents a true increase in energy intake. It may be that consumers are mistakenly assuming that if a product is fat free then it is alright to consume large quantities of it (unaware that lowfat or nonfat products are not necessarily low in calories). Furthermore, physical activity levels tend to be low, which may further contribute to the overweight problem (U.S. Department of Health and Human Services, 1990).

### **Hypertension**

Hypertension, or high blood pressure, is a common and important risk factor for CHD, stroke, and renal disease (U.S. Department of Health and Human Services, 1993b).<sup>8</sup> It is estimated to affect as many as 50 million adults in the United States—about one in every four. According to the National Center for Health Statistics (1993), hypertensive disease was listed as a direct cause of death in more than 33,000 cases in 1991.<sup>9</sup> In addition, Milio (1981) estimates that hypertension contributes to 50 percent of stroke deaths and 6 percent of CHD deaths. According to the American Heart Association (1993), as many as 30 percent of all deaths in hypertensive black men and 20 percent of all deaths in hypertensive black women may be attributable to high blood pressure.

<sup>8</sup>Hypertension, or sustained high blood pressure, is defined as systolic blood pressure (SBP) of 140 mm Hg or greater and/or diastolic blood pressure (DBP) of 90 mm Hg or greater.

<sup>9</sup>According to NCHS mortality statistics, there were 21,365 deaths attributed to hypertensive heart disease, 2,445 deaths due to hypertensive heart and renal disease, and 9,524 deaths due to hypertension with or without renal disease (NCHS, 1993). The problem is that the first two conditions are counted under "diseases of the heart," and the third condition is not sufficiently large to be included as a separate category. However, if these three conditions were tabulated as a separate category defined as "hypertensive disease," it would rank as the 8th largest cause of death, greater than suicides, HIV, and homicide and legal interventions.

Each year some 2 million new people start treatment for hypertension—although as many as 35 percent of hypertensives may be unaware of their condition (U.S. Department of Health and Human Services, 1993b). An estimated 24.5 million people (approximately half of those with hypertension) are currently on hypertensive medication. However, only about 10.5 million are estimated to be on adequate therapy (American Heart Association, 1993). Because hypertension can be controlled, but not cured, treatment is often costly. The American Heart Association (1993) estimates that hypertensive disease cost \$14.9 billion each year in direct medical care costs (with drug costs estimated at about \$3.6 billion per year), and \$2.5 billion in lost productivity (table 2).

The most common form of high blood pressure, responsible for a large proportion of fatal and nonfatal cardiovascular events, is Stage I hypertension—which used to be termed "mild" hypertension (systolic blood pressure (SBP) of 140-159 millimeters of mercury (mm Hg), and diastolic blood pressure (DBP) of 90-99 mm Hg). There are documented side-effects associated with hypertensive medications, but little is known about the implications of long-term drug therapy for the millions of people on drug therapy (U.S. Department of Health and Human Services, 1988).

Although the cause of 90-95 percent of the cases of high blood pressure is not known (American Heart Association, 1993), the prevalence of high blood pressure in the United States increases with age (table 4).<sup>10</sup> Age-related increases in blood pressure are associated with being overweight and physically inactive, high sodium and alcohol intakes, and low potassium intake (U.S. Department of Health and Human Services, 1993a). Although not all individuals are equally susceptible to the effects of sodium, a lower sodium intake might prevent blood pressure from increasing with age (U.S. Department of Health and Human Services, 1990b).

Overweight is an important risk factor for hypertension. According to 1976-80 data from the Second National Health and Nutrition Examination Survey (NHANES II), 50 percent of women and 39 percent of men suffer-

<sup>10</sup>In nonindustrialized countries, there is little increase in blood pressure with age (University of California—Berkeley, 1991). In the United States, high blood pressure affects men more than women until early middle age, but then it reverses. The prevalence of high blood pressure also is greater for blacks than for whites and is greater among less educated than more educated people. Regional differences are also present, with greater prevalence of high blood pressure and greater stroke death rates among blacks and whites in the southeastern parts of the country than in other parts of the country (U.S. Department of Health and Human Services, 1993a).

**Table 4—Prevalence of hypertension increases with age in the United States<sup>1</sup>**

Age in years	Share hypertensive
	Percent
18-29	4
30-39	11
40-49	21
50-59	44
60-69	54
70-79	64
80+	65

<sup>1</sup>Hypertension is defined as the average of three blood pressure measurements greater than or equal to 140/90 mm mercury (Hg) on a single occasion or reported taking of antihypertensive medication. Includes only civilian, noninstitutionalized population, based on *Third National Health and Nutrition Examination Survey, 1988-91*.

Source: U.S. Department of Health and Human Services, Public Health Service. *Working Group Report on Primary Prevention of Hypertension*. National High Blood Pressure Education Program, National Heart, Lung, and Blood Institute, NIH Publication No. 93-2669, May 1993.

ing from high blood pressure were overweight (U.S. Department of Health and Human Services, 1991). The National Heart, Lung, and Blood Institute estimates that 20-30 percent of hypertension can be attributed to overweight (U.S. Department of Health and Human Services, 1993b).

Improvements in the detection, treatment, and control of hypertension are believed to have contributed substantially to the decline in mortality rates from stroke and CHD in the past two decades (U.S. Department of Health and Human Services, 1993a). A 2-mm-Hg downward shift in the distribution of systolic blood pressure is estimated to reduce the annual mortality from stroke, CHD, and all causes by 6, 4, and 3 percent, respectively (U.S. Department of Health and Human Services, 1993b). A review of 14 randomized trials suggests a 42-percent reduction in stroke from a 5- to 6-mm-Hg lowering of diastolic blood pressure (U.S. Department of Health and Human Services, 1993a). The National High Blood Pressure Education Program (NHBPEP), launched in 1972, is credited with improving the number of hypertensives aware of their condition and receiving treatment for it (U.S. Department of Health and Human Services, 1993a).

### **Osteoporosis**

Osteoporosis affects some 25 million people in the United States. According to the National Osteoporosis Foundation (1994), one out of every two women over

the age of 50 has an osteoporosis-related fracture, and, by age 75, one-third of all men will be affected by osteoporosis. Osteoporosis is responsible for 1.5 million bone fractures a year, mostly at the wrist, spine, and hip. Hip fractures alone result in estimated annual medical costs of more than \$10 billion. About one in every five people with a hip fracture enter long-term care institutions; hip fractures are also associated with a high mortality rate due to surgical deaths and medical complications (Weaver, 1994).

Although osteoporosis is a multifactorial, complex disorder, low intake of calcium appears to be an important risk factor (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992). Estimated calcium intake levels from phase 1 of the Third National Health and Nutrition Examination Survey (NHANES III) suggest that, although average calcium intake is close to the age-specific Recommended Dietary Allowance (RDA) for most population groups, a large percentage of the population may not be obtaining enough calcium (Looker and others, 1994).

The Consensus Development Conference on Optimal Calcium Intake, convened by the National Institutes of Health in June 1994, emphasized the critical importance of optimizing the calcium intake of Americans, and recommended upgrading the recommended daily intake levels of calcium for most population groups to reduce the risk of osteoporosis (National Institutes of Health, 1994).

### **Overall Cost to Society**

Taken together, the health conditions described above cost society an estimated \$250 billion each year in medical costs and lost productivity (table 2). Although deaths from heart disease and stroke have declined significantly in the past few decades, mortality from cancer and diabetes has not demonstrated such trends (fig. 1). In particular, the toll from premature deaths associated with breast cancer increased between 1980 and 1990 (table 5). Even with the dramatic declines in mortality from heart disease and stroke, nearly two-thirds of deaths in the United States today are still attributable to the same four diet-related conditions. Although changes in diet would certainly not eliminate these chronic conditions, it is widely believed that current dietary patterns are responsible for a large proportion of the current health burden associated with the chronic conditions described above. It behooves us, now, to examine the American diet, to determine what changes might be necessary to improve the health of the population. In other words, just how healthful is the current American diet?

**Table 5—Years of potential life lost before age 65 from diet-related causes of death**

Disease	Years of potential life lost <sup>1</sup>	
	1980	1990
	<i>Number</i>	
Coronary heart disease	544.3	350.0
Cancer	907.5	848.6
Colorectal	68.7	60.6
Breast	105.5	109.4
Prostate	8.5	8.7
Cerebrovascular disease	140.8	110.7
Diabetes mellitus	56.2	67.0

<sup>1</sup>Per 100,000 population under 65 years of age.

Sources: U.S. Department of Health and Human Services, Public Health Service. *Health United States 1993* and *Healthy People 2000 Review*. National Center for Health Statistics, NIH Publication No. 93-1232, Aug. 1993.

## How Healthful Are Our Diets?

Although there is still much that scientists do not know about how diet affects health, there is significant agreement on the components of a healthful diet. The *Dietary Guidelines for Americans*, published by the U.S. Departments of Agriculture (USDA) and of Health and Human Services (DHHS) in 1990, summarizes these components into seven recommendations:

- Eat a variety of foods;
- Maintain healthy weight;
- Choose a diet low in fat, saturated fat, and cholesterol (with 30 percent or less of calories from fat and less than 10 percent of calories from saturated fat);
- Choose a diet with plenty of vegetables, fruits, and grain products;
- Use sugars only in moderation;
- Use salt and sodium only in moderation; and
- If you drink alcoholic beverages, do so in moderation.

The increasing evidence linking diet and health has not been lost among consumers, many of whom report having changed their eating habits to make their diets more healthful (Food Marketing Institute, 1993). Data from USDA's 1989 and 1990 Continuing Survey of Food Intakes by Individuals (CSFII) and the 1977-78 Nationwide Food Consumption Survey (NFCS) confirm that diets are slowly moving toward the *Die-*

*tary Guidelines*. The trend between 1977-78 and 1989-90 has been toward lower fat, higher carbohydrate diets—a step in the right direction. However, progress has not been uniform, and some changes have actually moved in the wrong direction. For example, although the proportion of food energy that comes from total fat and saturated fat has been declining, the proportion of adults who are overweight has been increasing. Data from the Economic Research Service on the amount of food available for consumption at the national level (food supply series) support most of these food consumption trends.

More specifically, we can use USDA survey data to assess how current diets compare with the first six of the *Dietary Guidelines*.<sup>11</sup>

### Eat a Variety of Foods

Because different foods supply different nutrients, the daily diet should contain an assortment of foods from each of the five major food groups as well as a variety of foods from within each food group. To assess variety, it is useful to examine changes that have occurred in both the types of foods consumed and the nutrients provided by those foods.

The types of foods eaten have changed considerably between 1977-78 and 1989-90. Americans are eating more grain products, more cheese, and fewer eggs; and drinking less whole milk and more lowfat and skim milk as well as more soft drinks. They are also consuming more mixed dishes in which meat, poultry, and fish are a main ingredient (such as hamburger and chicken sandwiches, and stews) and less beef and pork as separate cuts (such as steaks and roasts). There is some concern that this shift toward mixed dishes may affect total fat intake through food preparation practices that incorporate "hidden" fat (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992).

Meal patterns have changed as well, with more snacking, and a larger proportion of food being eaten away from home (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992). More research is needed on the extent to which these new patterns influence dietary intake.

The foods consumed in 1989-90 provided the Recommended Dietary Allowances (RDA) for many nutrients,

<sup>11</sup>Much of this section is adapted from Tippet, K.S., and J.D. Goldman, "Diets More Healthful, But Still Fall Short of Dietary Guidelines," *FoodReview*, Vol. 17, No. 1, pp. 8-14, Jan.-Apr. 1994.



but not for others. The nutrients that were below the RDA in 1989-90 were basically the nutrients that were below the RDA a decade earlier. Intakes for vitamin B-6, calcium, and zinc were below the RDA, regardless of income, but were lower for poorer adults.

### **Maintain Healthy Weight**

Despite growing consumer interest in more healthful diets and weight-loss programs, and a declining trend in fat intake (measured as a proportion of total calories from fat), overweight is a growing problem in the United States (Johnson, 1993; Tippett and Goldman, 1994; Kuczmarski and others, 1994). This trend is supported by data from both CSFII (which used self-reported weight and height data to classify respondents as overweight or not) and the 1988-91 phase 1 portion of NHANES III (which actually measured respondents' height and weight). According to NHANES III data, one-third of all adults in the United States are overweight—an increase from 25 percent a decade ago (table 3) (Kuczmarski and others, 1994). Americans may be eating too many lowfat or nonfat foods that are also high in sugar and sodium and low in fiber. That, coupled with the low level of physical activity of many Americans, contributes to the overweight problem.

### **Choose a Diet Low in Fat, Saturated Fat, and Cholesterol**

In 1989-90, total fat intake provided an average of 34 percent of calories, and saturated fat, 12 percent—with little difference by sex, age, income, or race. Although the percentage of calories from total fat is higher than the recommended level (30 percent or less of calories), it is considerably lower than the 40 percent level of 1977-78.

Cholesterol intakes averaged 259 milligrams in 1989-90, lower than the 300-milligram daily maximum recommended by many health authorities (the *Dietary Guidelines* do not include a quantitative recommendation for cholesterol). Since men tend to eat larger amounts than women do, their average cholesterol intakes were higher.

More adults met the recommendation for cholesterol than met the recommendations for total fat and saturated fat. About one-fifth of men and one-fourth of women had diets that met the recommendations for total fat or saturated fat. About half of the men and four-fifths of the women had diets that met the recommendation for cholesterol. Only 11 percent of men and 17 percent of women had diets that met all three recommendations (Tippett and Goldman, 1994).

### **Choose a Diet With Plenty of Vegetables, Fruits, and Grain Products**

Survey data show consumers eating more grains and fewer vegetables than a decade ago, and about the same amount of fruit, although ERS food supply data show that per capita availability of grains, fruits, and vegetables increased over the past decade.<sup>12</sup> However, the proportion of people 2 years old and older consuming at least 5 daily servings of fruits and vegetables was only 28.9 percent in 1989-91 (U.S. Department of Health and Human Services, 1994). Of further concern is the contribution of high-fat vegetables to overall consumption. In 1992, for example, one-third of all potatoes grown in the United States were processed into frozen products—mainly french fries (Putnam, 1994).

Vegetables, fruits, and whole-grain products are important sources of dietary fiber. The National Cancer Institute (NCI) recommends eating foods that provide 20 to 30 grams of fiber per day. The average intake of fiber in 1989-90 was 13 grams, well below NCI's recommendation (the *Dietary Guidelines* do not include a quantitative recommendation for fiber). Fiber intake was higher among men than among women—probably, to a large extent, because men eat more food than women do.

### **Use Sugars Only in Moderation**

It is currently impossible to examine intakes of total sugars in the diet because the nutrient database used with the consumption surveys does not include information on total sugar. However, ERS food supply data suggest that consumption of added sugars is on the rise. On average, consumption of added sugars was more than one-third pound per person per day in 1992 (Putnam, 1994). This is equivalent to over 40 teaspoons per person per day. Although the *Dietary Guidelines* do not include any quantitative recommendation for sugar, USDA's *Food Guide* provides examples of upper limits of added sugars. It suggests that individuals in a 1,600-calorie diet limit their intake of added sugars to 6 teaspoons per day. The

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<sup>12</sup>The discrepancy arises due to the way the data are collected and analyzed. USDA consumption survey analyses do not yet separate out all fruit and vegetables that are part of mixtures (such as fruit in pies, vegetables in stews, or tomatoes in sandwiches or spaghetti or pizza sauce). Since these are not included in the estimates of fruit and vegetables, the consumption survey data tend to underestimate intake of fruits and vegetables. Furthermore, some evidence suggests that participants in nutrition surveys underreport the food they eat, either by completely omitting foods or by underestimating the amount eaten. On the other hand, food supply data reflect the amount of the major food commodities entering marketing channels, regardless of their final use, and tend to overstate actual consumption because they include spoilage and waste accumulated through the marketing system and in the home



daily suggested limit increases to 12 teaspoons for those consuming 2,200 calories, and 18 teaspoons for those consuming 2,800 calories (U.S. Department of Agriculture, 1992). These limits are intended to be averages over time and not rigid prescriptions.

Since sugar is consumed largely as an ingredient in processed foods, such as baked goods and sweetened beverages, it is difficult for consumers to know how much sugar they are actually eating, or to realize that their consumption is increasing.

### **Use Salt and Sodium Only in Moderation**

The 1977-78 NFCS survey did not examine salt intake, so it is not possible to determine trends. But average intake of sodium in 1989-90, not including salt added to the food at the table, was 2,946 milligrams, higher than the recommendation by the Food and Nutrition Board of the National Academy of Science of 2,400 milligrams per day (Tippett and Goldman, 1994).

## **Why Are Diets Still Short of the *Dietary Guidelines*?**

If awareness of the diet-health link has increased over the past decades, and many consumers report changing their diets to make them more healthful, why are most diets still falling short of the *Dietary Guidelines*? There are a number of possible reasons:

### **Lack of Belief**

Many consumers do not believe that chronic disease is within their control, or that changing their diet is very important or worth it. This is particularly true among hard-to-reach populations, typically, those groups with lower income and education. Cultural differences may also play a role.

### **Lack of Motivation**

Some consumers believe that “lowfat” or “light” foods are diet foods, more costly, and less tasty; others confess to being so confused they do not really know what to do; still others believe, sometimes erroneously, that their diets are sufficiently healthful that there is no need to change their current eating patterns.

In a recent study, over two-thirds of those with high blood cholesterol or heart disease did not report being on a special lowfat/low-cholesterol diet (Frazão and Cleveland, 1994). The study did not make it clear whether these individuals had not been advised by their doctors to consume a lowfat/low-cholesterol diet, whether they had been advised to do so but had cho-

sen not to, or whether they were consuming a low-fat/low-cholesterol diet but did not see anything special about it.

### **Lack of Knowledge**

Among those who wish to change their dietary intakes, people armed with the proper knowledge may make better food choices. Both general nutrition knowledge and specific knowledge about fiber content of foods are associated with higher levels of fiber consumption (Smallwood and Blaylock, 1994), while specific knowledge about the total fat content of foods is associated with increased likelihood of meeting the intake recommendations for saturated fat and cholesterol (Frazão and Cleveland, 1994).

Yet, research suggests that many consumers have mistaken concepts about which foods are high in fat. Many shoppers do not know that lean ground beef is high in fat (Food Marketing Institute and Prevention Magazine, 1992); many think that white bread is high in fat (Cremer and Kessler, 1992); and many have difficulty identifying the degree of fat in some foods, such as pizza, cheese, and baked goods (U.S. Department of Health and Human Services, 1992b).

Misperceptions about the nutrient content of foods is likely to result in misperceptions about the total diet. A recent study found, for example, that meal planners tend to underestimate the amount of total fat and saturated fat, but overestimate the cholesterol in their diets. When asked to compare the levels of total fat, saturated fat, and cholesterol in their own diet with “what is most healthful,” 41 percent of meal planners thought the level of fat in their diets was “about right,” and 49 percent thought their diets were “about right” for saturated fat. Yet, only 25 percent of meal planners actually met the recommendations for total fat or saturated fat. Conversely, slightly more than half of the meal planners thought their diets were “about right” for cholesterol, although nearly three-fourths met the recommendation for cholesterol. The same study also found that many “lowfat/low-cholesterol” diets are not really that low in total fat. Among meal planners who claimed to be on a special “lowfat/low-cholesterol” diet, two-thirds consumed more than 30 percent of calories from total fat, and over half consumed more than 10 percent of calories from saturated fat (Frazão and Cleveland, 1994).

### **Ineffective Changes**

Changes in food consumption patterns do not always translate into more healthful diets. A study by USDA’s Economic Research Service showed that al-

**Table 6—Claims about fat content increase faster than claims about calorie content in new food products**

Nutrient claim on new food products <sup>1</sup>	New food products					
	1988	1989	1990	1991	1992	1993
	<i>Number</i>					
Reduced fat or lowfat	275	626	1,024	1,198	1,257	847
Reduced calorie or low calorie	475	962	1,165	1,214	1,130	609
Reduced sugar or low sugar	52	188	331	458	692	473
Low cholesterol or no cholesterol	126	390	694	711	677	287
Reduced salt or low salt	202	378	517	572	630	242
Added fiber or high fiber	56	73	84	146	137	51
Added calcium or high calcium	4	27	20	15	41	14
Total food products introduced	8,183	9,192	10,301	12,398	12,312	12,897

<sup>1</sup>Product claims cannot be added since a product may make more than one claim.

Source: *Prepared Foods*, various issues.

though women with higher education made greater changes in their diets between 1977 and 1988 than did women with less education, these changes did not result in significantly different levels of total fat intake. Basically, the women with higher education traded one source of fat for another, such as from red meats to dairy products and grain-based mixtures (such as pizza), with little net effect on overall intake of total fat (Putler and Frazão, 1991).

Another USDA study showed little difference in total fat intake of women in various income groups, even though higher income women were more likely to have reduced their intake of meat, whole milk, and eggs between 1977 and 1985 (Welsh and Harris, 1989). These ineffective dietary changes likely result from the difficulties in translating general nutrition knowledge into specific food choices (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 1992).

### Health Is Just One of Many Aspects of Eating

People choose the foods they eat to meet a variety of needs, including income constraints, convenience, cultural habits, and psychological satisfaction. Choosing a healthful diet requires changing attitudes, behavior, and eating practices—as well as commitment to those changes. Attitudes toward diet and knowledge about nutrition and the nutritional content of foods can affect motivation and ability to put dietary guidelines into practice. To consume a healthful diet, consumers must make many complex decisions about which foods to choose, how to prepare them, and how much of each individual food to eat in order to balance their

desires for good health, taste, convenience, economy, and satisfaction.

On the other hand, the food industry has responded to consumer interest in nutrition, introducing myriad new food products with reduced fat content. Among new product introductions, claims related to fat content steadily increased until 1992, when they surpassed claims about caloric content (table 6).<sup>13</sup> The increased availability of lower fat products and lean meats has probably contributed to the overall decline in total fat intake in the United States in the past decade. It is expected that the new nutrition labels, mandated for most processed foods, will provide an additional incentive for manufacturers to reformulate their products. With nutrition information available on most food packages, and improved nutrient content of processed foods, consumers may find it easier to choose a more healthful diet.

<sup>13</sup>Although the number of nutrient content claims fell sharply in 1993, it was likely a temporary drop associated with some uncertainty surrounding the new nutrition labeling regulations, which went into effect in mid-1994 and strictly define nutrient content claims. According to the annual consumer survey conducted by the Food Marketing Institute (1994), nutrition concern remains strong, and has even increased. In January 1994, 62 percent of the respondents stated that they were very concerned about the nutritional content of the food they eat, compared with 54 percent in 1993. Concern relating to fat content reached a historical high (59 percent compared with 54 percent in 1993), although concerns about salt and sugar content went down.

## Health and Economic Benefits of Dietary Changes

The extent to which mortality and societal costs might be reduced by improving the American diet is still wide open to research. As mentioned earlier, a number of considerations make it difficult to determine the extent to which dietary changes can delay or prevent the onset of chronic diseases, and thereby affect the incidence and mortality associated with these conditions. For example, an individual's risk for chronic disease can be increased by genetic predisposition, stress levels, smoking, and activity levels, as well as diet. For some conditions—such as CHD—the effects of these risk factors may be multiplicative, rather than additive (Berwick, Cretin, and Keeler, 1980). Further complicating attempts to identify the effect of diet on chronic disease is the prolonged time period before the onset of chronic disease. Since dietary patterns tend to change over time, the question has come up as to whether it is dietary patterns during childhood, recent dietary patterns, or lifelong dietary patterns that are more important in predicting risk for chronic disease. In spite of these difficulties, a few studies have estimated the potential benefits associated with dietary changes.

### Changes in Fat Intake and Mortality From CHD and Cancer

Two related studies (the second being an extension of the first) examined how changes in the intake of total fat, saturated fat, and cholesterol affected mortality from CHD and cancer (Browner, Westenhause, and Tice, 1991; Zarkin and others, 1991). The studies assumed that the effect of total dietary fat on the risk of prostate, breast, and colon/rectum cancer was directly related to the amount of total fat consumed, but that the effect on CHD was mediated through blood cholesterol level, which is affected by intake of saturated fat and dietary cholesterol. The Keys and Hegsted equations were used to predict the effect of reduced intake levels of saturated fat and dietary cholesterol on blood cholesterol levels. The analyses assumed a 2-year lag for dietary change to show a beneficial effect on CHD and a 10-year lag for dietary change to show a beneficial effect on cancer.

The Browner, Westenhause, and Tice (1991) study assumed that all Americans would restrict their intakes of total fat to the recommended level of a maximum of 30 percent of calories. In addition, the study assumed that the reduction in total fat intake was confined to a reduction in saturated fat, and that total energy intake did not change. The authors estimated this would postpone 42,000 premature deaths from CHD and cancers each year—2 percent of all deaths. Although this would be

equivalent to an increase of only 3-4 months in average life expectancy, if multiplied by a population of 250 million individuals it would result in over 60 million years of additional life. Benefits would not be distributed equally among all age groups. Although a proportionally larger reduction in CHD and cancer deaths would occur among the younger age groups, benefits—in absolute terms—would accrue mainly to those older than 65 years, the group with the highest CHD and cancer mortality.

Zarkin and others (1991) used the Browner model to estimate the health benefits associated with proposed changes in the nutrition label. Results of this study were used by the Food and Drug Administration (FDA) and USDA in the regulatory impact analyses accompanying each agency's nutrition labeling regulations (U.S. Department of Health and Human Services, 1991a; U.S. Department of Agriculture, 1991).<sup>14</sup> The analyses were based on the premise that mandatory nutrition labeling on processed foods would result in reduced consumption of total fat, saturated fat, and cholesterol. As in the Browner, Westenhause, and Tice (1991) study, the model assumed that a reduction in the intake of total fat had a direct effect on the number of cases and mortality from prostate, breast, and colon/rectum cancer, but that the effect on CHD was mediated by the effect of reduced intake of saturated fat and cholesterol on blood cholesterol levels. Benefits were calculated over a 20-year period.

Given 1987-88 average intake levels of total fat, saturated fat, and cholesterol, reductions in consumption levels would have to be quite large to meet current health recommendations (table 7) (U.S. Department of Agriculture, 1991). Yet, even small average reductions of only about 1 percent in the intake of total fat and saturated fat, and 0.1 percent in the intake of cholesterol, were estimated to prevent over 56,000 cases of CHD and cancer, avoid over 18,000 deaths, and save over 117,000 life-years over a 20-year period.

With average medical care costs estimated at more than \$74,000 for CHD, and more than \$108,000 for cancer, health care costs associated with the number

<sup>14</sup>The following discussion on the health benefits associated with nutrition labeling is adapted and condensed from U.S. Department of Health and Human Services, Food and Drug Administration. "Regulatory Impact Analysis of the Proposed Rules to Amend the Food Labeling Regulations." *Federal Register*, Vol. 56, No. 229, pp. 60856-77, Nov. 27, 1991a; and from U.S. Department of Agriculture, Food Safety and Inspection Service. "Nutrition Labeling of Meat and Poultry Products, Proposed Rule." *Federal Register*, Vol. 56, No. 229, Part II, pp. 60302-64, Nov. 27, 1991.

**Table 7—Large reductions in fat intake are needed to meet dietary recommendations**

Food component	Reduction needed <sup>1</sup>	
	Men	Women
	<i>Percent</i>	
Total fat	20.1	18.5
Saturated fat	25.1	24.0
Cholesterol	13.5	-- <sup>2</sup>

<sup>1</sup>Based on average intakes in 1987-88.

<sup>2</sup>Average daily intake of cholesterol among women was below the recommendation of 300 milligrams.

Source: U.S. Department of Agriculture, Food Safety and Inspection Service, "Nutrition Labeling of Meat and Poultry Products: Proposed Rule." *Federal Register*, Vol. 56, No. 229, pp. 60302-55, Nov. 27, 1991.

of cases avoided over the 20-year period yielded savings of \$800 million (discounted at 5 percent). This estimate, however, undervalues the true benefits of the regulations because it does not include productivity losses or the value of pain and suffering.

A more inclusive method of valuing such losses is to estimate the amount people are willing to pay to reduce the risk of premature death. Individuals, often without realizing, routinely make decisions to avoid or accept some incremental amount of risk when they choose to pay more for safer products or earn higher wages in jobs that incur higher risks (Aldrich, 1994). Researchers can estimate the values that consumers and workers place on reducing the risk of premature death in two ways: by analyzing wage differentials between high- and low-risk jobs; or by examining consumer market studies for the observable tradeoffs people make between risks and benefits in their consumption decisions, such as in their decision to use automobile seat belts or smoke detectors.

Researchers also estimate willingness to pay to reduce the risk of premature death by contingent valuation studies. In these studies, survey respondents are given a hypothetical situation and asked how much they would be willing to pay to reduce their risk of premature death by a specified (small) amount.

Willingness-to-pay estimates represent the value of a statistical life, not the value for any particular individual's life. For example, if each of 100,000 persons is willing to pay \$20 for a reduction in risk from 3 deaths per 100,000 people to 2 deaths per 100,000 people, the value per statistical life (or the willingness

to pay to reduce risk of death) is \$2 million (Fisher, Chestnut, and Violette, 1989).

In a review of willingness-to-pay studies, Fisher, Chestnut, and Violette (1989) determined that estimates of the value of statistical life ranged between \$1.6 million and \$8.5 million in 1986 dollars. More recently, Viscusi (1993) concluded that the range of reasonable estimates was narrower, between \$3 million and \$7 million.

In spite of the large range in willingness-to-pay estimates, these estimates provide a broad index of the overall desirability of a policy. In other words, they can be useful as a basis for considering whether a particular effort costing \$50,000 per life saved or \$50 million per life saved, is warranted (Viscusi, 1993).

Using the conservative willingness-to-pay estimate of \$1.5 million, FDA and USDA estimated the health benefits of mandatory nutrition labeling regulation using two methods. The first method considers that the number of life-years saved is more important than just the number of premature deaths avoided. According to this method, dying of a heart attack at age 35 is of more societal concern than dying of a heart attack at age 60, and saving 30 years of life is worth more to society than saving 5 years of life. In this method, the willingness-to-pay value is divided by the expected discounted life-years remaining after age 40, to yield a value per life-year saved. Multiplying this by the discounted number of life-years saved produced a benefits estimate of \$5.6 billion over 20 years.

The second method considers only the number of early deaths avoided (discounted at 5 percent), ignoring the average remaining years of life. Multiplying willingness-to-pay by the discounted number of early deaths avoided results in a benefits estimate of \$15.3 billion over 20 years.

Although these benefits estimates are relatively crude, they suggest that even small improvements in dietary intake may be associated with large perceived benefits. Both studies, however, emphasize that their estimates depend on the many assumptions used in the analysis. Some of the assumptions may result in overestimates of the health benefits, while other assumptions may underestimate the health benefits of changes in dietary intake of total fat.

### **Assumptions That May Overestimate Health Benefits**

Willett (1994) points out that the assumption that CHD risk is a function of total blood cholesterol may

overestimate the effect of changes in total fat intake on CHD risk. It now appears that the ratio of total blood cholesterol to high-density lipoprotein (HDL) is a much better predictor of CHD risk than is total blood cholesterol level alone. Depending on how a reduction in total fat intake is achieved, the effects on CHD risk may be smaller if the simultaneous effect on HDL is also considered. For example, reducing intake of saturated fat by substituting carbohydrates tends to reduce total blood cholesterol. But it also tends to reduce HDL. The resulting reduction in CHD risk may be smaller when estimated using the ratio of total blood cholesterol to HDL than when predicted by the effect of saturated fat on total blood cholesterol alone.

Although the studies assumed that the effects were independent of age, gender, or race, the effects of blood cholesterol on CHD have mostly been studied on white middle-aged men, and it may not be appropriate to extrapolate those results to women (who have different hormones and metabolism), or to younger individuals or to different races. Further, the relationship between total blood cholesterol and risk of death from CHD becomes weaker as people age, nearly disappearing in the elderly (Oliver, 1990; Taylor and others, 1990; Gladwell, 1991; Browner, Westenhause and Tice, 1991).

In both studies, final mortality rates depended only on final levels of total fat intake and blood cholesterol, regardless of how high the initial level had been. Thus, an individual whose high initial blood cholesterol level is lowered had the same risk as an individual whose blood cholesterol had always been at the lower level. Weinstein and Stason (1976) question that assumption in relation to hypertension, suggesting that some initial damage may have been done that would permanently increase the treated individual's risk, so that only a fraction of the benefit would apply.

Finally, although the studies did account for the fact that since fewer people die of CHD and cancer each year more are alive to die of other causes, and netted out these other causes, there is still some question as to whether a reduction in dietary fat intake and blood cholesterol level is associated with a reduction in all-cause mortality. Clinical trials of lipid-lowering drugs have not found a significant reduction in all-cause mortality associated with reduced blood cholesterol levels (Goldbloom and Lawrence, 1990). Similarly, clinical studies have failed to confirm the hypothesis that a reduction in total fat intake decreases mortality from cancers of the breast, prostate, and colon/rectum (Page and Asire, 1985; Browner, Westenhause, and Tice, 1991; Council on Scientific Affairs, AMA, 1993). It may be that the studies have not been long enough to identify a signifi-

cant effect, or that the type of fat consumed needs to be controlled for. Or it may be that fat intake needs to be reduced to much less than 30 percent of calories for a significant effect to be detected.

### **Assumptions That May Underestimate Health Benefits**

Several assumptions are likely to underestimate the health benefits associated with changes in dietary intake of fat. For example, both studies assumed that changes in total fat intake were not accompanied by changes in caloric intake, and therefore did not include any likely health effects associated with reductions in overweight which might have occurred if caloric intake had decreased. Yet, obesity is a risk factor for CHD, stroke, diabetes, and hypertension. And, at least in rodents, caloric restriction has been found to be more important than intake of dietary fat in determining risk of cancer (Page and Asire, 1985; Council on Scientific Affairs, AMA, 1993).

By failing to capture reductions in morbidity, and any associated gains in quality of life—particularly during the middle ages—the model may have severely underestimated health benefits. Although “quality of life” is a difficult concept to measure, a study on stroke victims found that they valued the loss in quality of life as equivalent to 1.5 years of life. In other words, they would have been willing to give up 1.5 years of life to avoid suffering the consequences of a nonfatal stroke (Weinstein and Stason, 1976; Milio, 1981).

### **Effect of Current Dietary Patterns on Total Mortality**

Analyzing the problem from a different perspective, McGinnis and Foege (1993) examined the influence of current dietary patterns on overall mortality. After reviewing hundreds of studies since 1977, they identified the underlying risk factors—behaviors that may have been controlled by the individual, such as diet, smoking, and activity level—behind the deaths. In their study, when an obese, inactive, middle-aged person died from a heart attack, the cause of death was attributed to poor diet and inactivity, rather than to heart disease (as would appear in the official death certificate).

Because the effects of diet and physical activity were hard to distinguish, the two effects had to be combined:

*“The interdependence of dietary factors and activity patterns as risk factors is illustrated by the case of obesity, which is associated with increased risk for cardiovascular disease, certain cancers, and diabetes, and is clearly related to*

*the balance between calories consumed and calories expended through metabolic and physical activity. Similarly, high blood pressure, a major risk for stroke, can be affected by dietary sodium, obesity, and sedentary lifestyle.”* (McGinnis and Foege, 1993).

Based on the studies reviewed, McGinnis and Foege (1993) determined that diet/physical inactivity were responsible for 22-30 percent of all cardiovascular deaths, 20-60 percent of all fatal cancers, and 30 percent of diabetes deaths. Using the most conservative estimates, and being careful not to double-count deaths with overlapping risk factors (such as alcohol or illegal drugs), they estimated that 300,000 of the 2.1 million deaths in 1990—14 percent—could be attributed to poor diets and/or inadequate physical activity.

### International Comparisons and the Potential for Prevention

Gori and Richter (1978) used a different technique to estimate, for the five major causes of death in the United States (in 1973), the proportion that could potentially be prevented. They reasoned that the leading causes of death today result from a variety of personal and social factors, such as improper diet, lack of exercise, excessive drinking, smoking, drug abuse, unsafe driving and working conditions, and inadvertent and deliberate environmental pollution. Thus, at least partial prevention of these diseases appears reasonable.

For each cause of death, they compared U.S. mortality rates with the mortality rates among 21 other developed countries.<sup>15</sup> The authors noted that, among the 21 countries, there was often a large gap between the lowest rate and the second lowest rate, while the gap between the second and the third lowest rates was usually small. To be on the conservative side, the authors used the second lowest mortality rate by cause of death. The difference between the death rate in the United States and the second lowest mortality rate among the 21 countries studied was defined as the prevention potential, or the proportion of deaths for each cause that could potentially be prevented.

Gori and Richter (1978) acknowledge that differences in mortality rates could reflect a number of factors, includ-

ing high infant mortality and shortened lifespans in other countries, inborn genetic differences, discrepancies in methods of data collection, or the availability of medical care and its quality. However, they argue that, by comparing the U.S. mortality rate with the second lowest mortality rate rather than the lowest, their estimates are quite conservative, and these factors are not sufficient to negate the validity of their prevention-potential estimates. Further, differences in the availability and quality of medical care would tend to underestimate the prevention potential when based on comparisons with other countries where the availability and quality of medical care is lower than in the United States. According to their estimates, 39 percent of deaths from major cardiovascular renal diseases in the United States are preventable, as are 25 percent of all deaths from cancer, and 63 percent of diabetes deaths (table 8).

Interestingly, although Gori and Richter (1978) do not attempt to identify the prevention factors, their estimates are quite similar to the proportion of premature deaths attributable to diet/inactivity (and thus preventable) presented by McGinnis and Foege (1993) for cardiovascular disease and cancer (table 9). It is not immediately apparent why Gori and Richter's (1978) estimate of the proportion of deaths from diabetes that could be prevented is twice as large as what McGinnis and Foege (1993) attribute to diet/inactivity. It may be that, for diabetes, a large genetic factor may be involved. On the other hand, McGinnis and Foege (1993) estimated that 50 percent of all cases of Type II diabetes could likely be prevented by controlling overweight.

**Table 8—Prevention potential of diet-related diseases<sup>1</sup>**

Cause of death	U.S. deaths, 1993 <sup>2</sup>		Prevention potential
	Number	Percent	
Major cardiovascular renal diseases	889,600	39.2	39
Malignant cancer	530,870	23.4	25
Diabetes mellitus	55,110	2.4	63

<sup>1</sup>U.S. mortality from diet-related diseases and prevention potential calculated by comparing U.S. mortality with second-lowest rate among 21 industrialized countries.

<sup>2</sup>Adapted from table 1, assuming that "major cardiovascular renal diseases" is composed of diseases of the heart and cardiovascular diseases (stroke).

Source: Adapted from Gori, Gio B., and Brian J. Richter. "Macroeconomics of Disease Prevention in the United States." *Science*, Vol. 200, pp. 1124-30, June 9, 1978.

<sup>15</sup>The countries were Canada, Mexico, Japan, Denmark, Finland, France, Federal Republic of Germany, Iceland, Italy, Netherlands, Norway, Switzerland, England and Wales, Scotland, Sweden, Portugal, Austria, Luxembourg, Belgium, Australia, and Israel. Although not included in this report, they also estimated the prevention potential for accidents and for diseases of the respiratory system.

**Table 9—Prevention potential from all causes and diet for U.S. mortality from top diet-related diseases<sup>1</sup>**

Cause of death	Prevention potential	Deaths attributable to diet/inactivity
	<i>Percent</i>	
Major cardiovascular renal diseases <sup>1</sup>	39	22-30
Malignant cancer	25	20-60
Diabetes mellitus	63	30

<sup>1</sup>Includes diseases of the heart and cerebrovascular diseases (stroke).

Sources: Gori, Gio B., and Brian J. Richter. "Macroeconomics of Disease Prevention in the United States." *Science*, Vol. 200, pp. 1124-30, June 9, 1978; and McGinnis, J. Michael, and William H. Foege. "Actual Causes of Death in the United States." *Journal of the American Medical Association*, Nov. 10, 1993.

## What USDA Is Doing To Help Americans Improve Their Dietary Patterns

As illustrated above, consumers have much to gain from improving their dietary patterns. Thus, there is an urgent need to improve consumers' knowledge about food, nutrition, and choosing a healthful diet. As an agency responsible for nutrition education and food assistance programs, USDA has a number of activities aimed at helping consumers improve their food consumption choices. Listed below are some of the instruments USDA is using in its efforts.

### Dietary Guidelines and Nutrition Labeling

Dietary guidelines and nutrition labeling provide a starting point for consumers interested in improving the healthfulness of their diets. The *Dietary Guidelines* is the Federal Government's basic document that provides advice to Americans on what to eat to stay healthy. The *Guidelines* are reviewed and published every 5 years, with the 4th edition due in 1995. To help consumers apply the information, USDA developed the *Food Guide Pyramid*, which is also supported by the U.S. Department of Health and Human Services (DHHS).

The new nutrition labeling regulations, issued by both FDA and USDA, mandate nutrition labels on most processed foods as of August 1994.<sup>16</sup> The new regulations

<sup>16</sup>USDA is responsible for labeling of meat and poultry products, while FDA oversees the labeling of all other food products.

update the list of nutrients that appear on the labels, standardize serving sizes, define nutrient content claims (such as "lowfat"), and provide a mechanism for evaluating health claims. The objective is to make information available—and then teach consumers how to use the information—to put together a healthful diet. Improved coordination with the Federal Trade Commission (FTC) may help reduce misleading advertising by food manufacturers.

### Nutrition Education

The difficulty of translating awareness into behavioral change is a major challenge to USDA's nutrition education efforts, since it is well known that dietary advice does not automatically translate into dietary practices. This is particularly true when dietary advice requires large changes in current behavior. Furthermore, advice to reduce consumption of certain foods is usually harder to follow than advice to increase consumption of certain foods. Further, health problems tend to be concentrated among hard-to-reach populations—those least likely to be aware of the diet-health links or to have adequate nutrition knowledge.

Nutrition education specialists also recognize they must overcome a common belief that the prevention of chronic disease is beyond one's control, and that a healthful diet is more costly, difficult, time-consuming, and less pleasurable. While motivating consumers to make dietary changes, nutrition education must also provide consumers with the knowledge necessary to make effective dietary changes.

In an attempt to improve the scope and effectiveness of its nutrition education efforts, USDA plans to include nutrition education activities in several of its food assistance programs (such as the Food Stamp Program). Other areas of attention include: improving coordination among the different agencies that develop nutrition education campaigns, programs, and materials, strengthening nutrition education programs, encouraging joint private and public nutrition education ventures, using innovative program designs and outlets, and encouraging production of more healthful food products.

### Improved Nutritional Content of School Lunches and Breakfasts

USDA is currently directing its efforts toward improving the nutritional content and types of foods offered under the National School Lunch and School Breakfast Programs, which tend to be high in total fat, saturated fat, and sodium (Burghardt and others, 1993).



Under the recently passed "Better Nutrition and Health for Children Act of 1994," school meals for children age 2 years and older will have to meet the *Dietary Guidelines*. Schools will have the option of adopting a food-based menu or using computer-based nutrient analysis to meet these dietary guidelines, which would apply over 1-week cycles, beginning in 1996 (Donnelly, 1994; U.S. Department of Agriculture, 1994).

A cost analysis prepared by ERS suggests that it is possible to improve the nutritional content of school meals without increasing food costs. Although there is some concern that lower total fat content of meals may result in lower student participation, USDA has requested additional funds to support training for local meal providers on how to plan and prepare nutritious and appealing meals as well as a national media campaign directed at building children's skills at making wise food choices for life-long health (U.S. Department of Agriculture, 1994).

### **Nutrition Monitoring**

Appropriate intervention programs depend on accurate knowledge about the situation. This makes nutrition monitoring vital to policymaking and research. Monitoring can provide information for public policy decisions related to nutrition education; public health nutrition programs; food assistance programs; federally supported food service programs; the regulation of fortification, safety, and labeling of the food supply; and food production and marketing.

The National Nutrition Monitoring and Related Research Program (NNMRRP) was established to provide timely information about the role and status of factors that bear on the contribution that nutrition makes to health. USDA and DHHS share joint responsibilities for the NNMRRP.

USDA is a major provider of data through its nationwide surveys of food consumption (and the associated survey on knowledge and attitudes related to food and nutrition), as well as the annual food supply time-series data. DHHS is another major provider of data through its health-based surveys and surveillance systems, many of which collect information on food consumption. However, there is a need to improve the type and accuracy of data collected. In particular, improved data are needed on the food supply, household and individual dietary intake, and nutrient composition of foods. The time period between when the data are collected and when they become available to researchers needs to be considerably shortened.

Additional research is also needed to explain the discrepancy between the food supply and individual intake data, to improve our understanding of the diet-health links as well as our understanding of consumer behavior.

### **New Efforts**

USDA, DHHS, and the U.S. Agency for International Development are involved in drafting a U.S. Plan of Action to address national nutrition priorities in response to the 1992 International Conference on Nutrition, sponsored by the Food and Agriculture Organization of the United Nations and the World Health Organization. The plan will address issues of both over- and underconsumption.

### **Research Needs**

There is no shortage of research topics in the area of diet and health, in both the biomedical area and in the social sciences. Additional biomedical research is needed to improve our understanding of how diet (or specific components of the diet) affects health, and how nutrient levels and interactions may impact on health. In the social sciences, research is needed in both economics and consumer behavior. Economic analysis on the costs and benefits of different interventions would provide information on how to best use our scarce resources. Improved understanding of how consumer knowledge, attitudes, and beliefs influence food choices might increase the effectiveness of policies and programs that aim to modify consumer behavior.

### **Biomedical research**

This is unquestionably a complex area, due to the enormous variety of foods consumed by individuals and the tremendous assortment of components associated with foods. For example, there are hundreds, perhaps thousands of individual yet interacting chemicals in each stalk of broccoli (Angier, 1993). Some of these chemicals have no known nutritional value, but many have been shown, in animal and test-tube research, to have specific biological actions that may prove helpful to our health (table 10). Thus, it is not surprising that scientists have not yet been able to determine whether the beneficial health effects associated with diets high in fruits and vegetables are due to their fiber content or to some other component(s) present in fruits and vegetables. In addition, diets high in plant foods also tend to be low in total fat, saturated fat, and cholesterol. Therefore, unless each factor is independently evaluated or controlled for, it is difficult to determine whether the effect is associated with a low intake of total fat and not really due to a high intake of, for example, fruits, or vitamin C (Subar and others, 1994). The problem is further complicated by the fact that many of the health problems associated



**Table 10—Potential cancer fighters in foods**

Component	Possible disease-fighting properties	Food sources
<b>Allylic sulfides</b>	May protect against carcinogens by stimulating production of a detoxification enzyme, glutathione-S-transferase.	Garlic and onion.
<b>Carotenoids (Vitamin A precursors)</b>	Antioxidants and cell differentiation agents (cancer cells are nondifferentiated).	Parsley, carrots, winter squash, sweet potatoes, yams, apricots, cantaloupe, spinach, citrus fruit, turnip greens, and kale.
<b>Catechins (tannins)</b>	Antioxidants, linked to lower rates of gastrointestinal cancer; mechanisms not understood.	Green tea and berries.
<b>Fiber</b>	Dilutes carcinogenic compounds in colon and speeds them through digestive system; discourages growth of harmful bacteria while bolstering healthful ones; may encourage production of healthier form of estrogen.	Whole grains and many vegetables.
<b>Flavonoids</b>	Block receptor sites for certain hormones that promote cancers.	Most fruits and vegetables.
<b>Indoles</b>	Induce protective enzymes.	Cabbage, brussels sprouts, and kale.
<b>Isothiocyanates</b>	Induce protective enzymes.	Mustard, horseradish, and radishes.
<b>Limonoids</b>	Induce protective enzymes.	Citrus fruits.
<b>Linolenic acid</b>	Regulates prostaglandin production.	Many leafy vegetables and seeds.
<b>Lycopene</b>	Antioxidant.	Tomatoes and red grapefruit.
<b>Monoterpenes</b>	Some antioxidant properties; inhibit cholesterol production in tumors; aid protective enzyme activity.	Parsley, carrots, broccoli, cabbage, cucumbers, squash, peppers, citrus fruits, tomatoes, eggplant, yams, mint, and basil.
<b>Phenolic acids (tannins)</b>	Some antioxidant properties; inhibit formation of nitrosamine, a carcinogen, and affect enzyme activity.	Parsley, carrots, broccoli, cabbage, tomatoes, eggplants, citrus fruits, peppers, whole grains, and berries.
<b>Plant sterols (Vitamin D precursors)</b>	Differentiation agents.	Broccoli, cabbage, cucumbers, soy products, whole grains, eggplant, tomatoes, and yams.
<b>Vitamin C</b>	Antioxidant; inhibits creation of nitrosamine, a potentially dangerous carcinogen, in the stomach.	Citrus fruits, tomatoes, green leafy vegetables, and potatoes.
<b>Vitamin E</b>	Antioxidant.	Wheat germ, oatmeal, brown rice, peanuts, and nuts.

Source: Angier, Natalie. "Chemists Learn Why Vegetables Are Good for You." *The New York Times*, Apr. 13, 1993.

with diets manifest themselves only after many years, during which time diets may change significantly, making it difficult to assign causality.

Dose-response and interactions between food and nutrient components further compound the problem. For example, although vitamins C, E, and beta-carotene act as antioxidants in some circumstances (such as in the amounts found in foods), they can act as prooxidants under different circumstances (such as in the pharmacologic amounts often found in dietary supplements) (Herbert, 1994a). Similarly, the American Medical Association's Council on Scientific Affairs (1993) cautions that a substance may be both an animal anticarcinogen and a carcinogen, depending on the circumstances. In general, carcinogenic effects are associated only with high doses, whereas anticarcinogenic effects are observed at lower levels of intake (albeit still higher than dietary levels). Vitamin C, which usually behaves as an antioxidant, turns violently prooxidant in the presence of high body stores of iron (Herbert, 1994a).

In the search for a "magic ingredient," it is critical that both consumers and researchers not lose sight of the fact that foods often contain a combination of antioxidants, prooxidants, carcinogens, anticarcinogens, mutagens, and antimutagens (Herbert, 1994b). And too much of one thing may be just as bad for health as too little. The key concept of "variety, moderation, and balance" in the overall diet may yet turn out to be the best advice.

Biomedical research also needs to address questions about the interpersonal variability observed in biomedical studies. Research is needed to explain why some individuals show a response in their blood cholesterol level when exposed to a high intake of saturated fat, while other individuals show no response. The ability to isolate the factors responsible for such responses or lack of response would make it possible to identify those individuals at risk who are more likely to benefit from specific dietary interventions.

### **Social sciences research**

Economic analysis is needed to address the issue of how best to measure the likely costs and benefits associated with specific dietary changes. It is implicitly assumed that if Americans improve their diets as recommended, their risks of chronic diseases will fall, with a concomitant drop in health care costs. However, Russell (1986) describes how medical expenditures actually increase with the detection and treatment of hypertension, even though the cost of a blood pressure test is small, and the costs of treating the heart attacks and strokes that often

accompany hypertension are high. Although some savings result from treating hypertension, the cumulative medical costs of treating hypertension exceed those savings. Among individuals with moderate or severe hypertension, the costs of treatment are estimated to be four times the savings; among individuals with mild hypertension, the costs are six times the savings.

This is not to say that programs to detect and treat hypertension—or improve diets—are not worthwhile if they are not associated with reduced health care expenditures. An aging population is likely to suffer from new causes of morbidity and mortality, imposing new health care costs (Gori and Richter, 1978). Thus, it may be more appropriate to evaluate nutritional programs in terms of whether they can extend and improve life at an acceptable cost.

On the other hand, cost-benefit analysis would allow policymakers to determine which of several alternative programs might be more effective. For example, Gladwell (1991) estimated that the costs of screening and treating high blood cholesterol among Americans older than 65 years may be close to \$16 billion a year—yet the precise impact of such treatment on the longevity of the elderly is not clear. Berwick, Cretin, and Keeler (1980) estimated that a mass media education campaign might be more cost-effective in reducing blood cholesterol and saving years of life than screening school-age children for high blood cholesterol.

In addition, more research is needed in the area of behavioral research and consumer choice models. What is it that makes some consumers change their diets and habits? Survey data are now available that allow researchers to look, for the first time on a national level, at the role that nutrition awareness, beliefs, attitudes, and knowledge may play in increasing the healthfulness of an individual's diet.

It is clear that much research is needed before we understand how to use specific foods or compounds to significantly reduce the incidence of chronic disease without inadvertently exposing the public to increased health risks (Council on Scientific Affairs, 1993). Through improved understanding of the mechanisms involved we will be able to address questions such as whether dietary supplements (and what type) are useful, whether the high risk of CHD associated with a high intake of saturated fat can be reduced by increased consumption of fruits and vegetables, and which individuals are more likely to benefit from what change.

Improved knowledge and experience with nutrition education messages may also lead to changes in the content

of the messages. For example, although nutrition education efforts have focused on getting consumers to reduce their intake of total fat, Subar and others (1994) suggest that a message to increase intake of fruits, vegetables, whole grains, and lowfat dairy products may not only increase the intake of nutrients/foods that might protect against chronic disease, but may also reduce calories from total fat. Doll and Peto (1981) suggest that, from a public policy perspective, it may be easier to recommend that consumers increase their consumption of protective agents/foods than to recommend that consumers decrease their intake of deleterious components.

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# Glossary<sup>1</sup>

Words in italics in the definitions of a term are defined elsewhere.

**Antioxidants.** Chemical compounds that prevent oxygen from reacting with other compounds. Some antioxidants have been shown to have cancer-protecting potential because they neutralize *free radicals*. Depending on the dose, beta-carotene (a nutrient that the body converts to vitamin A), and vitamins C and E all act as antioxidants (at high doses they can be *prooxidant*).

**Atherosclerosis.** A condition characterized by the accumulation of *plaque* in the arterial walls. This results in a progressive narrowing of the arteries, which reduces the flow of blood and oxygen to the heart and brain as well as to other parts of the body, resulting in angina pectoris (chest pain) or myocardial infarction (*heart attack*)—the most common manifestations of *coronary heart disease*—*stroke*, or sudden death.

**Blood cholesterol.** The level of *cholesterol* circulating in the blood, carried by lipoproteins; also referred to as “serum cholesterol.” An excess of cholesterol in the blood stream can contribute to the development of *atherosclerosis*, a risk factor for *coronary heart disease*. There are a number of factors that affect an individual’s blood cholesterol level, including genetics. Diets high in *saturated fats* and, to a smaller extent, *dietary cholesterol*, can increase blood cholesterol levels. Blood cholesterol levels are measured as milligrams of cholesterol per deciliter of blood, or mg/dl. Blood cholesterol levels below 200 mg/dl are considered desirable; levels of 200-239 mg/dl are considered borderline high; and levels above 240 mg/dl are considered high.

**Blood pressure.** The force of the blood against the walls of the arteries, expressed as how high it forces a column of mercury to rise in a tube (in millimeters). A blood pressure reading includes two numbers, expressed as a fraction, systolic pressure over diastolic pressure. Systolic blood pressure measures the maximum pressure in the arteries when the heart is

contracting; it is represented by the higher number in a blood pressure reading. Diastolic pressure measures the lowest pressure in the arteries, which occurs when the heart is relaxed between beats; it is represented by the smaller number in a blood pressure reading. Normal blood pressure is around 120/80 (systolic/diastolic) or less, measured in millimeters of mercury (mm Hg).

**Cardiovascular disease.** Includes a variety of pathological processes pertaining to the heart and blood vessels.

**Cholesterol.** A component of all the body cells of animals (including humans), cholesterol is needed to form hormones, cell membranes, and other body substances. Cholesterol is manufactured in the human body. It is also obtained by consuming animal food products—meat, poultry, fish, milk and milk products, and egg yolks—and mixtures, such as baked products and mayonnaise, that contain egg yolks, cheese, milk, butter, or lard as ingredients. Foods of plant origin, such as fruit, vegetables, grains, nuts, seeds, and dry beans and peas, contain no cholesterol (see also *dietary cholesterol*, *blood cholesterol*, *HDL* and *LDL*).

**Coronary (or ischemic) heart disease.** Several cardiovascular disorders resulting from inadequate circulation of blood to local areas of the heart muscle, almost always as a consequence of narrowing of the coronary arteries by *atherosclerosis*.

**Dietary cholesterol.** The amount of *cholesterol* obtained through the diet, from foods with animal products. In some people, the amount of dietary cholesterol consumed can affect the level of *blood cholesterol*. Many health authorities recommend that individuals limit their consumption of dietary cholesterol to 300 milligrams per day. All dietary cholesterol is the same, there is no “good” or “bad” dietary cholesterol (see also *HDL* and *LDL*).

**Fat.** Technically termed *lipids*, it is the most concentrated source of food energy (calories). All fats are made up of carbon, hydrogen, and oxygen atoms, arranged in combinations of glycerol and fatty acids. Fats found in foods are either in solid or liquid (oil) form. In the body, fat is part of all cell membranes, where it serves as a stored form of energy, helps cushion organs, and helps create certain hormones. Butter, margarine, shortening, and oil are obvious sources of fat. Other major sources of fat are well-marbled meats, poultry skin, whole milk, cheese, ice-cream, nuts, seeds, salad dressings, and some baked products. All fats contain both saturated and unsaturated fat (fatty acids), in different proportions. Liquid fats are higher in *unsaturated fatty*

<sup>1</sup> Adapted from: University of California, Berkeley. *The Wellness Encyclopedia*. Boston: Houghton Mifflin Company, 1991; Smolin, Lori A., and Mary B. Grosvenor, *Nutrition. Science and Applications*. New York: Saunders College Publishing, 1994; U.S. Department of Health and Human Services and U.S. Department of Agriculture, *Nutrition Monitoring in the United States*. DHHS Publication No. (PHS) 89-1255, Sept. 1989; and Frazão, Betsy, and Linda Cleveland. “Diet-Health Awareness About Fat and Cholesterol—Only a Start.” *FoodReview*, Vol. 17, No. 1, pp. 15-22, Jan.-Apr. 1994.

*acids*, solid fats (such as stick margarine) are higher in *saturated fatty acids*.

**Free radicals.** Unstable molecules, usually containing oxygen, created by normal chemical processes in the body as well as by radiation (especially X-rays) and other environmental influences. The interaction of free radicals with DNA and other macromolecules leads to impaired functioning of the cells. Free radicals are most likely an important factor in cancer development.

**HDL (High-density lipoprotein).** A transporter of *blood cholesterol* from the tissues to the liver to be broken down and excreted. Often called the “good” cholesterol. There are several types of HDL.

**Heart attack.** Condition in which an artery in the heart becomes blocked, cutting off blood flow and hence oxygen and nutrients to a segment of the heart muscle, resulting in tissue death.

**Hydrogenation.** The process of adding hydrogen atoms to an *unsaturated fat*, to make it more saturated, more solid, and more resistant to chemical change. Manufacturers often hydrogenate fats to give them a longer shelf life.

**Hypertension.** High *blood pressure*. Hypertension increases the risk of *heart attack*, *stroke*, and kidney failure because it adds to the workload of the heart, causing it to enlarge and, over time, to weaken; in addition, it may damage the walls of the arteries.

**Insulin.** A hormone secreted by the pancreas in response to elevated blood glucose levels. Insulin stimulates the liver, muscles, and fat cells to remove glucose from the blood for use or storage.

**LDL (Low-density lipoprotein).** A carrier of *blood cholesterol*, LDL delivers cholesterol to tissues and has

been implicated in the accumulation of *plaque* within the arteries. Often referred to as “bad” cholesterol. Elevated LDL cholesterol levels are linked with *coronary heart disease*.

**Plaque (arterial).** Deposits of fatty substances, such as *cholesterol*, on the inner lining of the artery walls. The buildup of these deposits can lead to *atherosclerosis*.

**Prooxidant.** A function opposite that of an *antioxidant*, promoting oxidation and releasing *free radicals*.

**Saturated fats (fatty acids).** *Fats* containing all the hydrogen atoms they can carry. Such fats, which are solid at room temperature, come chiefly from animal sources (such as beef, butter, whole-milk dairy products, dark meat poultry, and poultry skin) as well as tropical vegetable oils (coconut, palm kernel, and palm oils), and in some hydrogenated fats (margarine and vegetable shortening). For some people, the amount of saturated fats consumed in the diet can affect the level of *blood cholesterol*, therefore affecting the risk for *coronary heart disease* (see also *hydrogenation*).

**Stroke.** A hemorrhage or a blockage in a blood vessel that supplies the brain, resulting in insufficient blood (and therefore oxygen) to a portion of the brain. The most common manifestation is some degree of paralysis, but small strokes may occur without symptoms. If recurrent, strokes can lead to mental deterioration.

**Unsaturated fats (fatty acids).** In foods, *fats* missing hydrogen atoms in specific places in the fatty acid molecule; depending on the number of missing atoms, these fats are classified as either monounsaturated (one missing hydrogen atom) or polyunsaturated (two or more missing hydrogen atoms). Main dietary sources are plants and fish. These fats are generally liquid at room temperature.