Chapter 11
General Morbidity and All-Cause Mortality

Sections of this chapter on the health consequences of smoking are accompanied by evidence tables detailing the studies that were used to evaluate the evidence to assess causality. A supplement to this report is provided that contains these tables. The tables included in the supplement are indicated with an "*S*" where they are called out in the text.

Introduction

Smoking has long been known to increase mortality. Pearl's 1938 paper in *Science* showed increased mortality in users of tobacco compared to nonusers, a finding that was replicated in the 1950s by the first wave of cohort studies initiated to investigate the risks of smoking (Figure 11.1) (Pearl 1938). Previous Surgeon General's reports have commented on the increased overall risk for dying in smokers and identified smoking as the leading cause of avoidable premature mortality. The mortality risk associated with smoking has changed over time, driven by the trends in patterns of smoking in the population, as discussed in Chapters 2, "Fifty Years of Change 1964–2014," 4, "Advances in Knowledge of the Health Consequences of Smoking: From 1964–2014," and 13, "Patterns of Tobacco Use Among U.S. Youth, Young Adults, and Adults." Consequently, this chapter provides updated evidence on smoking and all-cause mortality, drawing on a pooled analysis of data from five cohorts that spans the period 2000–2010.

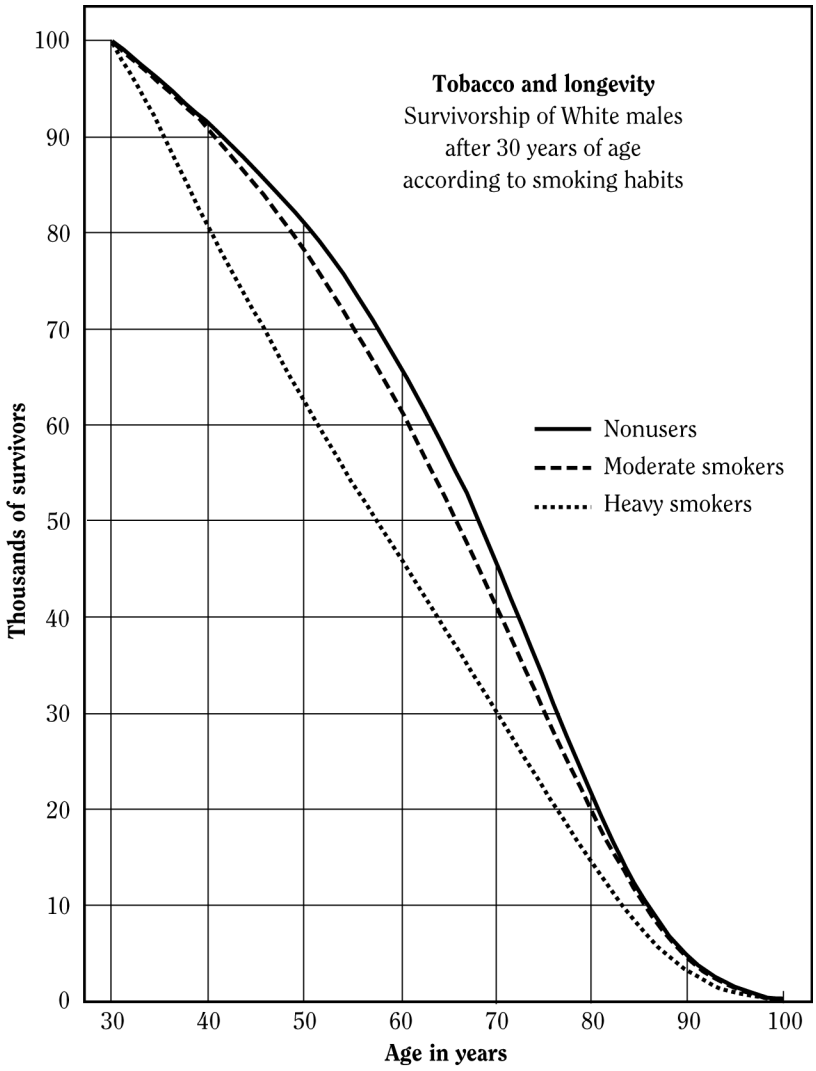
Other chapters in this report have addressed the causation of specific diseases by smoking. For each of these diseases, there is excess mortality attributable to smoking that is potentially avoidable through tobacco control. All-cause mortality provides a measure of the excess mortality attributable to smoking that integrates across all of these causes, as well as capturing mortality that may come from still unidentified associations of smoking with disease and through indirect pathways, such as diminished immune function.

Beyond causing specific diseases and a wide range of other adverse health effects, smoking is also associated with generally poorer health, when smokers are compared with nonsmokers. This chapter also addresses the evidence supporting such general adverse effects, which are not captured by the evidence on the many specific diseases caused by smoking. The 2004 Surgeon General's report concluded that smoking caused diminished health status, referring to a general reduction of health as manifest, for example, by absenteeism from work and self-report (U.S. Department of Health and Human Services [USDHHS] 2004). One manifestation of the diminished health status of smokers is an increase in morbidity (i.e., illness), generally.

These general health effects of smoking contribute to increased absenteeism, loss of well-being, and have implications for health care and its costs. As a result of the specific disease burden from smoking and the diminished health status of smokers, their health care costs exceed those of nonsmokers. This chapter examines new evidence, since the 2004 report, on all-cause mortality and measures of general health status, assessing the ongoing impact of smoking on health.

Chapter 12, "Smoking-Attributable Morbidity, Mortality, and Economic Costs" discusses the relationship of smoking to several highly prevalent illnesses, and the implications these have on national health burdens. In 2003, the Centers for Disease Control and Prevention (CDC) estimated that for the year 2000, 8.6 million persons (95% confidence interval [CI], 6.9–10.5) in the United States had an estimated 12.7 million (95% CI, 10.8–15.0) serious medical conditions that were caused by smoking. The most prevalent conditions were chronic bronchitis and emphysema, which accounted for 73% of the serious medical conditions reported by smokers. As discussed in previous reports (USDHHS 2004, 2010) and in Chapter 7, "Respiratory Diseases," smoking is a primary cause of respiratory diseases. In Chapter 8, "Cardiovascular Diseases," the causal relationship between tobacco smoke from either smoking and/or exposure to secondhand smoke and cardiovascular disease is presented. Chapter 10, "Other Specific Outcomes" of this report reviews the evidence of a causal relationship between smoking and diabetes, as well as the impact that smoking has on immune function.

Figure 11.1 Survivorship lines of life tables for White males falling into three categories relative to the usage of tobacco as in Pearl, 1938



Source: Pearl 1938. Reprinted with permission from American Association for the Advancement of Science, © 1938.

Smoking and General Morbidity and Economic Costs

Disease incidence and mortality are key indicators of the effects of smoking on health, but do not capture the full impact on the health and well-being of smokers. Declines in well-being may occur well before—or even in the absence of—diagnosed disease. The goal of this section is to evaluate the effects of smoking on global measures of health and well-being. These measures were not considered in the 1964 Surgeon General's report (U.S. Department of Health, Education, and Welfare [USDHEW] 1964), but have proven to be important contributors to the overall burden of smoking-related ill health (USDHHS 2004). Smokers experience measurable declines in overall health soon after smoking initiation, and these health deficits persist through adulthood (USDHHS 2012). In contrast to the premature mortality from smoking, which begins in middle age, and the diseases caused by smoking that have

rising incidence from the fourth decade of life, the effects on general health are an immediate and current concern for smokers of all ages.

Some measures that have been used to assess the overall health impact of smoking include self-reported health status, health care utilization and costs, and workplace absenteeism. These measures are clearly interrelated, but each provides a distinct indicator of the health effects of smoking. Self-reported health status may be the most relevant measure for the individual smoker, whereas employers, who are considering implementation of smoking cessation programs, may be more interested in lost workdays due to smoking, and the use and costs of health care by smokers.

The 2004 Surgeon General's report included a comprehensive review of these topics and concluded that the evidence was sufficient to infer a causal relationship between smoking and diminished health status, a term introduced in that report. The current report updates that review, strengthening the evidence base and confirming the causal relationship. Other topics relevant to this topic are also covered in this report, including the effects of smoking on the immune system (see Chapter 10) and smoking and respiratory infections (see Chapter 7).

Biologic Basis

A conceptual model of the relationship between cigarette smoking and diminished health was described in the 2004 Surgeon General's report: smoking adversely affects health through specific disease pathogenesis—such as the development of lung cancer—or through nonspecific mechanisms, such as alterations to the immune system, systemic oxidative stress, or subclinical organ injury. Consideration of all of these pathways is necessary to capture the full effects of tobacco on health. Previous Surgeon General's reports have covered these topics in depth (USDHHS 2004). The 2010 report specifically focused on the mechanisms by which smoking causes disease concluding that "Inhaling the complex chemical mixture of combustion compounds in tobacco smoke causes adverse health outcomes, particularly cancer and cardiovascular and pulmonary diseases, through mechanisms that include DNA damage, inflammation, and oxidative stress" (USDHHS 2010, p. 9). The report also noted that there is no risk-free level of exposure to tobacco smoke. The present report adds a comprehensive review of smoking and immune function (see Chapter 10) to these previous syntheses of the evidence on how smoking causes disease and affects health.

Conclusions of Previous Surgeon General's Reports

The first comprehensive evidence synthesis on the topic of smoking and general morbidity and health status was described in the 2004 Surgeon General's report (USDHHS 2004). The conclusions of that report were as follows:

- "The evidence is sufficient to infer a causal relationship between smoking and diminished health status that may manifest as increased absenteeism from work and increased use of medical care services" (p. 29).

- "The evidence is sufficient to infer a causal relationship between smoking and increased risks for adverse surgical outcomes related to wound healing and respiratory complications" (p. 29).

In discussing the implications of these findings, the report stated "Although preventing the specific diseases caused by smoking has been a public health priority for a long time, cigarette smoking also causes a substantial and costly burden of nonspecific morbidity" (p. 677).

Epidemiologic Evidence

The current report updates some findings of the 2004 Surgeon General's report with a selective review of studies published from 2000 onward. The 2004 report established a causal relationship between smoking and diminished health; the current review builds on these findings by discussing recent results from large, longitudinal and/or nationally representative studies, such as the Health and Retirement Study (HRS) and the Behavioral Risk Factor Surveillance System (BRFSS). Emphasis was placed on larger studies, nationally representative studies, and studies that quantified the effects of smoking. These studies provide results that can be generalized to large segments of the population. Furthermore, they may provide more precise estimates of effect than smaller studies. Focusing on these studies is unlikely to produce biased conclusions because causation has already been established and studies continue to be remarkably consistent in finding poorer health among smokers. Although a few studies with null findings are highlighted in the review, the body of evidence as a whole clearly demonstrates adverse health effects of smoking.

The review of workplace absenteeism focuses on more narrowly defined populations (people who were employed, sometimes in a single industry), and here studies are included that collected adequate information about smoking (at a minimum, smoking classified as current, former, or never). In the case of health care utilization and costs, the review was restricted to studies based in the United States. Studies of smoking and specific conditions (e.g., work loss due to back pain) were not included.

Health Status

Physical, mental, and social well-being are fundamental to the concept of health and are incorporated in the World Health Organization's (WHO's) (1948) definition of health. Mental and social well-being are inherently subjective and assessed in practice by self-report of health status.

The Short Form 36 (SF-36) and Short Form 12 (SF-12), for example, are widely used instruments that collect information about eight areas of health and functioning. Lower (i.e., worse) scores on these instruments have been found to predict mortality (Dorr et al. 2006; Kroenke et al. 2008) and hospitalization (Dorr et al. 2006) in older or middle-aged adults. Other tools—including the single question, "In general, would you say your health is excellent, very good, good, fair, or poor?" have also been linked with important health outcomes (McGee et al. 1999; DeSalvo et al. 2005). The studies in Tables 11.1*S*–11.9*S* are organized by the measures of health status that were assessed. As noted, many of the studies accounted for a broad range of potential confounding factors.

Self-Reported Poor or Fair Health

In studies of population groups, ranging from adolescents and college students to the elderly, current smokers have self-reported poorer health compared with never smokers (Johnson and Richter 2002; Ostbye et al. 2002; Arday et al. 2003; Caldeira et al. 2012; Wang et al. 2012). Among respondents 18 years of age and older in BRFSS, current smokers were 70% more likely than never smokers to report poor or fair health (Strine et al. 2005). A dose-response relationship for self-reported poor or fair health was observed among current smokers in the HRS; compared with never smokers, current light smokers had a 47% increase in risk and current heavy smokers had a doubling of risk (Ostbye et al. 2002).

Former smokers also tend to be more likely to report poor or fair health than never smokers, particularly if they had only recently quit smoking at the time of assessment. Among middle-aged participants in the HRS, former smokers who quit within the last 3 years were almost twice as likely as never smokers to report poor or fair health; former smokers who had quit more than 15 years previously had a risk of fair or poor health that was similar to that of never smokers (Ostbye et al. 2002). A decline in risk for reporting poor health, with increasing time since quitting, was also observed among elderly Medicare enrollees (Arday et al. 2003). One study, using the 2006 BRFSS data, found that health-related quality of life was poorer for smokers who had tried to quit but not succeeded, compared with smokers who did not try to quit (McClave et al. 2009). Former smokers had better health-related quality of life than both groups of current smokers.

Poor Physical or Mental Function

Poor physical or mental function—assessed through SF-36 or SF-12 scores or report of difficulty with specific tasks—was evaluated in several studies. In the Nurses' Health Study (NHS) cohorts, current smokers had poorer physical and emotional functioning than never smokers. Furthermore, among current smokers, physical and emotional function declined as the number of cigarettes per day increased (Sarna et al. 2008). Current smokers also had poorer physical and emotional function than never smokers in a study of elderly or disabled Medicare enrollees (Arday et al. 2003). Among participants in the HRS, self-reported limited ability to work because of impairment or health problems was more than twice as common among current heavy smokers than among never smokers. Current light smokers had a 73% increase in risk for disability compared with never smokers (Ostbye et al. 2002). Studies conducted in other countries have also found poorer physical and/or emotional health status among current smokers compared with never smokers (Mulder et al. 2001; Sulander et al. 2005; Laaksonen et al. 2006; Myint et al. 2007; Strandberg et al. 2008; Pisinger et al. 2009; Liao et al. 2011; Vogl et al. 2012).

A study of male veterans who receive U.S. Department of Veterans Affairs (VA) health care services did not find an association between current smoking and SF-36 physical or mental component summary scores (Borzecki et al. 2005). There are several potential explanations for the difference between this study and the results of the other studies reviewed. The study of veterans had relatively high rates of nonresponse and exclusion, because of missing data. Participants who were excluded tended to have poorer physical health, mental health, and health behaviors than subjects who were included. This selection bias may have weakened the association between smoking

and health status. The effect of smoking may also have been weakened by adjustment for the number of health problems, which are likely to be on the causal pathway between smoking and self-reported poor health. The null results of this study may reflect these methodologic issues.

Decline in function was evaluated among 558 community-dwelling older women with moderate-to-severe disability at baseline (Atkinson et al. 2005). Physical decline was based on walking speed; cognitive decline was based on Mini-Mental State Examination results. During 3 years of follow-up, current smokers were over five times more likely than never smokers to experience a combination of physical and mental decline.

The status of physical and mental functioning among former smokers tends to fall in between those of current and never smokers (Sulander et al. 2005; Myint et al. 2007; Liao et al. 2011; Vogl et al. 2012), although some studies have found similar results for never and former smokers (Borzecki et al. 2005; Laaksonen et al. 2006). The association varies with time since quitting. SF-36 physical and mental component summary scores improved with longer time since quitting in the NHS cohorts (Sarna et al. 2008). In the HRS, long-term quitters were no more likely than never smokers to report limited ability to work because of health problems (Ostbye et al. 2002). These findings add to the evidence that smoking cessation improves later health outcomes.

Other Measures of General Health and Well-Being

Several other measures of health and well-being have also been evaluated in relation to smoking, including ability to walk a short distance, frailty, overall quality of life, and successful aging. In studies of middle-aged (Ostbye et al. 2002) and older people (Ostbye et al. 2002; Hardy et al. 2010), current smokers reported greater difficulty than never smokers in walking a short distance. Former smokers—particularly recent quitters—may also be at increased risk compared with never smokers (Ostbye et al. 2002).

Among participants in the Women's Health Initiative (WHI) observational study, frailty—defined on the basis of self-reported poor physical function, exhaustion, low physical activity, and unintentional weight loss—was almost three times more common among current smokers than never smokers (Woods et al. 2005). Former smokers had a 12% increase in risk of frailty compared with never smokers.

Overall quality of life (Heikkinen et al. 2008) and life satisfaction (McClave et al. 2009) also appear to be reduced by smoking, although smoking cessation may improve quality of life. Among participants in a smoking cessation trial, successful quitters reported subsequent better quality of life than those who continued to smoke (Piper et al. 2012). Similarly, in a smoking reduction trial, those who reduced their smoking by at least one-half reported better general health than those who did not reduce their smoking (Bolliger et al. 2002).

A desired outcome—successful aging—was evaluated among men and women between 42–63 years of age at baseline (Sabia et al. 2012). Successful aging was defined as having good cognitive, respiratory, and cardiovascular functioning, and the absence of disability, mental health problems, and chronic disease. Compared with people who had ever smoked, never smokers were 29% more likely to experience successful aging.

Combinations of Health Behaviors

Another, and more holistic, way of assessing the impact of smoking on health status is to consider the effect of smoking in combination with other health risk behaviors. Two cohort studies considered smoking along with other health risk behaviors in aggregate indices. Four healthy behaviors were evaluated in a large cohort of men and women between 42–63 years of age: never smoking, moderate alcohol consumption, engaging in physical activity, and daily consumption of fruits and vegetables (Sabia et al. 2012). Individuals with all four healthy behaviors were more than three times more likely than those with none of the healthy behaviors to experience successful aging (odds ratio [OR] = 3.3; 95% CI, 2.1–5.1). Similarly, a study of adults 60 years of age or older evaluated never smoking, moderate alcohol intake, 6–8 hours of sleep per night, and regular exercise. Study participants with all four healthy behaviors were 75% less likely to develop functional disability than those with none of the healthy behaviors (hazard ratio = 0.25; 95% CI, 0.11–0.57) (Liao et al. 2011). In both studies, smoking had an independent effect.

Medical Services Utilization and Cost

Medical services utilization and cost provide another measure of the overall impact of smoking on health. As described in previous sections, smoking causes a broad range of diseases and has also been linked with significant deficits in overall health. Measures of health care utilization and cost capture the medical care that is required for all of these health effects combined. Tables 11.6*S*–11.9*S* provide additional information about studies that addressed these issues.

Hospitalizations

Hospitalizations among younger smokers were evaluated in two studies conducted in military populations. Among men and women serving on active duty in the U.S. Army, hospitalization for a reason other than injury or pregnancy was 30% more common among male current smokers and 25% more common among female current smokers relative to never smokers (Robbins et al. 2000). Risk of hospitalization was also higher among former smokers than among never smokers, but to a lesser extent. In a study of female naval recruits, the likelihood of nonpregnancy-related hospitalization differed significantly by smoking status with current daily smokers having a significantly higher rate of hospitalization than other smokers and never smokers (Woodruff et al. 2010). Study results in even younger people (Johnson and Richter 2002), and much older people (Ostbye et al. 2002; Kahende et al. 2009), also suggest that smokers have higher rates of hospitalization than never smokers.

The risk of hospitalization among former smokers appears to decline with lengthening time since quitting. Compared with never smokers in the HRS, former smokers who had quit within the last 3 years had a 46% increase in risk of hospitalization, and former smokers who quit between 3–15 years previously had a 22% increase in risk (Ostbye et al. 2002). Long-term quitters (i.e., those who had quit at least 15 years previously) had a risk of hospitalization that was similar to that for never smokers. An analysis of 1999–2004 National Health and Nutrition Examination Survey (NHANES) data also indicated that the risk of hospitalization declines with time since quitting, although even long-term quitters (10 years or more) remained more likely than never smokers to be hospitalized (Kahende et al. 2009).

Outpatient Visits

Outpatient visits may occur for routine check-ups and preventive care, follow-up of ongoing illnesses (e.g., hypertension), and work-up of new symptoms or acute illness. Evidence shows that the mix of visit types differs, comparing smokers with nonsmokers, as smokers are less likely to have routine visits (USDHHS 2004). Consequently, comparisons of total visits, without disaggregation by type, are less informative as to the effects of smoking.

In the analysis of 1999–2004 NHANES data, the frequency of at least one outpatient visit in the past year was similar in current and never smokers. Current smokers, however, were more likely than never smokers to have multiple (four or more) outpatient visits in the past year (Kahende et al. 2009). Former smokers were also more likely than never smokers to have multiple outpatient visits, even among long-term quitters. In contrast, among male veterans receiving care at VA medical facilities, current smokers had fewer outpatient medical visits than never smokers (Borzecki et al. 2005).

Nursing Home Stays

Although many studies have evaluated smoking in relation to outpatient care and hospitalization, far fewer studies have addressed the relationship between smoking and nursing home stays. The available data, however, suggest that smoking increases the likelihood of a nursing home stay among both middle-aged and older individuals.

In the NHANES I Epidemiologic Follow-up Study, smoking increased the risk of a nursing home admission by 32% among those 65–74 years of age at baseline, and by 56% among those 45–65 years of age (Valiyeva et al. 2006). The comparison group included both former and never smokers, which may have led to an underestimation of the effect of smoking.

A study that included only older people (i.e., 70 years of age or older) also found an increased risk of nursing home admission among current smokers. In the Asset and Health Dynamics Among the Oldest Old Survey, current smokers were 68% more likely than never smokers to have a stay in a nursing home, convalescent home, or other long-term care health facility (Ostbye et al. 2002). The risk among former smokers was similar to the risk among never smokers.

Total Health Care Costs

A 2012 report by the Congressional Budget Office (CBO) estimated annual per capita health care spending among adults 18 years of age and older (Table 11.10*S*) (CBO 2012). Spending tended to be highest among former smokers, likely reflecting cessation following onset of an illness caused by smoking. Current smokers had greater expenditures than never smokers. Among adults 45–64 years of age, for example, annual health care spending was $7,650 for recent quitters, $5,540 for current smokers, and $5,040 for never smokers. Never smokers had the lowest spending in each age group, except the oldest; among people 75 years of age or older, spending was $1,060 less for current smokers, than for never smokers. As noted in the report, continuing smokers who survive to that age may be in good health in spite of smoking, or may have a lower propensity to use health care.

In order to account for the many ways that smokers differ from nonsmokers, the CBO analysis also compared current and former smokers with people who had never smoked, but had characteristics that were similar

to smokers. Among people who had ever smoked, between 11–16% of their health care spending was attributable to smoking.

Among former smokers in the CBO analysis, spending declined with longer time since quitting among those 45 years of age or older (Table 11.10*S*). Nevertheless, even among long-term quitters, spending remained higher than for never and current smokers.

Together, these and previous studies indicate that smoking increases the use and cost of health care (USDHHS 2004). Increases in utilization and cost are apparent in young smokers, and persist into old age. An important message for the public is that increases in utilization involve more than just physician visits; smokers are also at increased risk of hospitalization and nursing home stays, beginning at relatively young ages.

Workplace Absenteeism

Workplace absenteeism is a common and costly problem. In a 2003 analysis of the American Productivity Audit, health-related loss of productive time cost employers $225.8 billion per year, or $1,685 per employee per year (Stewart et al. 2003). The 2004 Surgeon General's report found consistent evidence that current smokers were more likely to be absent from work than never smokers (USDHHS 2004). Former smokers tended to have rates of absenteeism that were lower than current smokers and higher than never smokers, but there was some evidence that absenteeism rates varied by time since quitting; recent quitters tended to have higher absenteeism rates than long-term quitters.

A 2013 review of smoking and absence from work included several of the studies presented in the 2004 Surgeon General's report along with more recent studies (Weng et al. 2013). In a meta-analysis of 17 of the studies, current smokers were 33% more likely to have an absence from work than nonsmokers (i.e., a group that combined never smokers and former smokers).

As shown in Tables 11.11*S* and 11.12*S*, studies have assessed many different measures of absenteeism, including any absence during a specified time period (Sindelar et al. 2005), any short-term absence (Laaksonen et al. 2009), any long-term absence (Morikawa et al. 2004; Christensen et al. 2007), or total days lost (Halpern et al. 2001; Tsai et al. 2003, 2005; Bunn et al. 2006; Labriola et al. 2006; Lundborg 2007). Regardless of definition, current smokers have higher levels of absenteeism than never smokers. Amount smoked also appears to have an impact, with heavy smokers having higher levels of absenteeism than lighter smokers (Christensen et al. 2007; Laaksonen et al. 2009).

Overall, former smokers tend to have rates of absenteeism that are in between those of current smokers and those of never smokers. As for other outcomes, however, absenteeism tends to be most common among recent quitters and decrease with longer time since cessation. In a large study of U.S. workers, former smokers were 33% more likely to have had an absence in the last week than never smokers. The most recent quitters, however (i.e., those who had quit in the last 3 months), were more than three times more likely to have had an absence than never smokers. This level of absenteeism was substantially higher than in current smokers, perhaps because cessation resulted from the onset of smoking-related symptoms or disease. With longer time since quitting, absenteeism dropped below the level in current smokers, but remained higher than the level in never smokers. Former smokers who had quit at least 5 years previously were 21–24% more likely to have an absence than never smokers (Sindelar et al. 2005). A decrease in absenteeism, with longer time since quitting, was also reported in a study of U.S. petrochemical workers (Tsai et al. 2005).

Control of potential confounders varied across studies, and few of the absenteeism studies accounted for other lifestyle behaviors such as obesity, alcohol use, and physical activity. In a Swedish study (Lundborg 2007), information about obesity, alcohol use, and snuff use was available for part of the study period; a sensitivity analysis, which accounted for these factors, found that they did not substantially change the association between current smoking and absenteeism.

Evidence Synthesis

This section reviewed the evidence on smoking and general health. A broad range of health measures was considered, including self-reported health status and functional ability, health care utilization and cost, and workplace absenteeism. These measures were previously reviewed in the 2004 Surgeon General's report, and the current review updates and expands those findings. Overall, the evidence base on this broad topic has expanded and reaffirms the causal findings in the 2004 report on smoking and diminished health.

Although the measures of health assessed in this section are nonspecific and undoubtedly affected by many factors, the finding that smokers have poorer health than never smokers is highly consistent across studies and indicators. Smokers of different gender, age, and country of residence experience poorer physical and mental health and higher rates of workplace absenteeism than people who have never smoked. Similarly, studies of health care utilization and costs within the United States show that

smokers have higher rates of hospitalization, higher rates of nursing home admission, and higher total health care costs than never smokers. The strength of the associations of smoking with indicators of health status tended to be moderate with effect estimates ranging from just above unity to an approximate doubling of risk with variation by study and the measure of health used. Given the nonspecificity of the indicators considered, these associations are in a plausible and anticipated range. The nonspecificity of the outcomes considered also raises concern for potential uncontrolled confounding as underlying the observed associations. Many of the studies of smoking, in relation to general health, did adjust for a broad range of potential confounders and the associations with smoking persisted. Given the broad range of studies and the consideration of potential confounding in many, it is unlikely that confounding can completely explain the poorer health of smokers, a conclusion also reached in the 2004 report. A causal link between smoking and poorer health is further supported by the biologic plausibility of the relationship based on multiple potential mechanisms of injury reviewed in previous reports (USDHHS 2004, 2010) and evidence of a dose-response relationship. In the studies that assessed amount smoked, heavier smoking tended to be associated with a higher risk of poor health than lighter smoking.

In interpreting the evidence related to former smokers, consideration needs to be given to the temporal relationship between illness onset and the timing of cessation. Across the studies reviewed in this section, former smokers—particularly those who have recently quit—tend to have poor outcomes. This is likely the result of quitting ill; the poor health that is experienced by recent quitters often precedes—and contributes to—the decision to quit and smoking cessation. For example, among smokers enrolled in a managed care organization in Minnesota, inpatient charges, or high ambulatory care charges, were linked with subsequent quit attempts, implying that people with illness are motivated to quit (Martinson et al. 2003). Similarly, among smokers enrolled in a managed care organization in Washington state, costs among former smokers began to increase in the period prior to smoking cessation, before peaking in the quarter following cessation (Fishman et al. 2006). Among participants in a smoking cessation trial—all of whom were identified on the basis of a routine primary care visit—early costs were similar among successful quitters and continuing smokers, and costs among successful quitters dropped below those of continuing smokers by the sixth quarter post-quit (Hockenberry et al. 2012). Other studies also showed benefits for former smokers as the length of time since quitting increased (USDHHS 2004).

Conclusion

1. The evidence is sufficient to infer a causal relationship between smoking and diminished overall health. Manifestations of diminished overall health among smokers include self-reported poor health, increased absenteeism from work, and increased health care utilization and cost.

Implications

The relationship between smoking and health extends well beyond the growing number of recognized smoking-related diseases. Smokers experience diminished overall health, beginning at an early age and extending throughout adult life. The resulting health deficits affect not only smokers directly, but also their participation in the workplace and their costs to the health care system. The diminished health status of smokers has implications for multiple sectors in prevention and research.

For employers, the poorer health of smokers and the attendant costs have motivated some to stop hiring people who smoke, a strategy that has led some states to prohibit such hiring practices (Schmidt et al. 2013). Employers who have implemented such hiring practices have done so because of the increased costs of employing smokers (Schmidt et al. 2013). The ethics of such hiring bans remain a topic of debate (e.g., Schmidt et al. 2013 and Asch et al. 2013). The documented costs of hiring smokers may also be a motivation for employers to more aggressively assist their smoking employees to quit.

In general, the public has little specific awareness of the general consequences of smoking and how they begin with the onset of regular smoking. Consideration should be given as to whether, and how, the findings on the poorer health of smokers could be used to tailor messages to smokers. Any messages would need to be specific to age groups and directed at younger and older smokers. Youth should be aware that their health is affected from the start of smoking; older smokers should understand that a lifetime of smoking contributes not only to their risks for specific diseases, but also to their health, generally, and risk for nursing home admission. The effects of smoking cessation on various measures of general health warrant additional research. The poor health of recent quitters is likely explained by the phenomenon of quitting when ill, but there is little information about the health and health changes in people who quit when not ill. If health outcomes among these earlier quitters are better in both the

short- and long-term, the information would be useful in developing more powerful strategies to motivate current smokers not to delay a quit attempt.

Combinations of health behaviors and states—such as smoking, physical inactivity, and obesity—also warrant additional research attention. The magnitude of the association between combinations of high-risk behaviors and poor health can be quite large and may provide individuals with more complete information about their health risks.

Finally, incorporating information about general health into smoking prevention messages may broaden the reach of the messages. The effects of smoking on general health occur quickly after starting to smoke regularly and may be more salient—especially to younger people—than health problems that are expected to occur many years later. Even if smokers avoid a diagnosis of a smoking-caused disease, they face an increased risk of unnecessarily poor health.

All-Cause Mortality

Here, this chapter turns to mortality from all causes. This section first discusses the relationship between smoking and all-cause mortality and how the association has strengthened among current smokers during the last 50 years. It considers the fraction of all deaths among current and former smokers that may be caused by smoking, setting the stage for the attributable burden estimates provided in Chapter 12. Chapter 12 also provides estimates of the overall morbidity burden and economic costs associated with smoking in the United States.

The increased risk for all-cause mortality in smokers has been noted in multiple Surgeon General's reports with relevant conclusions (see Table 4.12*S*). Economic costs have also been addressed in previous reports, as estimated by the Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) program of the CDC (see Chapter 12).

The accelerated mortality in smokers, compared to never smokers, has been assessed in large prospective cohort studies and is usually estimated either by comparing annual death rates (per 100,000 or per 10,000 per year) across categories of smoking status controlling for age, or by contrasting the percentages of individuals who survive to various attained ages in relation to smoking behavior. Death rates in smokers can be compared with rates in never smokers using the relative risk (RR) (i.e., the age-specific or age-adjusted death rate in smokers divided by that of never smokers) and the rate difference (i.e., the age-specific or age-adjusted death rate in smokers minus that of never smokers). Alternatively, the differences in life expectancy between current, former, and never smokers can be examined using survival curves, as illustrated by Pearl's 1938 figure (Figure 11.1).

Although the discussion on all-cause mortality presented in this chapter has focused primarily on RRs, differences in death rates per 100,000 by smoking status (never and current) are also informative. Such differences show the additional burden sustained at the population level because of smoking. Both rate differences and RRs for all-cause mortality and the five main causes of death in the pooled contemporary cohort of U.S. men and women 55 years of age and older from the United States are shown in Tables 11.13 and 11.14. This pooled contemporary cohort analysis includes follow-up time from 2000–2010 from five individual U.S. cohort studies as described by Thun and colleagues (2013). The analyses shown in Tables 11.13 and 11.14 (provided to CDC's Office on Smoking and Health by investigators from the contributing cohorts) include an additional 2 years of follow-up (2009–2010) that became available from the American Cancer Society (ACS) Cancer Prevention Study II (CPS-II) Nutrition Cohort after the original publication (Thun et al. 2013), and updated outcome information from the WHI cohort.

For all-cause death rates, the rates of dying are much higher within each age stratum (55–64, 65–74, and 75 years of age and older) and smoking stratum for men than women; however, the ratios of death rates between never smokers and current smokers within each age strata are very similar for men and women. For lung cancer, the death rates for never smokers increase with age for both men and women and are comparable. However, the lung cancer death rate among current smokers increases dramatically by age, as does the RR, for both men and women. For coronary heart disease (CHD), the pattern is somewhat different. The death rates among male never smokers is much higher within each age strata in comparison with females. The death rates among current smokers also increase with age, but at a somewhat slower rate than among never smokers; hence, the RRs for CHD are slightly smaller in men and women 75 years of age and older.

Table 11.13 All-cause mortality and five main causes of death by smoking status: death rates per 100,000 among men of Cancer Prevention Study II Nutrition Cohort, Health Professional Follow-Up Study, National Household Survey, National Institutes of Health-AARP Diet and Health Study, and Women's Health Initiative, 2000–2010

	Never-smoker			Current smoker				
	Number of deaths	Person-years	Death rate† (/100,000)	Number of deaths	Person-years	Death rate (/100,000)	Rate difference (/100,000)	RR (95% CI) current versus never smoker‡
All Causes								
Age 55–64	1,182	253,125	401.81	1,170	74,157	1,409.96	1,008.15	2.92 (2.69–3.18)
Age 65–74	6,495	586,441	1,075.35	4,011	110,799	3,619.35	2,544.00	3.00 (2.89–3.13)
Age ≥75	11,312	328,189	4,988.58	1,855	26,789	10,169.60	5,181.03	2.36 (2.24– 2.48)
Lung Cancer[1]								
Age 55–64	34	253,125	12.70	232	74,157	279.94	267.24	19.03 (13.19–27.47)
Age 65–74	147	586,441	24.00	891	110,799	804.05	780.05	28.29 (23.72–33.74)
Age ≥75	190	328,189	69.97	354	26,789	1,557.64	1,487.67	22.52 (18.83–26.92)
COPD[2]								
Age 55–64	2	253,125	0.48	68	74,157	80.61	80.13	84.79 (20.65–348.23)
Age 65–74	55	586,441	9.12	367	110,799	331.13	322.01	29.70 (22.31–39.53)
Age ≥75	137	328,189	61.72	233	26,789	1,378.06	1,316.34	23.01 (18.56–28.51)
Total Stroke[3]								
Age 55–64	40	253,125	13.03	28	74,157	30.52	17.48	2.07 (1.25–3.41)
Age 65–74	310	586,441	50.42	137	110,799	123.61	73.20	2.17 (1.77–2.66)
Age ≥75	748	328,189	356.66	72	26,789	501.14	144.48	1.48 (1.16–1.88)
Coronary Heart Disease[4]								
Age 55–64	216	253,125	72.96	235	74,157	265.88	192.91	2.99 (2.47–3.62)
Age 65–74	1,256	586,441	207.26	738	110,799	665.93	458.67	2.76 (2.52–3.03)
Age ≥75	2,381	328,189	1,073.69	332	26,789	1,944.94	871.25	1.98 (1.76–2.22)
Other Heart Diseases[5]								
Age 55–64	45	253,125	14.24	38	74,157	39.25	25.01	2.50 (1.60–3.89)
Age 65–74	395	586,441	65.51	180	110,799	162.42	96.91	2.22 (1.85–2.66)
Age ≥75	883	328,189	438.57	93	26,789	565.77	127.21	1.66 (1.33–2.06)

Source: Updated analyses of the pooled contemporary cohort population described in Thun et al. 2013 provided to CDC's National Center for Chronic Disease.

Note: **CDC** = Centers for Disease Control and Prevention; **COPD** = chronic obstructive pulmonary disease; **ICD** = International Classification of Diseases.

†Rates per 100,000 person-years adjusted to the U.S. 2000 population standard within age strata.

‡Results from Cox proportional hazards models adjusted for age, cohort, race, and education.

[1]Lung cancer includes *ICD-10* codes C33, C34.

[2]COPD includes *ICD-10* codes J40–J44.

[3]Total stroke includes *ICD-10* codes I60–I69.

[4]Coronary heart disease includes *ICD-10* codes I20–I25.

[5]Other heart disease includes *ICD-10* codes I00–I09, I26–I51.

Table 11.14 All-cause mortality and five main causes of death by smoking status: death rates per 100,000 among women of Cancer Prevention Study II Nutrition Cohort, Health Professional Follow-Up Study, National Household Survey, National Institutes of Health-AARP Diet and Health Study, and Women's Health Initiative, 2000–2010

	Never smoker			Current smoker				
	Number of deaths	Person-years	Death rate† (/100,000)	Number of deaths	Person-years	Death rate (/100,000)	Rate difference (/100,000)	RR (95% CI) current versus never smoker‡
All Causes								
Age 55-64	1,542	459,118	309.45	1,023	107,168	865.82	556.37	2.64 (2.43–2.86)
Age 65-74	8,125	1,095,878	723.01	3,686	164,575	2,243.97	1,520.96	2.87 (2.76–2.99)
Age ≥75	17,029	758,352	3,024.22	2,375	50,469	6,589.07	3,564.86	2.47 (2.37–2.58)
Lung Cancer[1]								
Age 55–64	52	459,118	10.12	248	107,168	208.62	198.50	18.95 (13.99–25.66)
Age 65–74	236	1,095,878	21.24	894	164,575	544.08	522.83	23.65 (20.46–27.35)
Age ≥75	340	758,352	53.43	502	50,469	1,121.49	1,068.05	23.08 (20.07–26.55)
COPD[2]								
Age 55–64	8	459,118	1.05	56	107,168	40.13	39.08	22.58 (10.71–47.60)
Age 65–74	55	1,095,878	4.86	368	164,575	224.12	219.26	38.89 (29.24–51.73)
Age ≥75	241	758,352	44.61	285	50,469	779.15	734.55	20.96 (17.60–24.96)
Total Stroke[3]								
Age 55–64	44	459,118	9.40	34	107,168	27.89	18.49	3.27 (2.07–5.18)
Age 65–74	486	1,095,878	42.38	170	164,575	103.60	61.22	2.27 (1.90–2.72)
Age ≥75	1,560	758,352	286.94	138	50,469	443.08	156.14	1.70 (1.43–2.03)
Coronary Heart Disease[4]								
Age 55–64	132	459,118	24.90	113	107,168	91.37	66.46	3.25 (2.51–4.21)
Age 65–74	908	1,095,878	80.26	490	164,575	298.40	218.13	3.29 (2.94–3.68)
Age ≥75	2,432	758,352	456.94	287	50,469	825.95	369.00	2.25 (1.99–2.55)
Other Heart Diseases[5]								
Age 55–64	97	459,118	16.69	36	107,168	29.10	12.41	1.49 (1.00–2.20)
Age 65–74	489	1,095,878	43.10	141	164,575	85.86	42.75	1.85 (1.53–2.24)
Age ≥75	1,363	758,352	267.53	119	50,469	410.68	143.15	1.75 (1.45–2.11)

Source: Updated analyses of the pooled contemporary cohort population described in Thun et al. 2013 provided to CDC's National Center for Chronic Disease.

Note: **CDC** = Centers for Disease Control and Prevention; **COPD** = chronic obstructive pulmonary disease; **ICD** = International Classification of Diseases.

†Rates per 100,000 person years adjusted to the U.S. 2000 population standard within age strata.

‡Results from Cox proportional hazards models adjusted for age, cohort, race, and education.

[1]Lung cancer includes *ICD-10* codes C33, C34.

[2]COPD includes *ICD-10* codes J40–J44.

[3]Total stroke includes *ICD-10* codes I60–I69.

[4]Coronary heart disease includes *ICD-10* codes I20–I25.

[5]Other heart disease includes *ICD-10* codes I00–I09, I26–I51.

Temporal Trends in Relative Risk for All-Cause Mortality

The RR value for all-cause mortality associated with current cigarette smoking has increased over the last 50 years as generations of smokers who began smoking as adolescents and continued to smoke into middle and older ages have incurred the consequences of persistent lifetime smoking (see Chapter 13). The 1964 Surgeon General's report discussed all-cause mortality in men, but not women (USDHEW 1964). Only two (Doll and Hill 1964; Hammond 1964) of the seven (Hammond and Horn 1958; Dunn et al. 1960, n.d.; Best et al. 1961; Doll and Hill 1964; Hammond 1964; Kahn 1966) large prospective cohort studies available at the time included substantial numbers of women. Among male smokers, the all-cause death rate was approximately 70% higher in those who smoked cigarettes only, and not other tobacco products, than in never smokers (RR = 1.68). The RR estimates ranged from 1.44 during the first 10 years of follow-up of the British Doctors Study (Doll and Hill 1964) to 1.83 during the first 22 months of follow-up of the ACS cohort study, CPS-I (Hammond, n.d.). The all-cause RR was highest in men who smoked cigarettes only and increased with daily cigarette consumption, duration of smoking, and earlier age at initiation; the all-cause RR decreased with the number of years since quitting.

The first systematic analysis of temporal changes in the RR for all-cause mortality associated with smoking was published in the 1989 Surgeon General's report (USDHHS 1989*)*. The 1989 report compared the RR values for cause-specific and all-cause mortality associated with current and former smoking during the first 6 years of follow-up of CPS-I (1959–1965) to the first 4 years of CPS-II (1982–1986). The analyses were based on approximately 1 million adults in CPS-I and 1.2 million in CPS-II who were 35 years of age or older. Among current male smokers, the all-cause RR increased from 1.80 (95% CI, 1.75–1.85) in CPS-I to 2.34 (95% CI, 2.26–2.43) in CPS-II. The corresponding increase in current female smokers was from 1.23 (95% CI, 1.18–1.28) in CPS-I to 1.90 (95% CI, 1.82–1.98) in CPS-II.

The RR values for all-cause mortality associated with current cigarette smoking have continued to increase into the twenty-first century. Thun and colleagues (2013) compared the risk difference and RR values associated with current and former cigarette smoking among men and women 55 years of age and older in three time periods (1959–1965, 1982–1988, and 2000–2010), based on the two historical ACS cohorts, CPS-I and CPS-II, and pooled analyses of five contemporary cohorts. The latter included the National Institutes of Health-AARP Diet and Health Study (Schatzkin et al. 2001), CPS-II Nutrition Cohort (Calle et al. 2002) (a subset of the original CPS-II mortality study), WHI (Hays et al. 2003; Anderson et al. 2003), NHS (Colditz et al. 1997), and Health Professionals Follow-up Study (Rimm et al. 1995). In total, the analysis included more than 2.2 million adults 55 years of age and older. For each cohort, updated smoking information had been collected at least once during the period 2000–2010. Among women, the multivariable-adjusted rates ratio for death from all causes in current versus never smokers increased from 1.35 (95% CI, 1.30–1.40) in CPS-I to 2.08 (95% CI, 2.02–2.14) in CPS-II to 2.76 (95% CI, 2.69–2.84) in the contemporary cohorts (Table 11.1*S*). Among men, the corresponding increase in rates ratio was from 1.76 (95% CI, 1.71–1.81) in CPS-I to 2.33 (95% CI, 2.26–2.40) in CPS-II to 2.80 (95% CI, 2.72–2.88) in the contemporary cohorts. The RR values associated with current smoking were highest in middle age for men, exceeding 3.0 among men 55–74 years of age and in women 60–70 years of age. The convergence of the RR values associated with all-cause mortality for men and women, over the span of the studies, was attributed to the convergence of male and female smoking patterns since the 1960s (Anderson and Burns 2001; USDHHS 2001) and the aging of birth cohorts with the heaviest lifetime smoking.

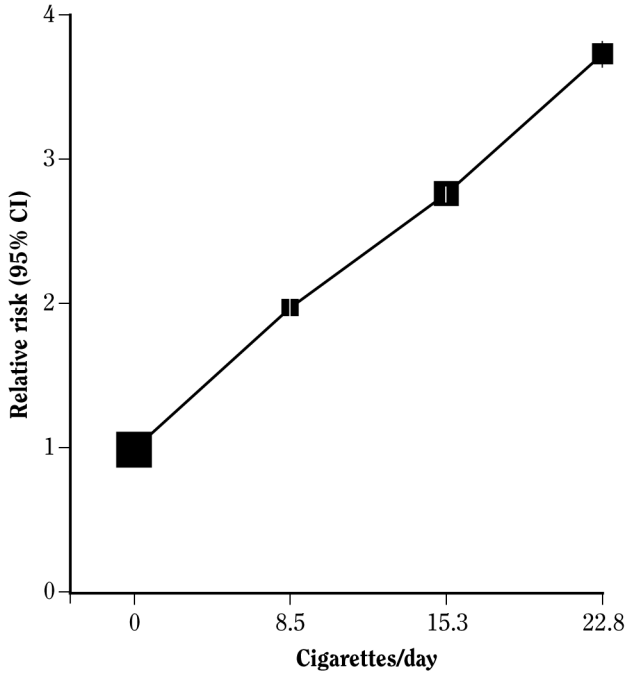
A similar temporal increase in the RR for all-cause mortality was observed in analyses of the 40-year follow-up data from the British Doctors Study, which compared the RRs associated with current versus never smokers during the first (1951–1971) and last (1971–1991) 20 years of the study (Doll et al. 1994). The all-cause RR during the first 20 years of the study was 1.62, when averaged across all ages, and increased to 2.06 in the second 20 years. Similar analyses conducted at the 50-year follow-up of the British Doctors Study compared smoking-related mortality among doctors born in the nineteenth century (1851–1899) to those born in the twentieth century (1900–1929) (Doll et al. 2004). The all-cause RR for men who reported smoking cigarettes, exclusively, were 1.46 for those born in the nineteenth century and 2.19 for those born in the twentieth century.

The Million Women Study in the United Kingdom provides another recent assessment of the mortality risk associated with smoking. The all-cause RR associated with current smoking in the Million Women Study (Pirie et al. 2013) is similar to that in the contemporary U.S. cohorts. In this study, 1.3 million women in the United Kingdom were recruited in 1996–2001 and resurveyed by mail about 3 and 8 years later. After a median of 12 years of follow-up, women who reported current smoking at baseline had almost three times the mortality rate of never smokers (RR = 2.76; 95% CI, 2.71–2.81). The RR

was slightly higher (RR = 2.97; 95% CI, 2.71–2.81) among women who reported smoking cigarettes, both at baseline and 3 years later at resurvey, although, even among these, many would have stopped smoking during the remaining follow-up. The risks among smokers increased steeply with the amount smoked (Figure 11.2), but even those smoking 1–9 cigarettes daily at baseline (mean of 8 cigarettes per day) had twice the overall mortality rate of never smokers. For former smokers, those who stopped at 45–54, 35–44, 25–34, and under 25 years of age (corresponding to around 50, 40, 30, or 20 years of age) had progressively lower all-cause RR values (Figure 11.3). Women who quit smoking by about 30 years of age avoided approximately 95% of the excess risk compared to those who continued to smoke (Pirie et al. 2013).

In the Life Span Study of Japanese atomic bomb survivors, Sakata and colleagues (2012) reported the impact of smoking on mortality in this prospective cohort study of atomic bomb survivors and a comparison group from Hiroshima and Nagasaki. The study was initiated in 1950 and smoking status was ascertained during 1963–1992. The authors found that the overall death rate ratio for current male smokers, compared to never smokers, differed by period of birth: 1.46 (95% CI, 1.38–1.54) for men born before 1920 and 1.89 (95% CI, 1.70–2.10) for men born during 1920–1945. A similar trend was observed among female smokers (Table 11.1*S*). For those born during 1920–1945 and starting to smoke continuously before age 20, overall mortality was more than doubled in both genders (i.e., rate ratios vs. never smokers: men, 2.21 [95% CI, 1.97–2.48]; women, 2.61 [95% CI, 1.98–3.44]); life expectancy was reduced by almost a decade (8 years for men, 10 years for women) (Sakata et al. 2012).

Figure 11.2 Relative risk for all-cause mortality among female current versus never smoker by amount smoked at recruitment



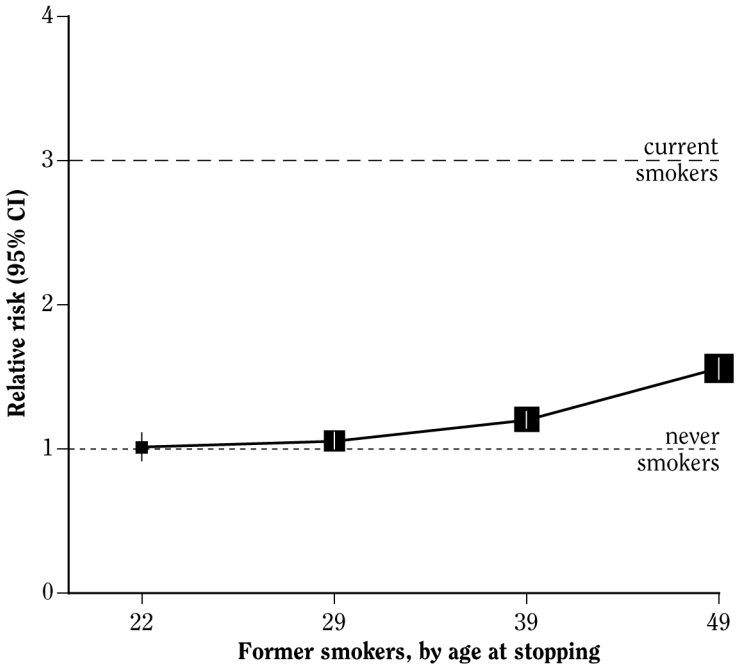
Source: Million Women Study; Pirie et al. 2013. Reprinted with permission from Elsevier, © 2013.
Note: **CI** = confidence interval.

Temporal Trends in Survival

Pearl (1938) found that the median survival of White males, recorded as heavy smokers in the Family History Records at Johns Hopkins, was approximately 7 years shorter than that of men recorded as nonsmokers (Figure 11.1). The 1968 Surgeon General's report on smoking and health estimated smoking-related loss of life expectancy as 8 years for heavy smokers (i.e., more than two packs per day) and 4 years for light smokers (i.e., less than ½ pack per day) (USDHEW 1968). Similar estimates were derived from the 40-year follow-up of the British Doctors Study (Doll et al. 1994) (Figure 11.4). On average during the full follow-up, median survival among men who reported being current cigarette smokers was 7.5 years shorter than among those who reported never having smoked, but the gap increased during the 40 years. Doctors who reported current smoking, during the first 20 years of the study lost an average of 5 years of life; this increased to an average loss of 8 years of life during the second 20 years of the study (Figure 11.5) (Doll et al. 2004). In the 50-year follow-up, those born in the twentieth century who smoked from an earlier age and more intensely than those born in the nineteenth century had a greater loss of life expectancy (Figure 11.5) (Doll et al. 2004).

A similar relationship between smoking and survival was reported by Jha and colleagues (2013) in an analysis of over 215,000 adults in the U.S. National Health Interview Survey during follow-up from 1997 and 2004 (Figure 11.6). Among women participating in this nationally representative survey, the estimated probability of survival to 80 years of age was 70% (99% CI, 64–76) for those who never smoked, but only 26% (99% CI, 18–33) for male current smokers. Compared to never smokers, current smokers lost an average of about 11 years for women and about 12 years of life for men. Some individual smokers will lose far more years of life than these population average figures.

Figure 11.3 Relative risk for all-cause mortality among female former versus current smokers by age at stopping



Age at stopping (mean), years	<25 (22)	25–34 (29)	35–44 (39)	45–54 (49)
Number of deaths	481	1,523	1,814	2,095
RR (95% CI)	1.01 (0.92–1.11)	1.05 (1.00–1.11)	1.20 (1.14–1.26)	1.56 (1.49–1.64)

Source: Million Women Study; Pirie et al. 2013. Reprinted with permission from Elsevier, © 2013.
Note: **CI** = confidence interval; **RR** = relative risk.

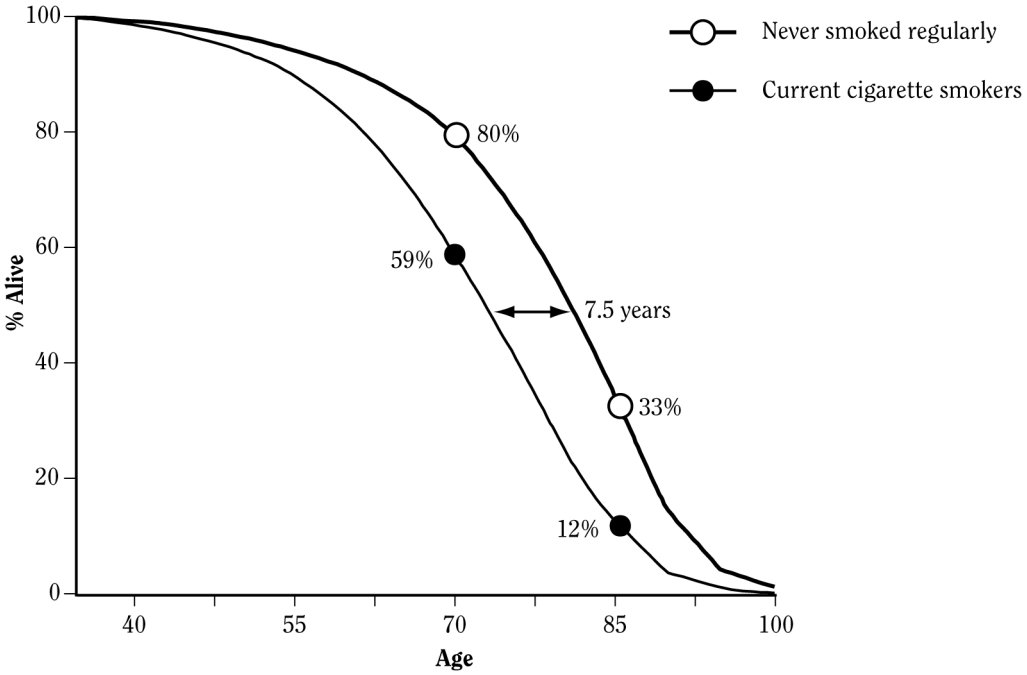
Explanation for the Temporal Trends in Relative Risk and Survival

Several factors contribute to the widening difference in survival between current and never smokers over the last 50 years. First, the death rates from lung cancer and chronic obstructive pulmonary disease (COPD), two major smoking-caused diseases, have increased among men and women who smoke, as generations of men, and later women, who began smoking in childhood and adolescence reach the ages at which the diseases caused by smoking have high incidence. The mortality risks from both diseases continue to increase in women who smoke; whereas, the lung cancer risk among male cigarette smokers appears to have plateaued at a high level since the 1980s, while COPD mortality continues to increase (Thun et al. 2013).

Second, smokers have not kept pace with the improvements in survival experienced by former and never smokers since the mid-twentieth century. For women who continue to smoke, the increasing risks from lung cancer and COPD have almost completely offset improvements in survival due to advances in prevention and treatment over the past 50 years. In male smokers, the decrease in cardiovascular mortality has been smaller, proportionately, than in never and former smokers. It is possible that some of the increase in the RR, over time, reflects changing patterns of confounding, which have not been fully accounted for in analysis. An analysis of CPS-II data for 1982–1988 showed that observed associations with smoking were only minimally altered by adjustment for a set of confounding factors compared with age-adjustment alone. This analysis, however, did not address changes in patterns of confounding over time (Malarcher et al. 2000; Thun et al. 2000; Schatzkin et al. 2001).

The premature deaths among smokers in contemporary studies result chiefly from diseases known to be caused by smoking, such as lung cancer, COPD, heart

Figure 11.4 Survival after 35 years of age among smokers and nonsmokers



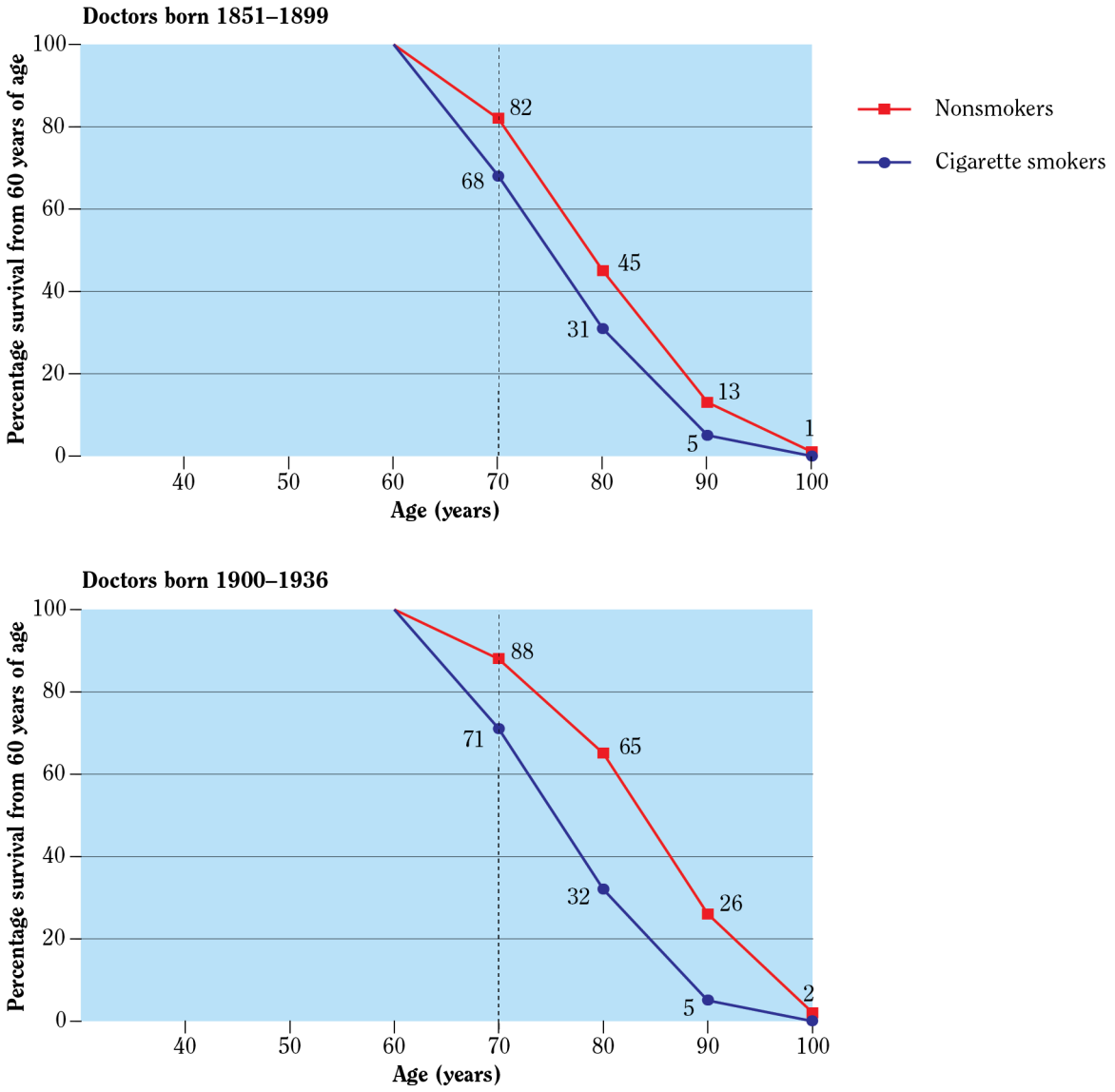
Source: Doll et al. 1994. Reprinted with permission from BMJ Publishing Group Ltd., © 1994.
Note: Overall survival after 35 years of age among British doctors recorded as cigarette smokers and nonsmokers during 40-year follow-up. Life tables are based on age-specific death rates for the entire 40-year period (Chahine et al. 2011). According to 1990 British death rates, 97% of male infants would survive from birth to 35 years of age.

disease, stroke, or other neoplastic, respiratory or vascular diseases. Studies of random samples of participants in the Million Women Study (Pirie et al. 2013) found little difference between smokers and others when potential confounding factors such as blood pressure or lipid profile were examined. Other factors, such as alcohol intake, body mass index, and socioeconomic status, were adjusted for in the analyses. Thus, most of the excess mortality associated with smoking appears to be caused directly by smoking and not by confounding. However, for some associations, such as suicide or liver cirrhosis, the association may largely reflect noncausal pathways (Doll et al. 2004).

Evidence Synthesis

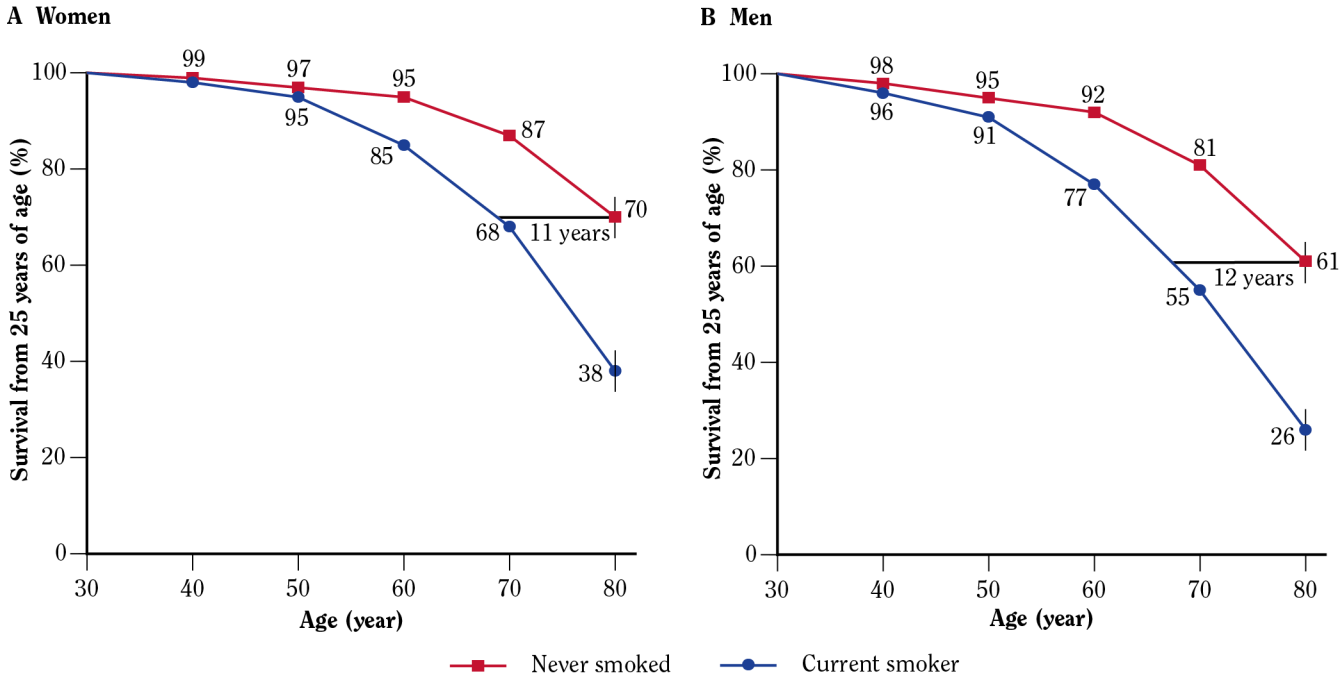
Increased all-cause mortality is a well-established causal consequence of smoking (USDHHS 2004). Evidence reviewed in this report shows that the association between active cigarette smoking and death from all causes has strengthened in both men and women since the 1964 Surgeon General's report. The age-standardized RR, comparing the all-cause death rate in current smokers to that of never smokers, has more than doubled in men and more than tripled in women during this 50-year period. At some ages, the increases for current smokers compared with never smokers are far greater, at least three times higher for men 55–74 years of age and women 60–70 years of age. Life-shortening by smoking is substantial. Smokers lose an estimated decade of life. Smoking cessation by 40 years of age reduces that loss by about 90%. Even stopping by about 60 years of age reduces the loss by 40%. Reductions in the number of cigarettes smoked per day are much less effective than smoking cessation in avoiding the mortality risks from smoking (USDHHS 2004, 2010). Based on these temporal trends in risk, changes in the design of cigarettes that reduced the tar and nicotine yield of cigarettes, as measured by smoking machines, did not prevent these increases in risk (USDHHS 2004, 2010).

Figure 11.5 Survival after 60 years of age for smokers and never smokers



Source: Doll et al. 2004. Reprinted with permission from BMJ Publishing Group Ltd., © 2004.
Note: Survival from 60 years of age for continuing cigarette smokers and never smokers among United Kingdom male doctors born 1851–1899 (median 1889) and 1900–1930 (median 1915), with percentages alive at each decade of age (Thun et al. 1997).

Figure 11.6 Survival probabilities for current smokers and never smokers for women and men



Source: Jha et al. 2013. Reprinted with permission from Massachusetts Medical Society, © 2013.
Note: Survival probabilities for current smokers and never smokers among men and women 25–80 years of age. The vertical lines at 80 years of age represent the 99% cumulative survival probabilities, as derived from the standard errors estimated with use of the jackknife procedure. Survival probabilities have been scaled from the National Health Interview Survey to the U.S. rates of death from all causes at these ages for 2004, with adjustments for differences in age, educational level, alcohol consumption, and adiposity (body mass index).

Summary

The evidence reviewed in this chapter reaffirms that smoking is a major cause of premature mortality and avoidable morbidity. Although emphasis has long been given to smoking as a cause of specific diseases, it is a powerful cause of ill-health generally, which reduces the quality of life of smokers and increases health care costs. The lives of smokers are cut short by the development of the many diseases caused by smoking and their greater risk of dying from common health events, such as complications of routine surgeries and pneumonia.

Conclusions

1. The evidence is sufficient to infer that cigarette smoking increases risk for all-cause mortality in men and women.

2. The evidence is sufficient to infer that the relative risk of dying from cigarette smoking has increased over the last 50 years in men and women in the United States.

Chapter Conclusions

1. The evidence is sufficient to infer a causal relationship between smoking and diminished overall health. Manifestations of diminished overall health among smokers include self-reported poor health, increased absenteeism from work, and increased health care utilization and cost.
2. The evidence is sufficient to infer that cigarette smoking increases risk for all-cause mortality in men and women.
3. The evidence is sufficient to infer that the relative risk of dying from cigarette smoking has increased over the last 50 years in men and women in the United States.

Implications

The increased risk of death among smokers is already a widely recognized consequence of smoking by the general public and health care professionals. This report shows that this risk is increasing, particularly among women, and threatens continuing gains in life expectancy. This information needs to be disseminated widely and effectively, reaching men and women and those who provide their health care.

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