

# Health Promotion, Disease Prevention

Ruby T. Senie, PhD

---

## Introduction

---

The 20th century witnessed major achievements and transitions in public health and clinical medicine, from controlling infectious diseases to addressing the growing prevalence of smoking followed by increased sedentary lifestyles leading to the obesity epidemic. Greater life expectancy has been achieved through reduced maternal and infant mortality, significantly improving the quality of American lives. Additional public health achievements include development of antibiotic therapy, fluoridation of water supplies, therapy for mental health disorders, less invasive surgical techniques, organ transplantation, and kidney dialysis.<sup>1</sup> Of major importance has been development of vaccines providing primary prevention of infectious conditions, including polio and other lethal childhood diseases. Vaccines have eliminated the causes of morbidity and mortality among children that were frequently experienced by earlier American generations and remain prevalent in many developing countries.

Among the most significant accomplishments of epidemiologic research was identification of cigarette smoking as a leading cause of death from lung cancer, heart disease, and respiratory conditions. Scientific progress has continued in the past 25 years with the identification of the human papilloma virus as the cause of cervical cancer, and development of a vaccine providing primary prevention of the malignancy.<sup>2</sup> The identification of human immunodeficiency virus (HIV) as the cause of acquired immune deficiency syndrome (AIDS) and development of effective therapy rank among many other successes. Although effective treatment has turned this infectious disease into a chronic condition with greatly reduced mortality,<sup>3</sup> the continuing rate of new infections emphasizes the urgent need for an effective vaccine to provide primary prevention.<sup>4</sup>

Behavioral and environmental risks associated with chronic conditions such as heart disease, stroke, cancer, and diabetes are now the focus of primary prevention research. However, 21st century lifestyles, including worldwide travel, changes in environmental exposures, climate patterns, and other factors enable new diseases

and health conditions to emerge.<sup>5</sup> Fauci and Morens advised that infectious diseases remain a perpetual challenge, requiring monitoring of pathogens that may evolve to more aggressive strains creating new infectious threats.<sup>3</sup> Therefore, constant surveillance and preparation by clinicians and public health workers are essential,<sup>3</sup> as are programs to prevent or delay onset of chronic conditions, such as the Million Heart project<sup>6</sup> and Tips from Former Smokers.<sup>7</sup> This chapter addresses some of the personal and community-based activities promoted by public health workers to improve quality of life, reduce health disparities, and lower healthcare costs.

---

## Health Maintenance and Avoidance of Disease

---

In 1948, the constitution of the newly formed World Health Organization (WHO) stated: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."<sup>8</sup> The WHO constitution also noted that the highest attainable standard of health was a fundamental right of every person regardless of race, religion, economic or social condition, or political belief. Among Americans, health issues became a focus when the federal government established the National Institutes of Health in 1948 and the National Science Foundation in 1950. With considerable federal support, the United States developed an enviable biomedical research environment, recognized internationally as a primary source of scientific discoveries, new therapies, and medical devices.<sup>1</sup>

In 1965 stimulated by the WHO goals, Breslow et al. launched one of the earliest research projects assessing the role of personal behaviors in health maintenance.<sup>8</sup> Although advances in clinical medicine increased life expectancy in the United States, epidemiologic studies conducted over many decades identified health behaviors that prevented major disabilities and premature mortality. In an early study by Breslow et al., physical, mental, and social well-being at baseline were found to correlate with mortality 5 and 10 years after recruitment of more than

7,000 residents of Alameda County, California.<sup>8</sup> Seven health practices contributed to health status: never smoking cigarettes, routine physical exercise, moderate or no alcohol intake, sleeping 7-8 hours, maintaining proper weight for height, eating breakfast, and not eating between meals.<sup>8</sup> Women in the cohort with positive health behaviors lived 7 years longer than those who were less health conscious. Based on the continued follow-up of the cohort, Breslow predicted that health promotion would be the focus of public health efforts in the 21st century designed with a two-pronged approach: 1) primary prevention through personal and community efforts to reduce or eliminate risk factors of chronic diseases and 2) secondary prevention by monitoring biomarkers predictive of disease to detect diseases at early, treatable stages.<sup>8</sup>

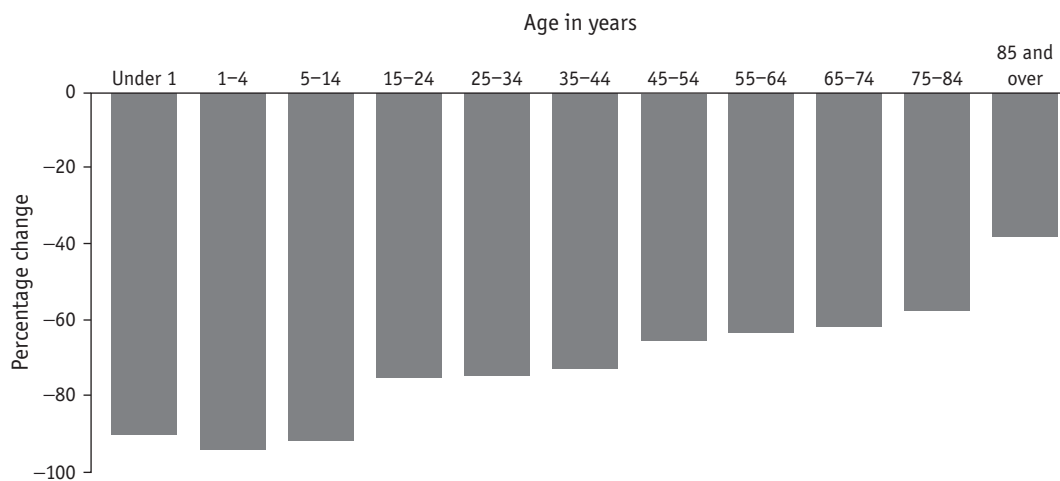
Few “magic bullets” exist to remedy medical conditions resulting from years of smoking, lack of routine exercise, overeating of inappropriate foods, inadequate rest, overindulgence in alcoholic beverages, etc. Therefore, the combination of personal behaviors and community health promotion efforts became the public health model for chronic disease prevention<sup>10</sup> reflected in several new federal health programs discussed in this chapter.<sup>6,7</sup>

Between 1935 and 2010, significant changes in mortality were recorded in the United States, an indicator of public health successes.<sup>11</sup> Analyses of data from the National Vital Statistics System presented in Figure 4-1 indicate significantly decreased death rates over the 75-year interval among children younger than age 15, although mortality also fell more than 50% for all except the oldest age group (Figure 4-1).<sup>11</sup> In 2008, several causes of mortality, including heart disease, stroke, and cancer, remain among the top five although age-related differences in rank exist. Chronic lung disease has become a relatively new cause of death related to long-term smoking. Women have benefited more than men from the declining rates of mortality. Over the 75 years mortality trends have differed. Between

1935 and 1954, introduction of antibiotics was credited with lowering death rates by 29%. More recent progress in prevention, diagnosis, and treatment of heart disease has lowered mortality by 41%.<sup>11</sup>

The public continues to expect major discoveries to enhance disease prevention and improve clinical care as a result of federal support of scientific research. However, expectations may lead to misconceptions, as complaints about the slow progress have been noted in the media. Much time is required for scientific discoveries to be appropriately tested for safety and efficacy before translation from the laboratory to clinical practice. Substantial reforms of biomedical research efforts and U.S. health systems were proposed by Moses and Martin.<sup>1</sup> Health-care costs in the United States far exceed other developed nations, although achievements are lower compared with others when assessed by traditional measures noted in Table 4-1, which provides a comparison of the United States health measures with superior ranking of other industrialized countries.<sup>12</sup> Additionally, clinical improvements are not equally distributed within the United States; disparities in health outcomes by economic and social status have a long history. The heterogeneity of Americans has been suggested as a contributing factor to the nation’s inferior ranking<sup>12</sup> primarily attributable to large immigrant populations, which often lack access to clinical care due to limited financial resources, low education level, and language barriers that impede health-seeking behaviors.<sup>13</sup> Inadequate health care, specifically of women in these populations, also adversely affects the health status of their children. Multidisciplinary community-based programs have been developed by public health workers to address the unique health needs of culturally diverse communities.

Recent projections of greater longevity have focused attention on aging and potential increases in morbidity due to higher incidence of chronic conditions among the elderly. As the rates of disabilities increase, the quality



**Figure 4-1** The percent decline in mortality by age group over 75 years between 1935 and 2010 in the United States.

Source: Reproduced from Hoyert DL. 75 years of mortality in the United States, 1935–2010 NCHS data brief, no 88. Hyattsville, MD: National Center for Health Statistics. 2012.

AGE	35-44	45-54	55-64	65-74	75-84	85+
1	Cancer 25.7%	Cancer 35.8%	Cancer 41.0%	Cancer 36.1%	Heart disease 25.9%	Heart disease 33.9%
2	Accidents 16.5%	Heart disease 15.3%	Heart disease 18.1%	Heart disease 20.6%	Cancer 23.1%	Cancer 10.2%
3	Heart disease 12.0%	Accidents 8.4%	Chronic lung diseases 5.3%	Chronic lung diseases 8.2%	Stroke 7.5%	Stroke 8.5%
4	Suicide 4.9%	Stroke 4.1%	Diabetes 4.2%	Stroke 5.2%	Chronic lung diseases 7.1%	Alzheimer's disease 7.4%
5	HIV/AIDS 3.8%	Chronic liver disease 3.1%	Stroke 4.1%	Diabetes 4.2%	Alzheimer's disease 4.3%	Chronic lung diseases 4.0%
6	Stroke 3.4%	Diabetes 3.1%	Accidents 3.2%	Kidney disease 2.1%	Diabetes 3.4%	Influenza and pneumonia 3.6%
7	Chronic liver disease 2.9%	Chronic lung diseases 2.8%	Chronic liver disease 1.9%	Accidents 1.9%	Influenza and pneumonia 2.5%	Diabetes 2.1%
8	Diabetes 2.6%	Suicide 2.6%	Kidney disease 1.7%	Septicemia 1.8%	Kidney disease 2.1%	Kidney disease 2.0%
9	Homicide 2.4%	HIV/AIDS 1.6%	Septicemia 1.7%	Influenza and pneumonia 1.6%	Accidents 1.9%	Accidents 1.9%
10	Chronic lung diseases 1.4%	Septicemia 1.5%	Influenza and pneumonia 1.1%	Alzheimer's disease 1.2%	Septicemia 1.7%	Hypertension 1.6%

**Figure 4-2** The 10 leading causes of death among women by age group in 2008.

Source: Modified from Heron M. Deaths: Leading causes for 2008. National vital statistics reports; vol 60 no 6. Hyattsville, MD: National Center for Health Statistics. 2012.

**Table 4-1**

**Selected health measures in the US compared with top ranking countries in 2010**

Assessed Health Factor	In America	In Top Ranking Country	Country with Top Ranking
Female life expectancy from birth	81.1 years	86.4 years	Japan
Female life expectancy from age 65	20.3 years	23.9 years	Japan
Infant mortality rate	6.1 per 1000 live births	2.2 per 1000 live births	Iceland
Low birth weight infants [ $<2500$ g]	8.2%	4.1%	Sweden
Cesarean Section	329 per 1000 live births	161 per 1000 live births	Finland
Obesity [BMI $>30$ ] self-reported weight & height	27.8%	13.4%	France
Clinically measured obesity	36.3%	3.2%	Japan
Current female smokers ages $<15$	13.6%	8.4%	Japan
Diabetes among adults ages 20-79	10.3%	3.6%	Norway & United Kingdom

Data From: Organization for Economic Cooperation and Development (OECD). [http://www.oecd-ilibrary.org/social-issues-migration-health/health-key-tables-from-oecd\\_20758480](http://www.oecd-ilibrary.org/social-issues-migration-health/health-key-tables-from-oecd_20758480).

of life during elder years may decline.<sup>14</sup> However, early research by Breslow, Fries, and others indicated that onset of chronic and disabling conditions may be prevented or delayed by healthy lifestyles during youth and early adulthood.<sup>10,15</sup> Krieger emphasized that healthy choices may be impeded by diverse social factors, including continuing racial discrimination that adversely affects health status beginning at birth into a low-income setting in a segregated neighborhood with limited recreational facilities and lack of access to high-quality health care.<sup>16</sup>

## Focus on Primary Prevention

Preventive care became the major focus of health legislation in 2010, shifting from treatment targeted for acute symptomatic disease to the admirable goal of improving quality of life by reducing disease risk and reserving funds for essential clinical care.<sup>17</sup> In 2011 the Institute of Medicine (IOM) published a landmark review of effective preventive services specifically addressing the needs of women between ages 10 and 65. The IOM report emphasized that the reproductive role of women creates the need for specific preventive services because pregnancy and childbirth carry health risks.<sup>18</sup> The independent panel of IOM reviewers included nonfederal primary care clinicians, health behavior specialists, and methodologists whose role was to 1) evaluate the benefits and harms of preventive services for asymptomatic women for specific conditions based on age and personal risk factors, and 2) recommend inclusion of specific preventive services in routine primary care. The grading system guiding recommended services was based on scientific evidence from A (advised to include) to D (discouraged from inclusion) or insufficient research for classification.

In addition to U.S. Preventive Services Task Force recommendations, the IOM reviewers relied upon published studies of programs that significantly decreased or delayed onset of diseases and disabling conditions.<sup>18</sup> Criteria for inclusion of evidence-based preventive services were

set high to ensure benefits would exceed any potential harms because preventive services are targeted to healthy women.<sup>18</sup> Table 4-2 lists preventive services recommended by the IOM reviewers; these and many others were included in the Affordable Care Act (ACA) of 2010. Before the ACA, preventive services were not standardized and insurance coverage varied considerably among policies. The ACA defined required preventive health services for all insured Americans without copayments, and the law included funding for prevention programs developed by state and community-based health departments.<sup>17</sup>

Epidemiology research has as its major focus identification of modifiable causes of disease to guide personal health decisions, community-based activities, and appropriately scheduled clinical care. However, epidemiologic studies are complicated due to interactions among biological, behavioral, and societal factors.<sup>19</sup> Potential causal factors frequently influence one another; therefore, the challenge for researchers is to identify the specific genetic and environmental aspects that explain, modify, or mediate causal relationships.<sup>19</sup> Primary prevention of an infectious condition requires identifying the common sources of an etiologic agent by analyzing biospecimens in order to interrupt its transmission from mother to child, person to person, carried by an insect, or indirectly by contaminated food or water.<sup>20</sup> HIV provides an interesting example of an infectious disease transformed by new therapeutic modalities to a become chronic condition, lowering risks of transmission of the virus to sexual partners, lowering risk of progression to AIDS, and reducing mortality.<sup>21</sup> Development of a vaccine that stimulates immunity against the infectious agent is the ultimate avenue for primary prevention but remains a work in progress. Although new therapies prolong life, the Centers for Disease Control and Prevention (CDC) reported in 2011 that a considerable percentage of HIV-infected women and men were not receiving appropriate therapy. Therefore, community-based efforts to remove barriers to HIV testing and increase treatment adherence are needed in addition

**Table 4-2**

### Institute of Medicine identified gaps and recommended inclusion of specific services

- Improved screening for cervical cancer, counseling to prevent sexually transmitted infections, including counseling and screening for HIV
- A full range of contraceptive education, counseling, methods, and services enabling women to avoid unwanted pregnancies and space their pregnancies to promote optimal birth outcomes
- Services for pregnant women, including screening for gestational diabetes, lactation counseling, and funds for equipment to help women choose to breastfeed successfully
- At least one well-woman preventive care visit annually to receive comprehensive services including screening of blood pressure, cholesterol, fecal occult testing, diabetes, mental health, alcohol abuse, obesity, physical activity, tobacco use, and osteoporosis
- Screening and counseling of women and adolescent girls for interpersonal and domestic violence in a culturally sensitive and supportive manner
- The preventive healthcare services provided in a clinical setting specified in the ACA will be fully covered without requiring a patient copayment for women ages 10 to 65.

Reproduced from the Institute of Medicine at the National Academy of Sciences, 2011. *Clinical Preventive Services for Women: Closing the Gaps*. Washington, DC: The National Academies Press.

to counseling patients about personal behaviors to avoid disease transmission.<sup>22</sup>

In contrast to infectious disease research, studies focusing on chronic diseases search for risk factors reported more frequently by affected women compared with unaffected controls. After specific factors are consistently reported in multiple studies, public health programs are designed to lower the prevalence of risk factors with the goal of reducing disease incidence.<sup>20</sup> Epidemiologic research incorporating serologic testing of biomarkers contributes to recognition of subclinical diseases, and monitoring changes of molecular markers has become a major component of cohort studies.

During the 20th century, the CDC shifted their public health focus from communicable to chronic conditions as morbidity and mortality rates from infectious diseases were surpassed by disabilities and deaths from heart disease, stroke, diabetes, and cancer. The centers expanded their mission with a new focus on prevention and a commitment to develop programs addressing smoking cessation, reducing risks of diabetes and its complications, assessing illness due to environmental contaminants, studying patterns of mortality due to gun violence, etc., while continuing to protect the nation from the potential challenges of emerging infections.<sup>22</sup>

---

## Preventive Measures Targeted to Personal Risks

---

Technologic advances enabled the decoding of the human genome 12 years ago, enabling clinicians and researchers to translate newly identified genetic information into customized person-specific health messages with opportunities for individualized medical care. The possible contribution of genetic inheritance to determining personal risk of diseases stimulated the search among molecular markers leading to the identification of susceptibility genes such as *BRCA1* and *BRCA2*.

Before genetic testing became available in medical practice, most clinicians began their clinical assessment inquiring about a patient's family history in order to guide recommendations for appropriate disease screening, health behaviors, and advice about preventive measures. Although a positive family history for a condition is a complex issue given that disease patterns vary by family size, age distributions, environmental influences, and accuracy of past diagnoses,<sup>23</sup> this traditional assessment provided the basis for studies of hereditary cancer syndromes initially identified by Lynch and others decades ago.<sup>24</sup>

Although identifying susceptibility genes holds great promise, most affected individuals are found to be negative for inherited susceptibility. Therefore, geneticists are searching for additional genetic markers and epidemiologists investigate potential nongenetic causes of diseases. Two approaches commonly used to identify avenues for disease prevention include experimental and observational studies. Experiments are conducted in the laboratory with animal models, cell cultures, or human volunteers in randomized trials such as the Women's Health Initiative.<sup>25</sup> In some settings experimental studies may not be practical

or the proposed intervention may not be ethically acceptable for random assignment such as use of fertility drugs. Therefore, to answer specific risk factor questions epidemiologists conduct observational cohort studies following healthy women over time or by designing case-control studies to compare exposures that occurred before diagnosis among women with a disease compared to those without the condition. Factors identified through observational studies cannot be classified as causal because multiple complex environmental exposures do not occur randomly and are rarely independent events; however, the results provide direction for future targeted research of larger more varied populations.

The public became increasingly aware of the role of genetics through reports in the media of the Human Genome Project,<sup>26</sup> which has now been heralded as enabling personalized medicine. As the cost of genetic testing has fallen, interest has grown in personal testing, which has led to the development of a new unregulated industry including direct-to-consumer marketing of genotyping without external standards to ensure accuracy.<sup>1</sup> In addition, the value of the newly acquired personal knowledge will depend upon research linking inherited susceptibilities with potential interventions that may prevent or delay disease development. A person's risk and responses to preventive interventions may depend on an individual's unique genetic characteristics; therefore, the risk–benefit balance will be unique for each person.<sup>27</sup> As studies identify effective interventions for individuals with specific genetic susceptibilities, research will be required to quantify anticipated benefits. The focus of epidemiologic studies will be to stratify populations into subgroups of individuals using genetics and disease-specific biomarkers in order to evaluate the risks and benefits of targeted interventions.<sup>27</sup> Ames provided an example of a potential targeted intervention addressing unique genetic profiles of individuals. He suggested that technology will soon mature to provide person-specific assessment of micronutrient deficiencies through a single finger prick blood sample that will generate guidance for diet adjustments or nutrient supplements in order to achieve optimum health, disease prevention, and greater longevity.<sup>28</sup>

Research is also needed to link genetic risk differences with personal and environmental exposures that may modify inherited susceptibilities. Each individual woman carries a person-specific trajectory affecting her health status during her life course related to biologic, behavioral, social, and psychologic influences. Therefore, health counseling may be the most important physician–patient interaction occurring during periodic medical encounters. Schroeder among others noted that health status is influenced disproportionately by five domains: behavioral patterns (40%), genetics (30%), social circumstances (15%), health care (10%), and environmental exposures (5%).<sup>12</sup> He suggested that access to medical care contributes only minimally to preventing premature mortality. In contrast, personal health behaviors especially smoking, physical inactivity, and obesity account for a major component of reduced life expectancy among Americans. Although technology was crucial for accomplishing the major public

health successes of the past and will continue to enhance clinical care, behavioral changes are essential to improve the health of Americans in the 21st century.<sup>12</sup>

---

## Primary Prevention in Communities

---

Following the recognition of disease-associated risk factors public health researchers faced challenges when applying the knowledge to educate diverse communities about health risks. Although chronic diseases most often occur among adults, epigenetic studies have provided scientific evidence that some risk patterns that become established early in life, in utero or prior to puberty, may have an impact on adult health. Therefore, parents and teachers have been encouraged to focus on establishing healthy lifestyles among youngsters.

Social, economic, and cultural factors influence health-related decisions among families affecting dietary choices, frequency of physical activity, and general health behaviors. Community programs may influence these decisions when multisite collaborative programs are coordinated among schools, clinical settings, markets, and local government policies. The Million Hearts, a collaboration of government and private sector health facilities, was designed to expand a core of standardized practices based on scientifically proven preventive efforts for heart disease in clinical settings and community-based health promotion programs. The goal is to avoid 1 million heart attacks and strokes during the next 5 years.<sup>6</sup> The program emphasizes four primary clinical interventions based on the proven efficacy of the ABCS protocol: aspirin therapy, blood pressure control, cholesterol management, and smoking cessation.<sup>6</sup> Data from the National Health and Nutrition Examination Survey (NHANES) indicated almost 50% of the American public has at least one risk factor for heart disease—including untreated hypertension, smoking, and/or elevated cholesterol—and many had more than one untreated risk factor, leaving many Americans at risk for heart disease and stroke. Electronic medical records will identify individuals requiring enhanced care and digital monitoring of health changes will indicate the value of clinical interventions and community-based programs. The project is directed to high-risk populations who will receive appropriate preventive treatment, whereas community-based efforts will promote healthful behaviors to lower heart disease risk, diabetes, and obesity in the broader population.<sup>6</sup>

Many federal, state, and local initiatives are coordinating their efforts by addressing healthy diets, smoking cessation, increased exercise, and weight control. Communities have received funding for tobacco control and chronic disease prevention efforts, including reduced use of sodium and elimination of trans fats. Media messages and package labeling are included to educate the public about health risks of smoking, counteracting tobacco advertising that often targets women.<sup>6</sup> ACA emphasizes prevention by eliminating cost sharing by patients for preventive services such as blood pressure and cholesterol screening and smoking cessation services; ACA also facilitates increased access to care for many who have lacked

medical coverage. Team-based care by multidisciplinary providers is being encouraged to work closely with individuals to address their specific needs.<sup>6</sup> Other community-based programs are discussed later in this chapter.

---

## Primary Prevention Associated with Adult Vaccinations

---

Vaccines are among the greatest public health achievements of the 20th century, credited with significant reduction of morbidity and mortality from many diseases caused by bacteria and viruses.<sup>29</sup> Many conditions that were lethal in the past, causing massive outbreaks, are now prevented.<sup>30</sup> However, the public has questioned the safety of vaccines, and some have resisted vaccine protection for their children. In addition, fewer than expected adults have received annual protection from influenza or pneumonia.<sup>29</sup> Much of the fear has been associated with a retracted study published in *Lancet* that erroneously linked the measles-mumps-rubella (MMR) vaccine with increased risk of autism and created a worldwide controversy, although multiple additional studies found no association.<sup>31</sup>

To address these public concerns, the IOM was again requested by the CDC to review the epidemiologic, clinical, and biologic evidence regarding any adverse health effects associated with specific vaccines; the effectiveness of the vaccines was not addressed in the requested review published in the 2012 report.<sup>30</sup> The authors carefully noted that among the vaccines studied, very rare adverse events were reported in publications and these occurred only among individuals whose immune deficiencies or unique susceptibility left them at increased risk of an adverse response. The review committee encouraged continued reporting of cases by clinicians to the Vaccine Adverse Event Reporting System, which they recommended for posting on the Web. They also encouraged use of electronic medical records for monitoring rare adverse health events.<sup>30</sup>

Vaccination for primary prevention of influenza was received by 40.5% of adults in 2010–2011 with coverage among states varying widely, from 56% in South Dakota to 33% in Nevada.<sup>32</sup> Children aged 17 and younger as well as adults over age 65 were more likely to receive the seasonal vaccine than middle-aged Americans. Vaccine coverage was significantly below the public health goals during the past two flu seasons, although heightened awareness of the H1N1 pandemic was associated with a small increase in coverage during 2009–2010.<sup>32</sup>

Pneumococcal vaccination is recommended for adults diagnosed with diabetes, emphysema, coronary heart disease, and other conditions associated with heightened susceptibility. Less than 19% of adults aged 19–64 at high risk have ever received pneumococcal vaccine in contrast to 59.7% of adults aged 65 and older, although percentages varied by race/ethnicity. Zoster vaccine is advised for primary prevention of a painful blistering skin rash condition, shingles (herpes zoster), which occurs among older immune-suppressed adults, but only 20% to 30% of eligible elders have received the vaccine.<sup>33</sup>

The recently developed human papillomavirus (HPV) vaccine to prevent cervical cancer and malignancies of other organs has been targeted to young women prior to potential exposure to HPV.<sup>33</sup> Although preventing a malignancy has been heralded as a major breakthrough in cancer prevention, some parents have questioned the timing, cost, number of doses, and appropriateness of the target population. However, as research continues, new findings now recommend HPV vaccine for young males, and studies suggest fewer than three doses may be equally effective.<sup>2</sup>

CDC and other federal agencies continue to educate the public regarding the safety of vaccines and their essential contribution to the nation's health. Many Americans lack personal knowledge of or experiences with the severe morbidity and mortality associated with many preventable conditions.<sup>30</sup> Public health workers have promoted the importance of adult vaccines and encouraged their availability at low cost in multiple locations, including clinical settings, employee health services, and pharmacies, which has increased acceptance although at rates that are still considered far lower than optimum.

### Prevention by Not Smoking

The health hazards of smoking were recognized by clinicians as the incidence of lung cancer increased and epidemiologic studies documented the risks. Ecologic data linking cigarette consumption and mortality from lung cancer noted in Figure 4-3 confirmed clinical evidence of a national trend.<sup>34</sup> The first American studies indicating smoking was contributing to risk of lung cancer were published in 1950 and were confirmed by many investigators, leading to the First Surgeon General's report of 1964<sup>35</sup> linking smoking with multiple adverse health outcomes. Cigarette sales continued to climb until finally beginning to decline in 1980 (Figure 4-3).

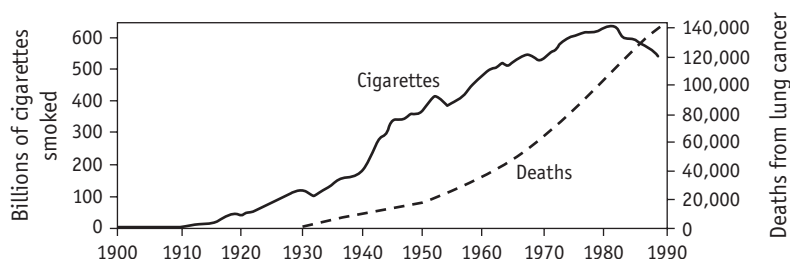
Figures 4-4 and 4-5 present data on differences in smoking patterns among women and men during the 20th century in relation to the year of birth, noting the percentage of smokers who began smoking before age 20 and the number of years they smoked before age 40.<sup>34</sup> Women were slower to become regular smokers, but in more recent years they began smoking at an earlier age than men and are more resistant to quitting. In the past, cigarette advertising targeting women strongly influenced habit formation as adolescent females were influenced by

seductive, slender female smokers.<sup>36</sup> Brandt described the deceptive cigarette advertising based on scientific misinformation that tobacco companies used to compete for smokers. He strongly encouraged greater public health attention to tobacco control.<sup>37</sup>

The prevalence of smoking among Americans decreased from 42.4% in 1965 to 19.3% in 2010, when the number of former smokers exceeded current smokers. To counteract continued tobacco advertising, the American Legacy Foundation created a campaign revealing the deceptive antismoking messages of the tobacco industry.<sup>38</sup> The combined effect of state and local laws creating smoke-free public environments while increasing cigarette taxes have encouraged many people to stop smoking. The ACA will cover the cost of smoking cessation programs, which have had a significant impact of reduced smoking in Massachusetts. Effective avenues for quitting smoking include advice from personal healthcare providers; individual, group, and telephone counseling; and medications. Data indicate former smokers are less likely to die from any cause and have longer years of life with lower risks of tobacco-associated disabilities than women and men who continue smoking.<sup>39</sup>

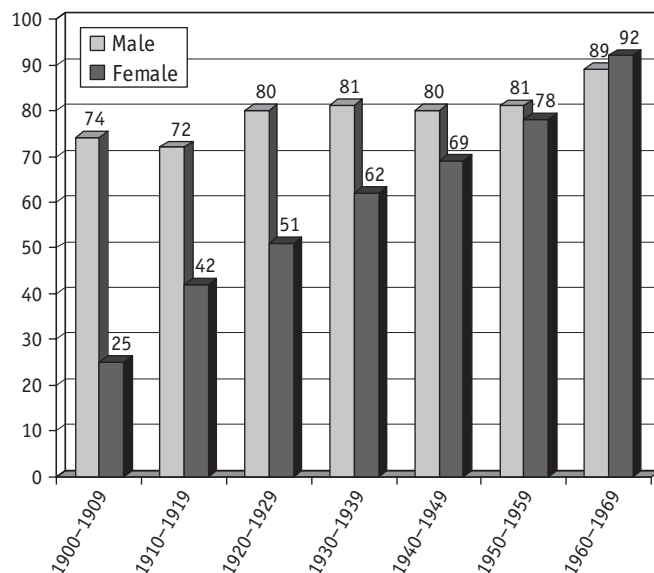
Although diminished in prevalence, smoking has remained the primary preventable cause of premature mortality in 2011 among women and men although the decline among men occurred more rapidly than among women. Gritz et al. noted the significant burden of tobacco-related disability and death associated with smoking that grew during the 20th century.<sup>40</sup> Figure 4-4 and Figure 4-5 indicate smoking grew faster early in the century among men than women. In 1924, 6% of women were smokers, rising to 16% only 5 years later, but more than 50% of men were smokers during these years. The sex differences reached a high of 28% before declining to less than 5%, suggesting that gender differences in longevity, so strongly influenced by smoking, may diminish in coming decades.<sup>41</sup>

Data from a national random-digit-dialing study, the American Smoking and Health Survey (ASHES), funded by the American Legacy Foundation, revealed that women lacked adequate knowledge of causes of tobacco-related mortality.<sup>42</sup> Many women identified breast cancer rather than lung cancer as the leading cause of cancer death among women, which Heaton et al. related to the greater attention of the public, media, and government agencies to health risks associated with breast compared with lung



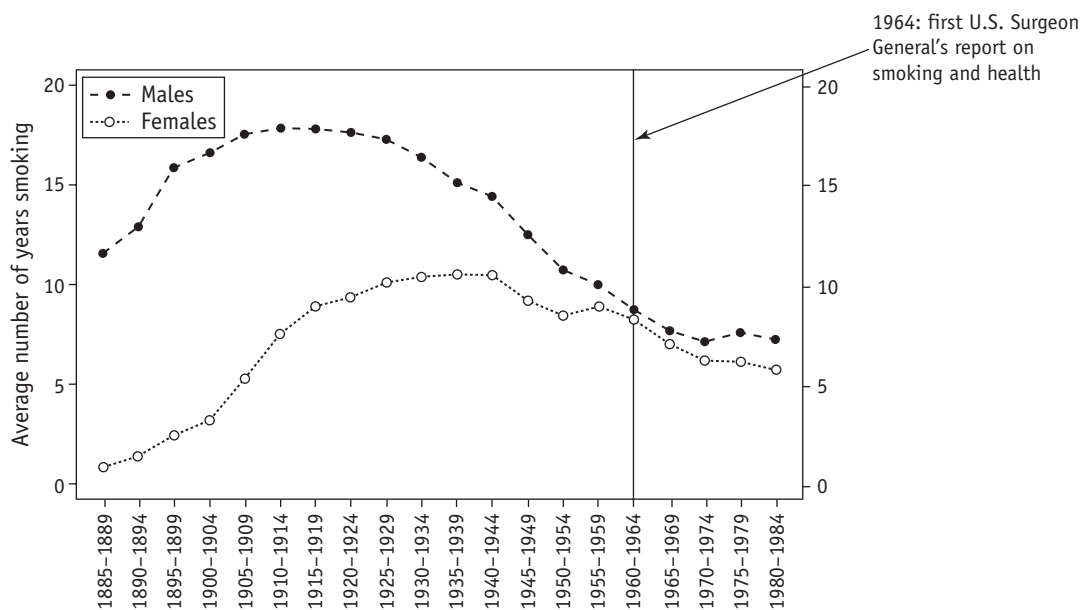
**Figure 4-3** Cigarette consumption and number of lung cancer deaths, United States 1900–1990.

Source: Reproduced from Smoking, Tobacco, and Cancer Program, US Dept of Health and Human Services, NIH Pub No. 90-3107, 1990.



**Figure 4-4** Percent of smokers who began smoking before age 20 by year of birth.

Source: Reproduced from Smoking, Tobacco, and Cancer Program, US Dept of Health and Human Services, NIH Pub No. 90-3107, 1990.



**Figure 4-5** Average years of smoking before age 40 among women and men by birth cohort.

Source: Reproduced from Wang H, Preston S. Forecasting United States mortality using cohort smoking histories. PNAS 2009;106:393-398.

cancer. Women are repeatedly confronted with messages stressing annual mammography and any new research findings are featured.<sup>42</sup> Some investigators have suggested the more limited attention to lung cancer results from the stigma associated with the belief that the disease is self-imposed.<sup>42</sup>

For every woman who dies as a result of smoking, 20 others suffer serious chronic, painful disease such as arthritis, osteoporosis, and heart disease. Smoking also adversely affects fetal growth and newborn babies exposed to secondhand smoke are more likely to develop asthma.

Almost all medical problems experienced by women across the life span discussed in this text have an association with smoking. Given the magnitude of health risks associated with smoking, the CDC has launched a new program, Tips from Former Smokers, which features individuals whose quality of life and longevity have been threatened by their smoking histories or exposures to secondhand smoke.<sup>7</sup> This campaign is another major commitment of the federal government to prevent young people from beginning smoking and to convince adults to quit. The 12-week program will include messages on



television, radio, newspaper, billboards, the internet, in movie theaters, magazines, and newspapers. The campaign is timely given that the cigarette package warnings have been contested in court by tobacco companies.

Reports indicate that 90% of men and women dying from tobacco-related illnesses began smoking as adolescents. Many studies have noted that smoking by parents and peers influences early onset of smoking in youth<sup>43</sup> and a new study reported exposures to smoking in films during early adolescents was linked with higher probability of young adolescents becoming established smokers at young ages. Films designed for young audiences should reconsider inclusion of smoking by their actors and potentially cigarette smoking could be included as a youth-rating criterion.<sup>44</sup>

---

## Aspirin for Primary Prevention

Cardiovascular disease differs among women compared with men. Women tend to be older with a first cardiac event and the lifetime risk of stroke is higher than for men. After reviewing new research findings, the U.S. Preventive Services Task Force in 2009 recommended regular use of aspirin by women between the ages of 55 and 79 to reduce the risk of stroke when the estimated benefits for the individual exceeded risks of gastrointestinal bleeding.<sup>45,46</sup> Other studies indicating that aspirin lowered risk of heart disease included a wider spectrum of ages and was especially beneficial in reducing recurrence after a first myocardial infarction. The double-blind randomized trial, the Women's Health Study, reported reduced risks of stroke (RR = 0.83, 95% CI = 0.69 – 0.99), although no significant benefit in combined cardiovascular events including myocardial infarction or death for cardiac causes was found.<sup>47</sup> Many studies conducted over more than 2 decades have reported daily aspirin protected against several forms of cancer as well as lowering the risk of metastases.<sup>48,49</sup> The use of aspirin as a chemopreventive agent to lower cancer risk has been associated with suppression of inflammation and inhibition of COX-2, an enzyme that promotes tumor growth. Health behaviors that protected against infectious agents are repeatedly being found to also protect against chronic conditions; for example, recent reports suggest that daily aspirin may be protective against inflammation associated with heart disease and some forms of cancer.<sup>50</sup>

Clinical guidance has been complicated for patients at average risk by potential adverse health outcomes from aspirin studies that differ by dosages and frequency of use. The Million Heart project of the federal government previously discussed includes routine aspirin use as one preventive component of four recommendations to reduce heart disease among Americans.<sup>6</sup> However, some public health researchers hesitate to recommend expanded use of aspirin due to potential side effects, which include gastrointestinal bleeding, ulcers, and hemorrhagic stroke.<sup>51</sup> The risk of gastrointestinal bleeding requiring transfusion was more frequent among women randomized to aspirin than placebo in the Women's Health Study (RR = 1.4, 95% CI = 1.07 – 1.83).<sup>47</sup> Future genetic analyses may identify individuals with inherited bleeding disorders

for whom routine low-dose aspirin may increase susceptibility to bleeding disorders.

---

## Risks and Benefits of Alcohol Consumption

Alcohol drinking among women has major risks and some benefits varying by quantity consumed, frequency of drinking, age, pregnancy status, underlying health risks, social circumstances, cultural patterns, and other factors. Although some studies suggest women who consume a **maximum** of one alcoholic beverage per day may benefit from diminished risk of cardiovascular disease, heavy drinking (three or more drinks per day) and binge drinking (four or more alcoholic drinks consumed on one occasion) increases risks of death from injuries, cirrhosis of the liver, suicide, hypertension, myocardial infarction, sexually transmitted diseases, unplanned pregnancy, and several types of cancer.<sup>52</sup> CDC's Behavioral Risk Factor Surveillance System (BRFSS) data indicated the 11% of female respondents who reported binge drinking were between ages 18 and 34; frequency and intensity varied by economic status.<sup>53</sup> Driving while alcohol impaired has been associated with an estimated 11,000 crash fatalities annually in the United States, with 4.5% of adults who reported binge drinking four or more times a month accounting for 55% of all alcohol-impaired driving episodes, often without use of seat belts.<sup>54</sup> Alcohol consumption during pregnancy has been associated with fetal alcohol syndrome, miscarriage, premature birth, sudden infant death syndrome, and birth defects.<sup>53</sup> To curb excess alcohol consumption some public health workers have encouraged higher taxes, greater regulation of the number of stores selling alcohol in a community, maintaining limits for sale of alcohol, and monitoring retail outlets for sales to minors.<sup>53</sup>

In contrast to these adverse effects of excess consumption, several studies indicated light to moderate drinking provided protection against cardiovascular disease by counteracting harmful effects of high cholesterol from high-saturated fat diets. Protective effects have been attributed to antioxidant and antithrombotic components primarily found in red wine. Goldberg et al. published a review of potential benefits for the American Heart Association.<sup>55</sup> The authors noted the difficulty of comparing and summarizing diverse studies that employed differing research methods, with varying definitions for drinking quantities and lack of control for other health-related factors. They advised that women should drink no more than one glass of wine per day, which could potentially increase high-density lipoprotein (HDL) cholesterol by 10%, a benefit that they considered comparable to routine exercise or niacin therapy.<sup>55</sup> In limited quantities alcoholic beverages also reduce platelet aggregation, they noted, providing antithrombotic action similar to aspirin. These authors concluded that the data from observational studies did not provide clear evidence of a protective role for wine and/or other alcoholic beverages, warning of the potential for abuse and development of addiction.<sup>55</sup>

Several large cohort studies have identified a modest protective role of alcohol. Among the 85,000 participants

ages 34 to 59 in the Nurses' Health Study, light to moderate drinking (1.5 to 29.9 grams/day), compared with nondrinkers, was associated with decreased risk of death from cardiovascular disease especially among older members of the cohort. Women who drank more heavily were at increased risk of death from multiple causes.<sup>56</sup> Another report from Nurses' Health Study I followed the older cohort to age 70 or beyond and reported moderate alcohol consumed daily was an independent contributor to successful aging.<sup>57</sup> Postmenopausal women ages 50 to 79 at entry to the Women's Health Initiative (WHI) who indicated low to moderate alcohol consumption (one to six drinks per week) benefitted from reduced total mortality (HR = 0.81, 95% CI = 0.72 – 0.91) and lower incidence of hypertension (HR = 0.76, 95% CI = 0.65 – 0.87).<sup>58</sup> Moderate drinking also lowered mortality of Caucasian and African American WHI participants with a history of hypertension.<sup>58</sup> Among 72,000 female subscribers of Kaiser Permanente in Oakland, California, who were followed for more than 12 years after enrollment when drinking behaviors were recorded on entry health appraisals, either red or white wine but not liquor or beer was related to lower mortality from coronary heart disease and respiratory conditions.<sup>59</sup> A national project of the American Cancer Society, Cancer Prevention Study II, with more than 250,000 women enrolled, also noted lower risk of mortality associated with one alcoholic drink per day, although alcohol drinking did not compensate for the doubling of mortality risk associated with smoking.<sup>60</sup> In summary, the 2010 U.S. Department of Agriculture dietary guidelines suggested **moderate** alcohol intake up to one drink per day for women to provide health benefits. However, genetic differences influencing alcohol metabolism may alter the benefits and risks of drinking among women of different ages.

---

## Preventing or Controlling Hypertension

---

Hypertension is among the nation's most common chronic conditions with nearly one-third of American adults having elevated blood pressure. Data from NHANES examinations of a representative sample of the U.S. population has suggested that nearly one in three Americans has hypertension and 43 million women and men are unaware of their elevated blood pressure.<sup>61</sup> Definitions of hypertension vary among clinicians, although antihypertensive medication is generally recommended for individuals with a blood pressure reading of 140 systolic or 90 diastolic or greater. The risk of women and men over age 50 developing hypertension is nearly 90%. Hypertension is a key risk factor for stroke, heart attack, and heart failure among other health problems; therefore, this condition requires routine monitoring and appropriate treatment.<sup>61</sup>

The CDC has recently advised a population-based strategy for blood pressure control that would benefit entire communities. The program, planned in collaboration with states and local communities as well as health-care providers, emphasizes consumption of a healthful diet that excludes excessive salt, encourages increased physical activity, and maintenance or regaining an appropriate weight for height.<sup>62</sup> Collection of dietary data during

NHANES interviews indicated a majority of respondents were consuming more salt than recommended and an estimated 75% of salt is added during commercial food processing or in restaurant meals, preventing individual controls on consumption. To prevent the adverse effect of high dietary sodium on blood pressure, several public health programs and reports from the CDC have focused on dietary salt reduction.<sup>61</sup>

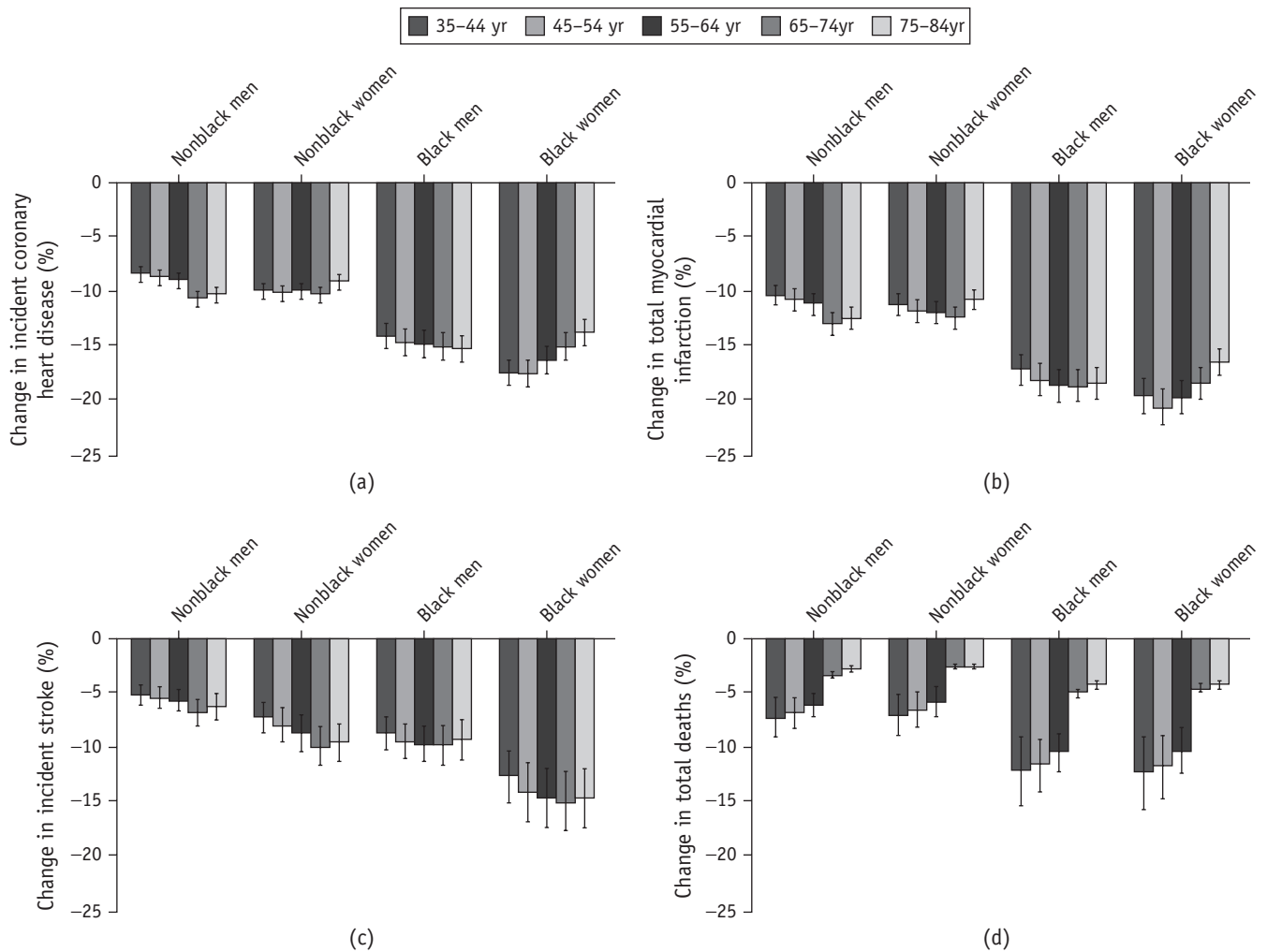
The Institute of Medicine recommended the United States adopt new strategies already established in other countries to establish sodium limits on foods and to improve sodium quantity labeling.<sup>63</sup> Recommendations for salt restriction were based on many studies, including the results reported by Bibbins-Domingo et al., who constructed a Markov model using national data from several sources to estimate reductions in morbidity and mortality following a dietary salt reduction of 3 g per day.<sup>64</sup> The number of new cases of coronary heart disease would be reduced by 60,000 to 120,000, stroke by 32,000 to 66,000, and myocardial infarction by 54,000 to 99,000 and the annual number of deaths from any cause would decline by 44,000 to 92,000. Figure 4-6 notes the benefit of salt dietary reduction among women and men by age and race. Modest salt restrictions would be especially beneficial among black women and men whose rates of hypertension are 50% higher than whites. Reduced sodium could potentially lower mortality disparities. The authors estimated 3 g per day salt reduction provided disease reduction comparable to a 50% decline in smoking, a 5% reduction in body mass index among obese people, or use of statin drugs to lower individual risk of heart disease. Salt reduction would reduce risk of stroke more than other interventions.<sup>64</sup> The Million Hearts project needs to convince food manufacturers to reduce sodium in processing to help accomplish the successes predicted.<sup>6</sup>

---

## Primary Prevention Drug Interactions

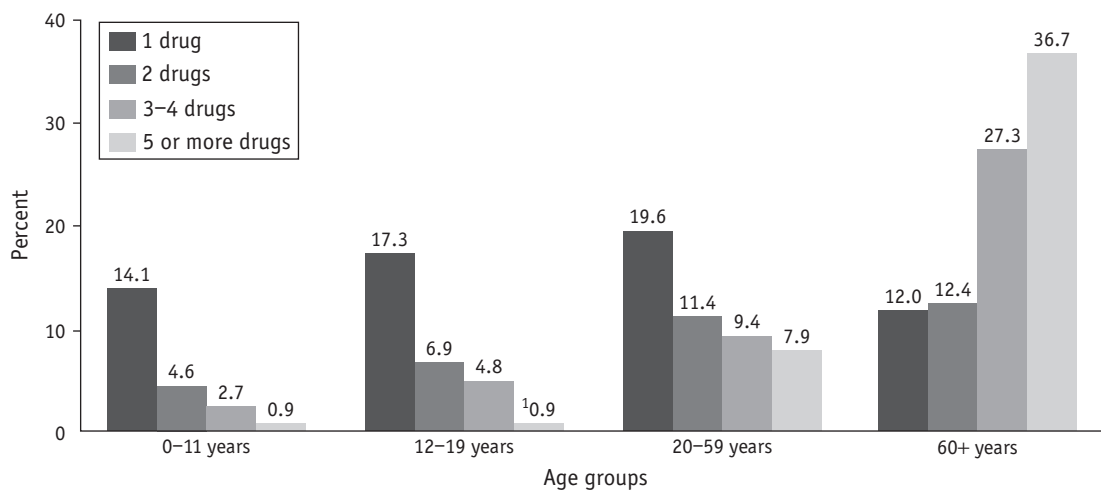
---

The pharmaceutical industry has achieved many successes in treatment of heart disease, cancer, and infectious conditions including HIV/AIDS, which have significantly lowered mortality. Use of prescription drugs rose steadily between 1999 and 2008 in the United States with 48% of Americans reporting at least one prescribed drug and 11% using five or more medications. NHANES data indicated treatment with multiple prescribed drugs during the month prior to interview increased significantly with age (Figure 4-7). High rates of drug use have increased adverse interactions among prescribed medications as well as potentially lethal effects of their combination with over-the-counter products, illegal drugs, and alcohol, resulting in emergency visits.<sup>65</sup> Among the 41,000 deaths from poisoning in 2008, almost 90% were associated with combinations of legal and illegal drugs; 40% were specifically prescribed opioid analgesics.<sup>66</sup> Paulozzi et al. reported 100 deaths occurred per day from drug overdoses, a rate of 11.8 per 100,000 population.<sup>67</sup> Rates were higher among men (14.8/100,000) than women (9.0/100,000).<sup>66</sup> Drug poisoning associated with natural and semisynthetic opioid analgesics such as morphine,



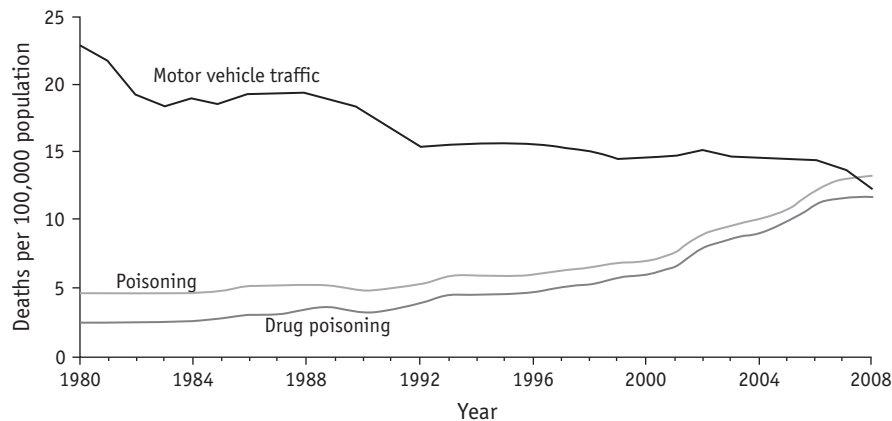
**Figure 4-6** Projected annual reductions in cardiovascular events associated with dietary salt reduction of 3 g per day by race and age group.

Source: Reproduced from Bibbins-Domingo K, Chertow GM, Coxson PG, et al. Projected effect of dietary salt reductions on future cardiovascular disease. *N Engl J Med* 2010;362:590-599. © 2010 Massachusetts Medical Society. All rights reserved.



**Figure 4-7** Percentage of prescription drugs used within past month, by age, United States, 2007-2008.

Data from Centers for Disease Control and Prevention, National Center for Health Statistics, National Health and Examination Survey. Reproduced from Gu Q, Dillon CF, Burt VL. Prescription drug use continues to increase: U.S. prescription drug data for 2007-2008. *NCHS data brief*, no 42. Hyattsville, MD: National Center for Health Statistics. 2010.



**Figure 4-8** Motor vehicle, poisoning and drug poisoning death rates: United States, 1980–2008.

Source: Reproduced from Warner M, Chen LH, Makuc DM, Anderson RN, Miniño AM. Drug poisoning deaths in the United States, 1980–2008. NCHS data brief, no 81. Hyattsville, MD: National Center for Health Statistics. 2011.

hydrocodone, and oxycodone totaled more than 14,800 in 2008, triple the rate reported in 1999.<sup>66,68</sup> Over 5 million Americans reported use of prescription drugs for nonmedical purposes obtained from family and friends without personally receiving a doctor's order.<sup>68</sup>

To raise public awareness and focus attention on poison prevention, the CDC annually designates National Poison Prevention Week, which celebrated its 50th anniversary in March 2012.<sup>69</sup> However, the announcement included the sobering data tabulated from 2008 that indicated deaths from poisoning had become the leading cause of injury-related mortality in the United States, exceeding motor vehicle deaths (noted in Figure 4-8).<sup>66</sup> Unintentional and intentional injuries place a heavy burden on the lives of women, their families, and communities. Significant progress in lowering motor vehicle injury risk has been accomplished through driver education programs, required use of seat belts, improved technology including airbags, and sight testing before driving license renewal. Guided by their successes, these programs are being used as a model for comprehensive, multidisciplinary approaches to reversing the trend in drug poisoning. Among the planned approaches are recommendations to physicians to prescribe opioid medications exclusively for pain relief when nonopioid drugs are inadequate.

Public health interventions to reduce prescription drug overdose must be balanced between misuse and abuse while protecting the appropriate access for patients requiring pain relief.<sup>67</sup> Studies have indicated that 40% of opioid overdoses occurred among patients receiving care from multiple doctors; therefore, one avenue proposed to reduce risks would combine state-based monitoring of drug sales and insurance restrictions preventing early refills and multiple prescriptions for the same medications.<sup>68</sup> Additional proposals to control the current epidemic include advocating for improved legislation and greater enforcement of current laws and addressing issues raised during clinical care by encouraging physicians to follow evidence-based drug treatment guidelines.<sup>68</sup>

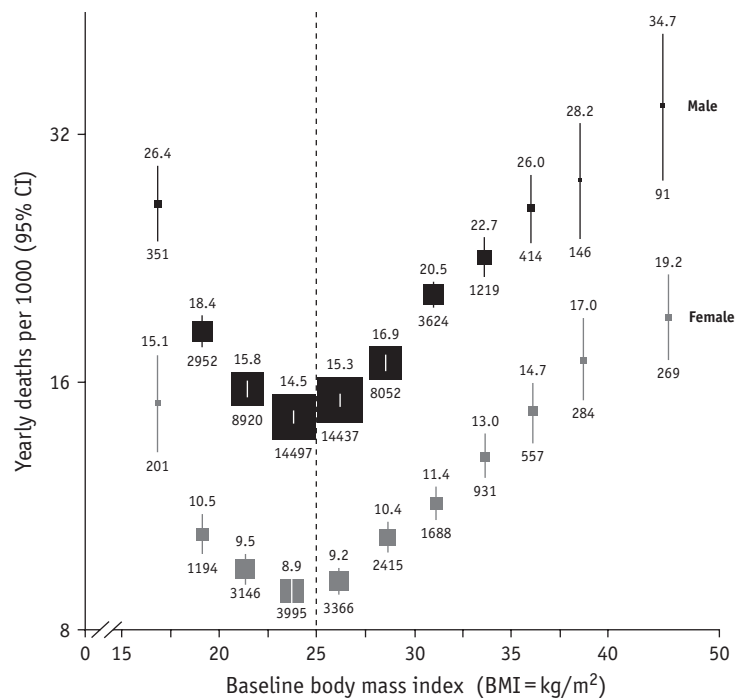
During the more than 4 decades since Congress passed the Poison Prevention Packaging Act requiring

child-resistant caps on medication and toxic substances, progress has been achieved, although medication poisoning of children remains a significant problem. Annual estimates include 60,000 emergency department visits and more than 500,000 calls to poison control centers following potential poisoning of children from medications.

## Prevention Through Physical Exercise and Weight Control

Studies of the increasing obesity epidemic have identified multiple interrelated contributing factors including genetic or familial susceptibility, personal diet and exercise behaviors, and aspects of residential neighborhoods such as availability of safe outdoor recreation facilities and sources of healthy foods.<sup>19</sup> For individuals, weight control relies on balancing food consumption with amount of physical exercise. Changing portion sizes in restaurants, greater availability of high-calorie foods in some local stores, and limited financial resources may compromise personal plans for healthy eating and weight control. Many people claim to desire following a healthy lifestyle, but time commitments to employers, family responsibilities, and other barriers interfere.

Community-based efforts and government regulations have become essential components of epidemiologic studies to identify preventive behaviors to avoid chronic disease. For example, a sedentary lifestyle and resulting obesity have been studied among urban residents by linking personal health behaviors including physical activity, diet, and obesity with the individual's residential environment including recreational use of land and proximity to safe, walkable neighborhoods.<sup>70</sup> Geographic information systems were employed to assess proximity to well-maintained outdoor recreational areas including parks and hiking trails plus access to public transportation, which were positively associated with greater physical activity and lower body mass index. Collaborative studies have shown that city residents are by necessity more physically active and less likely to be obese than individuals living in suburban or rural environments. However, highly



**Figure 4-9** All cause mortality by BMI for males and females.

Source: Reproduced from Whitlock G, Lewington S, Sherliker P, et al. Body-mass index and cause-specific mortality in 900,000 adults: collaborative analyses of 57 prospective studies. *The Lancet* 2009;373:1083–1096 with permission from Elsevier.

dense areas of low-income families were found to have fewer amenities for exercise and recreation and those that existed were poorly maintained. In addition, higher crime rates may also inhibit outdoor activities. These characteristics resulted in residents reporting higher rates of obesity and less physical exercise than people living in more affluent sections where parks and trails are well maintained.<sup>70</sup>

Research has documented the importance of physical exercise at all ages across the life span, especially among the elderly; however, recently more Americans have become sedentary as they watch television, play computer games, or communicate for hours over the Internet. Studies have repeatedly indicated a minimum of 30 minutes per day of moderately intense exercise can reduce risks of several types of cancer, diabetes, heart disease, and depression. Regular exercise also enhances the quality of sleep, reduces stress, and helps control weight. A well-rounded exercise program provides for aerobic activity, strength training, flexibility, and balance training, each of which benefits the body in different ways.

## Obesity

The prevalence of obesity has significantly increased in the United States with resulting higher incidence rates of diabetes, hypertension, heart disease, stroke, breast and endometrial cancers, among other chronic conditions. Olshansky et al. have predicted that obesity may cause a decline in life expectancy during the 21st century.<sup>71</sup> Figure 4-9 reflects the analyses from 57 international collaborative studies with data indicating cause-specific mortality from more than 900,000 women and men with body mass index (BMI) measurements recorded at

enrollment. Figure 4-9 indicates that the lowest mortality occurred between 22.5 and 25.0 BMI. Each 5 kg/m<sup>2</sup> higher weight was associated with 30% greater mortality.<sup>72</sup> Compared with the ideal BMI of 25, increasing BMI was associated with higher mortality than women or men closer to the ideal, whereas very low BMI, possibly due to preexisting disease, was also associated with more deaths.<sup>72</sup> The J-shaped curve is striking for the high mortality at either BMI extreme.

Being overweight or obese at older ages increases the risk of developing type 2 diabetes. This major health threat often develops in childhood, when food consumption and physical activity are out of balance. Excess consumption and limited strenuous exercise establish an unhealthy pattern affecting long-term health risks. In addition to diabetes, overweight and obese women increase their probability of developing cardiovascular disease, cancer, sleep apnea, arthritis, and other conditions that cause disabilities limiting mobility. Walking at a steady pace 30 to 60 minutes per day enhances health maintenance without straining muscles, maintains joint flexibility, strengthens bone, and controls weight while controlling risks of heart disease, hypertension, and other chronic conditions associated with aging.

## Preventing Excess Exposure to Radiation

Epidemiologic data from atomic bomb survivors<sup>73</sup> and medical exposures<sup>74</sup> have established that moderate to high exposures to radiation, especially at young ages, may increase risks of cancer development years later. For this reason individualized screening recommendations

have been proposed.<sup>75</sup> Several new powerful technologies provide significantly advanced diagnostic information guiding essential clinical care; however, these modalities also carry risks of high levels of radiation exposure.<sup>76</sup> As of 2010 an estimated 75 million computed tomography (CT) scans have been performed on approximately 10% of the population. CT scanning is a unique technology that produces three-dimensional images although at 100 to 500 times the radiation exposure of conventional X-rays. Therefore, a balance of the benefits and risks of CT scans is essential and the Food and Drug Administration (FDA) encourages clinicians to appropriately justify ordering CT scans for specific clinical problems and to carefully monitor radiation doses during the procedures.<sup>76</sup> Patients are being advised to retain a record of medical imaging in addition to the physician and/or hospital record as radiation is cumulative and risk–benefit ratio estimates per scan may be warranted.<sup>77</sup> Radiation is a known carcinogen documented through extensive epidemiologic research especially when exposures occur at young ages. Therefore, the FDA and professional organizations are committed to reducing unnecessary use of CT testing and protecting patients from excessive, unnecessary exposures.<sup>77</sup> Few evidence-based guidelines for CT use or the optimum radiation doses per scan have been developed. Although the FDA has approved CT scanners, the agency has no authority to oversee the use of the machines in clinical practice. Physicians often request imaging for legal protection, as failure to diagnose a serious problem may initiate a lawsuit, whereas overuse of scanning is rarely questioned.<sup>78</sup>

Physicians and technologists must be educated to limit radiation exposure and patients should question the necessity of the imaging. Currently, no agency is monitoring CT-dose information although some clinicians have suggested programs comparable to the Mammography Quality Standards Act of 1992 controlling breast screening programs.<sup>77</sup> However, the planning currently does not include standardization of appropriate use of the imaging equipment because the agency lacks that authority. Instead the FDA is encouraging professional organizations to standardize appropriate guidelines. Brenner and Hall anticipated increased use of CT-based screening of asymptomatic patients for lung and colon cancer as well as cardiac and whole body scanning. These investigators noted lifetime risk of cancer associated with CT scanning was relatively small on an individual level but given the increased exposure of Americans to ionizing radiation during the past 2 decades, the public health implications of CT exposure could be significant in future years.<sup>79</sup>

---

## Prevention Through Public Health Education

---

Goals of the Office of Research on Women's Health (ORWH) during the next decade include studies to personalize prevention, diagnostics, and therapeutics for women and girls.<sup>80</sup> An essential component of that goal is health literacy, which has been strongly associated with health outcomes.<sup>81</sup> Although the focus has often been

on reading and comprehension skills of the public, now health professionals including clinicians are held responsible for removing literacy-related barriers to improve health. Recent statistics indicate that almost 50% of Americans have difficulty reading and understanding printed health brochures and data have linked literacy level with health outcomes; therefore, health materials have been redesigned and presentations on the Web and mobile devices are providing preventive health concepts in simpler more direct language.<sup>81</sup>

Human biology classes enabling adolescents to understand body changes necessary for successful reproduction and the birth of healthy babies have been recommended for all high school students. Avoidance of unplanned or poorly timed pregnancies and sexually transmitted infections including HIV should be incorporated into these programs; however, data recently collected by CDC indicate a high percentage of high schools lack classes addressing these important health topics.<sup>82</sup> Young mothers may be unaware that their developing fetus may experience lifelong adverse health consequences from maternal exposures occurring very early in pregnancy, shortly after conception, when many women are not aware they are pregnant. Recommendations for primary prevention of adverse birth outcomes include improving preconception health care by developing interventions that identify biomedical, behavioral, and social risks that may cause harm to a developing baby.<sup>83</sup> Improved age-appropriate health education during childhood will provide benefits to the child and family throughout the life course. Health information must be designed to meet the intellectual levels and cultural understanding of all members of the population, especially the most vulnerable. The outcomes of meaningful public health efforts should result in delaying or avoiding the onset of disease and disability.<sup>15</sup>

Over the past few decades mass media campaigns have been conducted among large populations with the goal of encouraging healthful behaviors such as recently launched programs from CDC including Million Hearts, Tips from Former Smokers, and Text4Baby, which provides helpfully timed suggestions for pregnant women and new mothers. New electronic technology has expanded the ability of mass media campaigns to reach younger members of the population by targeting different subgroups with culturally appropriate messages including familiar music and language. The great public health promise resulting from mass media campaigns is based on the ability of messages to reach large audiences repeatedly over time often with subtle messages that encourage personal behavior changes. By influencing cognitive or emotional responses the health concepts may indirectly enhance norms developed and shared among social networks.<sup>84</sup> These avenues may reinforce specific health behaviors among individuals who did not personally observe advertisements.<sup>84</sup> More mass media campaigns have been directed to reducing smoking than any other primary prevention behavior and their success is documented by evidence of reduced smoking among adults. Greater success has been achieved when advertising is coordinated with other community-level

policies such as higher cigarette taxes, smoke-free regulations, and messages targeted to specific segments of the population.<sup>84</sup>

---

## Prevention of Disparities in Health Outcomes

---

Each woman carries her own unique life-course trajectory influenced by biologic, behavioral, social, and psychologic factors including health related events.<sup>85</sup> Health status at various stages of life is known to differ significantly by economic status, race/ethnicity, geographic environment, and personal lifestyle. Risk factors, incidence of diseases, and causes of mortality vary considerably by region in the United States as noted in two examples: HIV/AIDS and cardiovascular disease. Although major advances in biomedical sciences have contributed to improved health and greater life expectancy for most Americans, benefits are not shared equally among all segments of the U.S. population many of whom experience higher disease incidence, less successful treatment outcomes, and greater premature mortality.<sup>13</sup>

Access to high-quality health care is essential for treatment of symptomatic conditions; however, Danaei et al. reported disparities in risk factors were strongly related to disparities in mortality by race/ethnicity and income.<sup>86</sup> Health literacy may be a barrier for low-income and poorly educated members of communities to understand the health risks associated with specific behaviors. Skilled clinicians who are able to communicate complex issues in simple terms will be able to meet the specific needs of patients with low literacy skills.<sup>81</sup>

Although disparities have been recognized for decades and extensive research has been directed to defining the causes, statistics continue to reflect limited improvements in several critical health indicators such as perinatal mortality, frequency of infectious diseases, rates of nutrition-related conditions, and survival following diagnosis of chronic diseases including cancer.

Although high-risk behaviors identified by many public health researchers are associated with poor health statistics, other factors also contribute to health disparities. Research directed by Freeman, a breast surgeon, in the Harlem section of New York City identified several critical determinants of disparities affecting his patient population including social position, economic status, culture beliefs and practices, and residential environment.<sup>87</sup> Freeman focused on the lack of education and limited health literacy of patients who were unable to navigate the complex environment of Harlem Hospital and proposed a “patient navigator” program to reduce barriers to timely and appropriate clinical care.<sup>87</sup> Each patient was assigned a trained health navigator who provided assistance with scheduling appointments, enhancing patient–physician communication, ensuring timely diagnosis and treatment, and identifying available services and supportive care. The program has been mandated as a required service for accreditation of cancer centers by the American College of Surgeons’ Commission on Cancer beginning in 2015. This program was tested in many settings and found

to significantly improve care provided to low-income patients of diverse racial/ethnic origin.<sup>87</sup> Epidemiologic studies emphasize the necessity of interventions appropriately meeting the needs of targeted populations and encouraging community awareness of available resources.

An avenue to address health disparities suggested by Moses and Martin included use of electronic data files in the clinical setting to provide objective assessment of the effectiveness of existing drugs and devices, greater participation in clinical trials within teaching hospitals and medical centers, collaborative arrangements for financing healthcare research and clinical care, cost-effective targets for basic health care for common diseases, and greater recognition of the important role of social and economic factors in disease development and health improvement.<sup>1</sup>

The Commission on Social Determinants of Health of the WHO noted that economic status has been a major source of disparity in health outcomes among rich and poor populations across countries and within nations including the United States.<sup>13</sup> Woolf et al. estimated almost 900,000 deaths could have been averted between 1991 and 2000 if white and black individuals had equal mortality rates.<sup>88</sup> Data collected during national surveys conducted between 1999 and 2010 identified a potential contributor to these disparities, increasing inability of low-income working-age adults to purchase high-cost prescribed medications. In 2010, 21.5% of those below the poverty level did not obtain medications compared to 3.9% of respondents with higher income.<sup>89</sup> Some progress is evident by the change in the ratio of black to white deaths between 1988 and 1996 was 1:4 and has declined to 1.2:1 between 2008 and 2010.<sup>11</sup>

Marmot and Bell suggested that the health gradient within a society is responsive to changing political, social, and economic status as occurred in Russia when adult mortality increased during the economic upheaval in 1992 that led to the demise of the Soviet Union.<sup>13</sup> Health status in the United States has declined since the 1980s as the economic gap between rich and poor significantly widened.<sup>90</sup> These challenges cannot be corrected simply through improved access to medical care.

Limited education including low health literacy may prevent some women from appreciating the importance of health messages regarding nutrition, early detection modalities, clinical instructions, or timely treatment.<sup>91</sup> Appropriate health education is essential among young women before pregnancy to ensure their children have a healthy environment during early development in utero. Healthful patterns established following birth, during childhood and adolescence will enhance the quality of life throughout the life course.

Recommendations from federal health agencies and professional organizations published in 2006 were designed to promote optimal health throughout the life span of women, children, and their families based on clinical care and population-focused public health strategies.<sup>83</sup> Programs that are culturally and linguistically appropriate are being developed to ensure maximal use and impact on the diverse American female population. The report encouraged greater

education of consumers beginning among high school students to increase awareness of factors associated with adverse reproductive health outcomes especially among populations known to experience health disparities.<sup>83</sup> The guidance for preconception health planning defines a continuum of clinical care addressing women's needs during differing stages of their reproductive years. Recognized disparities influence disease development and survival among subsets of women whose exposures have differed significantly by socioeconomic status, education, personal lifestyle, and access to high-quality health care from early life through senior years.

## Summary

A life-course approach has guided the organization of this text reflecting the recent understanding of critical growth periods that may affect long-term health outcomes. At all ages, beginning with 9 months in utero to elder years, females undergo continual development and change requiring age-related protective behaviors to minimize risks of adverse clinical events while maximizing disease-free years. Focused studies are assessing prenatal development, factors associated with rapid growth before puberty, timing of sexual maturation, reproductive decisions, and the menopausal transition to better quantify beneficial preventive behaviors. These life phases are characterized by differing rates of cell replication and organ-specific susceptibility. Hormonal influences create the unique setting for preventive health services needed by women; environmental, medical, and behavioral factors influence personal decisions; and community programs increase awareness of health promotion activities. In addition, the heterogeneity of responses among women to disease-related risk factors and options for prevention will be modified when genetic analyses provide information to guide individuals. By identifying those at highest risk who carry specific susceptibility mutations, clinicians may be able to develop personalized medical care, encouraging preventive strategies and recommending early detection modalities to ultimately reduce morbidity along the life course and enable greater longevity free of disabilities. Health promotion and disease prevention are major aspects of public health efforts that must also continue to address the burden of disparities in health outcomes.

## Discussion Questions

1. Describe a community health promotion objective and the design of community-wide interventions to achieve the objects.
2. What controls would be needed to adequately control prescribed medications that have recently been associated with increased emergency events and deaths?
3. How do epidemiologic studies of infectious conditions differ from chronic diseases? Describe some complex conditions that overlap infectious and chronic statuses?
4. Disparities in health outcomes have been present for many decades. Describe causes and some remedies.

## References

1. Moses H, Martin JB. Biomedical research and health advances. *N Engl J Med*. 2011;364:567–571.
2. Kreimer AR, Rodriguez AC, Hildesheim A, et al. Proof-of-principle evaluation of the efficacy of fewer than three doses of a bivalent HPV 16/18 vaccine. *J Natl Cancer Inst*. 2011;103:1444–1451.
3. Fauci AS, Morens DM. The perpetual challenge of infectious diseases. *N Engl J Med*. 2012;366:454–461.
4. Johnson MI, Fauci AS. HIV vaccine development—Improving on natural immunity. *N Engl J Med*. 2011;365:873–875.
5. Morse SS. Public health surveillance and infectious disease detection. *Biosecur Bioterror*. 2012;10:6–16.
6. Frieden TR, Berwick DM. The “Million Hearts” initiative—Preventing heart attacks and strokes. *N Engl J Med*. 2011;e27:1–4.
7. Centers for Disease Control and Prevention. CDC Launches national tobacco education campaign. *MMWR Morb Mortal Wkly Rep*. 2012;61:178.
8. World Health Organization Constitution. 22 July 1946 basic documents. Geneva, Switzerland: WHO; 1985. [http://www.who.int/governance/eb/who\\_constitution\\_en.pdf](http://www.who.int/governance/eb/who_constitution_en.pdf).
9. Breslow L, Enstrom JE. Persistence of health habits and their relationship to mortality. *Prev Med*. 1980;9:469–483.
10. Breslow L. From disease prevention to health promotion. *JAMA*. 1999;281:1030–1033.
11. Hoyert DL. 75 Years of mortality in the United States, 1935–2010. *NCHS*. 2012;no 88.
12. Schroeder SA. We can do better—Improving the health of the American people. *N Engl J Med*. 2007;357:1221–1228.
13. Marmot MG, Bell R. Action in health disparities in the United States. *JAMA*. 2009;301:1169–1171.
14. McKenna MT, Zohrabian A. US burden of disease—past, present and future. *Ann Epidemiol*. 2009;19:212–219.
15. Fries JF. Aging, natural death, and the compression of morbidity. *N Engl J Med*. 1980;303:130–135.
16. Krieger N. Embodiment: a conceptual glossary for epidemiology. *J Epidemiol Community Health*. 2005;59:350–355.
17. Koh HK, Sebelius KG. Promoting prevention through the Affordable Care Act. *N Engl J Med*. 2010;363:1296–1299.
18. Institute of Medicine. *Clinical Preventive Services for Women: Closing the Gaps*. Washington, DC: The National Academies Press; 2011.
19. Galea S, Riddle M, Kaplan GA. Causal thinking and complex system approaches in epidemiology. *Int J Epidemiol*. 2010;39:97–106.
20. Kuller LH. Relationship between acute and chronic disease epidemiology. *Yale J Biol Med*. 1987;60:363–376.
21. Cohen SM, Van Handel MM, Branson BM, et al. Vital signs: HIV prevention through care and treatment—United States. *MMWR Morb Mortal Wkly Rep*. 2011;60:1618–1622.
22. Rosner D, Fried LP. Traditions, transitions, and transfats: new directions for public health. *Public Health Rep*. 2010;125:3–7.
23. Freedman RA, Garber JE. Family cancer history: healthy skepticism required. *J Natl Cancer Inst*. 2011;103:776–777.
24. Lynch HT, Watson P, Bewira C, et al. Hereditary ovarian cancer. Heterogeneity in age at diagnosis. *Cancer*. 1991;67:1460–66.
25. Chlebowski RT, Anderson GL. Changing concepts: menopausal hormone therapy and breast cancer. *J Natl Cancer Inst*. 2012;104:517–527.
26. Lander ES, Linton LM, Birren B, et al. Initial sequencing and analysis of the human genome. *Nature*. 2001;409:860–921. (Errata, *Nature*. 2001;411:720, 412:565)
27. Whittemore AS. Evaluating health risk models. *Statist Med*. 2010;29:2438–2452.
28. Ames BN. Prevention of mutation, cancer and other age-associated diseases by optimizing micronutrient intake. *J Nucleic Acids*. 2010;2010:725071.
29. Parmet WE. Pandemic vaccines—the legal landscape. *N Engl J Med*. 2010;362:1949–1952.
30. Institute of Medicine. *Adverse Effects of Vaccines: Evidence and Causality*. Board on Population Health and Public Health Practices. Washington, DC: The National Academies Press; 2012.
31. Poland GA, Jacobson RM. The age-old struggle against the antivaccinationists. *N Engl J Med*. 2011;364:97–99.
32. Centers for Disease Control and Prevention. Recommended adult immunization schedule—United States, 2012. *MMWR Morb Mortal Wkly Rep*. 2012;61:1–7.
33. Williams WW, Lu PJ, Singleton JA, et al. Adult vaccination coverage—United States, 2010. *MMWR Morb Mortal Wkly Rep*. 2012;61:66–72.
34. Smoking, Tobacco, and Cancer Program. 1985–1989 Status Report. NIH Pub. No 90–3107. Washington, DC: US Department of Health and Human Services; 1990.
35. Surgeon-General's Advisory Committee on Smoking and Health. *Smoking and Health*. Pub. no 1103. Washington, DC: Public Health Service; 1964.
36. Howe HL. An historical review of women, smoking and advertising. *Health Education*. 1984; 15:3–8.
37. Brandt AM. FDA regulation of tobacco—Pitfalls and possibilities. *N Engl J Med*. 2008;359:445–448.



38. Farrelly MC, Heaton CH, Davis KC, et al. Getting to the truth: evaluating national tobacco countermarketing campaigns. *Am J Public Health.* 2002;92:901–907. (Erratum, *Am J Public Health.* 2003;93:703.)
39. Woloshin S, Schwartz LM, Welch HG. The risk of death by age, sex, and smoking status in the United States: putting health risks in context. *J Natl Cancer Inst.* 2008;100:845–853.
40. Gritz ER, Sarna L, Dresler C, Heaton CG. Building a united front: aligning the agendas for tobacco control, lung cancer research, and policy. *Cancer Epidemiol Biomarkers Prev.* 2007;16:659–663.
41. Wang H, Preston SH. Forecasting United States mortality using cohort smoking histories. *PNAS.* 2009;106:393–398.
42. Heaton CG, Gritz ER, Davis KC, et al. Women's knowledge of the leading causes of cancer death. *Nicotine Tob Res.* 2007;9:761–768.
43. Simons-Morton B, Haynie DL, Crump AD, et al. Peer and parent influences on smoking and drinking among early adolescents. *Health Educa Behav.* 2001;28:95–107.
44. Primack BA, Longacre MR, Beach ML, et al. Association of established smoking among adolescents with timing of exposure to smoking depicted in movies. *J Natl Cancer Inst.* 2012;104:549–555.
45. Wolff T, Miller T, Ko S. Aspirin for the primary prevention of cardiovascular events: An update of the evidence for the US Preventive Services Task Force. *Ann Intern Med.* 2009;150:405–410.
46. US Preventive Task Force. Aspirin for the prevention of cardiovascular disease: US Preventive Task Force recommendation statement. *Ann Intern Med.* 2009;150:396–404.
47. Ridker PM, Cook NR, Lee IM, et al. A randomized trial of low-dose aspirin in the primary prevention of cardiovascular disease in women. *N Engl J Med.* 2005;352:1293–1304.
48. Rothwell PM, Wilson M, Price JF, et al. Effect of daily aspirin on risk of cancer metastasis: a study of incidence cancers during randomised controlled trials. *Lancet.* 2012;379:1591–1601
49. Rothwell PM, Price JF, Fowkes GR, et al. Short-term effects of daily aspirin on cancer incidence, mortality, and non-vascular death: analysis of the time course of risks and benefits in 51 randomised controlled trials. *Lancet.* 2012;379:1602–1612.
50. McKeown RE. The epidemiologic transition: changing patterns of mortality and population dynamics. *Am J Lifestyle Med.* 2009;3(1 suppl):19S–26S.
51. Chan AT, Cook NR. Are we ready to recommend aspirin for cancer prevention? *Lancet.* 2012; (Pub ahead of print)
52. Bouchery EE, Harwood HJ, Sacks JJ, et al. Economic costs of excessive alcohol consumption in the US, 2006. *Am J Prev Med.* 2011;41:516–524.
53. Kanny D, Liu Y, Brewer RD, et al. Vital signs: Binge drinking prevalence, frequency, and intensity among adults—United States, 2010. *MMWR Morb Mortal Wkly Rep.* 2012;61:14–19.
54. Bergen G, Shults RA, Rudd RA. Vital signs: Alcohol-impaired driving among adults—United States, 2010. *MMWR Morb Mortal Wkly Rep.* 2011;60:1–6.
55. Goldberg IJ, Mosca L, Piano MR, Fisher EA. Wine and your heart. a science advisory for healthcare professionals from the Nutrition Committee, Council of Epidemiology and Prevention, and Council on Cardiovascular Nursing of the American Heart Association. *Circulation.* 2001;103:472–475.
56. Fuchs CS, Stampfer MJ, Colditz GA, et al. Alcohol consumption and mortality among women. *N Engl J Med.* 1995;332:1245–1250.
57. Sun Q, Townsend MK, Okereke OI, et al. Alcohol consumption at midlife and successful ageing in women: a prospective cohort analysis in the Nurses' Health Study. *PLoS Med.* 2011;8:e1001090.
58. Freiberg MS, Chang YF, Kraemer KL, et al. Alcohol consumption, hypertension, and total mortality among women. *Am J Hypertens.* 2009;22:1212–1218.
59. Klatsky AL, Friedman GD, Armstrong MA, Kipp H. Wine, liquor, beer, and mortality. *Am J Epidemiol.* 2003;158:585–595.
60. Thun MJ, Peto R, Lopez AD, et al. Alcohol consumption and mortality among middle-aged and elderly US adults. *N Engl J Med.* 1997;337:1705–1714.
61. Gunn JP, Blair NA, Cogswell ME, et al. CDC Grand Rounds: Dietary sodium restriction—time for choice. *MMWR Morb Mortal Wkly Rep.* 2012;61:89–91.
62. Institute of Medicine. *Informing the Future: Critical Issues in Health.* Washington, DC: The National Academies Press; 2011
63. Institute of Medicine. *Strategies to Reduce Sodium Intake in the United States.* Washington, DC: The National Academies Press; 2010.
64. Bibbins-Domingo K, Chertow GM, Coxson PG, et al. Projected effect of dietary salt reductions on future cardiovascular disease. *N Engl J Med.* 2010;362:590–599.
65. Cai R, Crane E, Poneleit K, Paulozzi L. Emergency department visits involving nonmedical use of selected prescription drugs—United States, 2004–2008. *MMWR Morb Mortal Wkly Rep.* 2010;59:705–709.
66. Warner M, Chen LH, Makuc DM, et al. Drug poisoning deaths in the United States, 1980–2008. *NCHS Data Brief.* 2011;81.
67. Paulozzi LJ, Jones CM, Mack KA, Rudd RA. Vital signs: overdoses of prescription opioid pain relievers—United States, 1999–2008. *MMWR Morb Mortal Wkly Rep.* 2011;60:1487–1492.
68. Paulozzi LJ, Baldwin G, Franklin G, et al. CDC Grand Rounds: prescription drug overdoses—a US epidemic. *MMWR Morb Mortal Wkly Rep.* 2012;61:10–13.
69. Centers for Disease Control and Prevention. Announcements: National Poison Prevention Week, 50th Anniversary. March 18–24, 2012. *MMWR Morb Mortal Wkly Rep.* 2012;61:177.
70. Weiss CC, Purciel M, Bader M, et al. Reconsidering access: park facilities and neighborhood disamenities in New York City. *J Urban Health.* 2011;88:297–310
71. Olshansky SJ, Passaro DJ, Hershow RC et al. A potential decline in life expectancy in the United States in the 21st century. *N Engl J Med.* 2005;352:1138–45.
72. Whitlock G, Lewington S, Sherliker P, et al. Body-mass index and cause-specific mortality in 900,000 adults: collaborative analyses of 57 prospective studies. *Lancet.* 2009;373:1083–1096.
73. Land CE. Studies of cancer and radiation dose among atomic bomb survivors: the example of breast cancer *JAMA.* 1995;274:402–407.
74. Elkin EB, Klem ML, Gonzales AM, et al. Characteristics and outcomes of breast cancer in women with and without a history of radiation for Hodgkin's lymphoma: a multi-institutional, matched cohort study. *J Clin Oncol.* 2011;29:2466–2473.
75. Kerlilowske K. Evidence-based breast cancer prevention: The importance of individual risk. *Ann IntMed.* 2009;151:750–752.
76. US Food and Drug Administration. Radiation-emitting products. Initiative to reduce unnecessary radiation exposure from medical imaging. <http://www.fda.gov/Radiation-EmittingProducts/RadiationSafety/RadiationDoseReduction/ucm2007191.htm>
77. Smith-Bidman R. Is computed tomography safe? *N Engl J Med.* 2010;363:1–4.
78. Hillman BJ, Goldsmith JC. The uncritical use of high-tech medical imaging. *N Engl J Med.* 2010;363:4–6.
79. Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. *N Engl J Med.* 2007;357:2277–2284.
80. Pinn VW, Clayton JA, Begg L, Sass SE. Public partnership for a vision for women's health research in 2020. *J Women's Health.* 2010;19:1603–1607.
81. Rudd RE. Improving Americans' health literacy. *N Engl J Med.* 2010;2283–2285.
82. Kann L, Brener N, McManus T, Wechsler F HIV, other STD, and pregnancy prevention education in public secondary schools—45 states, 2008–2010. *MMWR Morb Mortal Wkly Rep.* 2012 61:222–228.
83. Johnson K, Posner SF, Bierman J, et al. Recommendations to improve pre-conception health and health care—United States. *MMWR Morb Mortal Wkly Rep.* 2006;55:1–23.
84. Wakefield M, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. *Lancet.* 2010;376:1261–1271.
85. Lynch J, Smith GD. A life course approach to chronic disease epidemiology. *Annu Rev Public Health.* 2005;26:1–35.
86. Danaei G, Rimm EB, Oza S, et al. The promise of prevention: the effects of four preventable risk factors on national life expectancy and life expectancy and life expectancy disparities by race and county in the United States. *PLoS Med.* 2010;7:e1000248.
87. Freeman HP, Rodriguez RL. History and principles of patient navigation. *Cancer.* 2011;117(15 suppl):3539–3542.
88. Woolf SH, Johnson RE, Fryer GE, Rust G, Satcher D. The health impact of resolving racial disparities: An analysis of US mortality data. *Am J Public Health.* 2004;94:2078–2081; *Am J Public Health.* 2008;98(9 suppl):S26–S28.
89. QuickStats. National Center for Health Statistics. Percentage of adults aged 16–64 years who did not get needed prescription drugs because of cost, by poverty status—National Health Interview Survey, 1999–2010. *MMWR Morb Mortal Wkly Rep.* 2011;60:1495.
90. Krieger N, Rehkopf DH, Chen JT, et al. The fall and rise of US inequalities in premature mortality: 1960–2002. *PLoS Med.* 2008;5:e46.
91. Institute of Medicine. *Health Literacy: A Prescription to End Confusion.* Board of Neuroscience and Behavioral Health. Washington, DC: The National Academy Press; 2004.

