Chapter 10
Control of Secondhand Smoke Exposure

Introduction

This chapter examines measures to control exposure to secondhand smoke in public places, workplaces, and homes, including legislation, education, and approaches based on building designs and operations. The discussion reviews progress toward smoke-free indoor spaces in the United States during the past three decades, including approaches that have been employed to reduce exposure, in the context of extensive scientific evidence on health effects and control measures. Table 10.1 provides a chronology of some landmark or exemplary efforts at all levels of government to limit exposure to secondhand smoke.

Historical Perspective

Over the past three decades, substantial progress has been made to control secondhand smoke exposure. The number of public and workplace policies restricting or not allowing smoking has increased; concomitantly, the prevalence of reported exposure to secondhand smoke in public places and workplaces has progressively declined, and the levels of the biomarker cotinine have fallen among U.S. nonsmokers. Cotinine levels dropped sharply during the 1990s, particularly among adults (Centers for Disease Control and Prevention [CDC] 2003). This trend stems from voluntary actions by employers and businesses, declining smoking prevalence, changing patterns of smoking in homes, and increasingly comprehensive and stringent government regulations at the local, state, and national levels (U.S. Department of Health and Human Services [USDHHS] 2000c). The findings and conclusions of previous Surgeon General's reports and other governmental scientific reports have played a critical role in supporting efforts to reduce secondhand smoke exposure, especially policy initiatives. These findings have been frequently cited by persons implementing policy changes.

The first Surgeon General's report to systematically review existing evidence on the health effects of secondhand smoke was the 1972 report, *The Health Consequences of Smoking* (U.S. Department of Health, Education, and Welfare [USDHEW] 1972). This report concluded that an atmosphere contaminated with tobacco smoke could cause discomfort in many persons, and levels of carbon monoxide (CO) measured in experiments in rooms filled with cigarette smoke could, on occasion, be harmful, particularly for individuals with preexisting diseases such as chronic obstructive pulmonary disease and coronary heart disease (CHD) (USDHEW 1972). Thus, the 1972 report raised the possibility that secondhand smoke could be detrimental to the health of some segments of the population. However, this report did not prompt widespread policy changes.

The 1986 report of the Surgeon General, *The Health Consequences of Involuntary Smoking* (USDHHS 1986), has had a great impact on tobacco control policy. It was the first report to focus exclusively on secondhand smoke and remains a milestone in the history of translating scientific evidence on secondhand smoke into policy initiatives. The report reached the following three major conclusions:

1. Involuntary smoking is a cause of disease, including lung cancer, in healthy nonsmokers.

2. The children of parents who smoke, compared with the children of nonsmoking parents, have an increased frequency of respiratory infections, increased respiratory symptoms, and slightly smaller rates of increase in lung function as the lung matures.

3. Simple separation of smokers and nonsmokers within the same air space may reduce, but does not eliminate, exposure of nonsmokers to environmental tobacco smoke (p. vii).

Although the 1986 Surgeon General's report had no direct regulatory consequences at the federal level,

Table 10.1 Summary of milestones in establishing clean indoor air policies in the United States

Year	Event
1971	The Surgeon General proposes a federal smoking ban in public places.
1972	The first report of the Surgeon General to identify secondhand smoke as a health risk is released.
1973	Arizona becomes the first state to restrict smoking in several public places. The Civil Aeronautics Board requires no-smoking sections on all commercial airline flights.
1974	Connecticut passes the first state law to apply smoking restrictions in restaurants.
1975	Minnesota passes a statewide law restricting smoking in public places.
1977	Berkeley, California becomes the first community to limit smoking in restaurants and other public places.
1983	San Francisco passes a law to place private workplaces under smoking restrictions.
1986	A report of the Surgeon General focuses entirely on the health consequences of involuntary smoking, proclaiming secondhand smoke a cause of lung cancer in healthy nonsmokers. The National Academy of Sciences issues a report on the health consequences of involuntary smoking. Americans for Nonsmokers' Rights becomes a national group; it had originally formed as California GASP (Group Against Smoking Pollution).
1987	The U.S. Department of Health and Human Services establishes a smoke-free environment in all of its buildings, affecting 120,000 employees nationwide. Minnesota passes a law requiring all hospitals in the state to prohibit smoking by 1990. A Gallup Poll finds, for the first time, that a majority (55 percent) of all U.S. adults favor a complete ban on smoking in all public places.
1988	A congressionally mandated smoking ban takes effect on all domestic airline flights of two hours or less. New York City's ordinance for clean indoor air takes effect; the ordinance bans or severely limits smoking in various public places and affects 7 million people. California implements a statewide ban on smoking aboard all commercial intrastate airplanes, trains, and buses.
1990	A congressionally mandated smoking ban takes effect on all domestic airline flights of six hours or less. The U.S. Environmental Protection Agency (EPA) issues a risk assessment draft on secondhand smoke.
1991	The National Institute for Occupational Safety and Health issues a bulletin recommending that secondhand smoke be reduced to the lowest feasible concentration in the workplace.
1992	Hospitals applying for accreditation to the Joint Commission on Accreditation of Healthcare Organizations are required to develop a policy prohibiting smoking by patients, visitors, employees, volunteers, and medical staff. The U.S. EPA releases its report classifying secondhand smoke as a Group A (known to be harmful to humans) carcinogen, placing secondhand smoke in the same category as asbestos, benzene, and radon.

Table 10.1 Continued

Year	Event
1993	Los Angeles passes a ban on smoking in all restaurants.
	The U.S. Postal Service eliminates smoking in all facilities.
	Congress enacts a smoke-free policy for Special Supplemental Food Program for Women, Infants, and Children (WIC) clinics.
	A working group of 16 state attorneys general releases recommendations for establishing smoke-free policies in fast-food restaurants.
	Vermont bans smoking in all public buildings and in many private buildings open to the public.
1994	The U.S. Department of Defense prohibits smoking in all indoor military facilities.
	The Occupational Safety and Health Administration proposes a rule that would ban smoking in most U.S. workplaces.
	San Francisco passes a ban on smoking in all restaurants and workplaces.
	The *Pro-Children Act* requires persons who provide federally funded children's services to prohibit smoking in those facilities.
	Utah enacts a law restricting smoking in most workplaces.
1995	New York City passes a comprehensive ordinance effectively banning smoking in most workplaces.
	Maryland enacts a smoke-free policy for all workplaces except hotels, bars, some restaurants, and private clubs.
	California passes comprehensive legislation that prohibits smoking in most enclosed workplaces.
	Vermont's smoking ban is extended to include restaurants, bars, hotels, and motels, except for those establishments holding a cabaret license.
1996	The U.S. Department of Transportation reports that about 80 percent of nonstop scheduled U.S. airline flights between the United States and foreign points will be smoke-free by June 1, 1996.
1997	President Clinton signs an executive order establishing a smoke-free environment for federal employees and all members of the public visiting federally owned facilities.
	The California EPA issues a report determining that secondhand smoke is a toxic air contaminant.
	Settlement is reached in the class action lawsuit brought by flight attendants exposed to secondhand smoke.
1998	The U.S. Senate ends smoking in the Senate's public spaces.
	California law takes effect banning smoking in bars that do not have a separately ventilated smoking area.
	The Minnesota tobacco document depository is created as a result of the tobacco industry settlement with the State of Minnesota and BlueCross BlueShield of Minnesota. U.S. tobacco companies are required to maintain a public depository to house more than 32 million pages of previously secret internal tobacco industry documents.

Table 10.1 Continued

Year	Event
2000	The New Jersey Supreme Court strikes down a local clean indoor air ordinance adopted by the city of Princeton on the grounds that state law preempts local smoking restrictions. A congressionally mandated smoking ban takes effect on all international flights departing from or arriving in the United States.
2002	New York City holds its first hearing on an indoor smoking ban that would include all bars and restaurants. The amended *Clean Indoor Air Act* enacted by the state of New York (Public Health Law, Article 13-E), which took effect July 24, 2003, prohibits smoking in virtually all workplaces, including restaurants and bars. The Michigan Supreme Court refuses to hear an appeal of lower court rulings striking down a local clean indoor air ordinance enacted by the city of Marquette, on the grounds that state law preempts local communities from adopting smoking restrictions in restaurants and bars that are more stringent than the state standard. Delaware enacts a comprehensive smoke-free law, and repeals a preemption provision precluding communities from adopting local smoking restrictions that are more stringent than state law. Florida voters approve a ballot measure that amends the state constitution to require most workplaces and public places, with some exceptions such as bars, to be smoke-free.
2003	Dozens of U.S. airports, including airline clubs, passenger terminals, and nonpublic work areas, are designated as smoke-free. Connecticut and New York enact comprehensive smoke-free laws. Maine enacts a law requiring bars, pool halls, and bingo venues to be smoke-free. State supreme courts in Iowa and New Hampshire strike down local smoke-free ordinances, ruling that they are preempted by state law.
2004	Massachusetts and Rhode Island enact comprehensive smoke-free laws. The International Agency for Research on Cancer issues a new monograph identifying secondhand smoke as "carcinogenic to humans."

Table 10.1 Continued

Year	Event
2005	The Centers for Disease Control and Prevention issues the *Third National Report on Human Exposure to Environmental Chemicals,* which documents that cotinine levels decreased 68 percent for children, 69 percent for adolescents, and 75 percent for adults from the early 1990s to 2002. Illinois becomes the second state, after Delaware, to completely repeal a state preemption provision precluding local smoking restrictions that are more stringent than the state standard. Illinois also became the first state to repeal a provision of this kind as a stand-alone action; Delaware had done so in conjunction with the enactment of a comprehensive statewide smoke-free law. Washington state passes Initiative Measure 901 (Clean Indoor Air Act). Montana enacts legislation that makes most workplaces and restaurants smoke-free. North Dakota enacts legislation that makes most workplaces smoke-free. Georgia enacts a law that makes some workplaces and public places, including some restaurants, smoke-free. The Georgia law allows communities to continue to enact more comprehensive local smoke-free ordinances. Vermont, which already has a law in place making restaurants smoke-free, enacts a provision making bars smoke-free as well. Maine, which has already made restaurants and bars smoke-free, strengthens its smoking restrictions in workplaces. A comprehensive Rhode Island law enacted in 2004 that makes workplaces, restaurants, and bars smoke-free took effect, and was further strengthened through the removal of two temporary exemptions.
2006	The District of Columbia enacts legislation requiring most workplaces and public places to be smoke-free. Bars and bar areas in restaurants are required to be smoke-free as of January 1, 2007. Colorado and New Jersey enact legislation requiring most workplaces and public places, including restaurants and bars, to be smoke-free. Both laws exempt casino floor areas. Utah, which already had a law in place mandating smoke-free restaurants, enacts legislation requiring most workplaces and bars to also be smoke-free. Arkansas enacts legislation requiring many workplaces and public places to be smoke-free; restaurants and bars that deny entry to persons under 21 years of age are exempt. Arkansas enacts a separate law making it illegal to smoke in a vehicle when a child is present who is younger than six years of age or who weighs less than 60 pounds. Puerto Rico enacts legislation requiring most workplaces and public places, including restaurants, bars, and casinos, to be smoke-free. The law also makes it illegal to smoke in a private vehicle with a child in a child's seat.

the report provided an important impetus to a trend that was already under way in California and, to a lesser extent, in other states toward local ordinances that restrict smoking in enclosed public places and workplaces. In fact, the three conclusions noted above (particularly the third one) were cited in the "Findings and Intent" section of many of these ordinances (Rigotti and Pashos 1991; National Cancer Institute [NCI] 2000b; American Lung Association [ALA] 2005; American Nonsmokers' Rights Foundation [ANR] 2005d). The 1986 Surgeon General's report also provided an impetus to the adoption of voluntary (or private) smoking restrictions by businesses (USDHHS 1986). The year 1986 also saw the publication of a report by the National Research Council (NRC 1986b) of the National Academy of Sciences on the health effects of secondhand smoke, which also concluded that secondhand smoke exposure is a cause of lung cancer in nonsmokers.

A second milestone in establishing a scientific foundation for efforts to reduce secondhand smoke exposure was the publication of the 1992 U.S. Environmental Protection Agency (EPA) report, *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders* (USEPA 1992). The report concluded that secondhand smoke is a Group A carcinogen (i.e., a carcinogen that has been shown to cause cancer in humans). Specifically, the report found that secondhand smoke is a human lung carcinogen estimated to be responsible for approximately 3,000 lung cancer deaths of U.S. nonsmokers annually. The report also concluded that secondhand smoke exposure is causally associated with a number of health conditions in children, including lower respiratory tract infections, an increased prevalence of fluid in the middle ear, and additional episodes and an increased severity of symptoms in children with asthma.

Although the EPA report had no direct regulatory effect, the report provided additional scientific evidence and authoritative conclusions supporting the need for the adoption of smoking restrictions by governmental bodies and private businesses. It was widely cited by local advocates and policymakers, particularly the conclusion that secondhand smoke is a Group A carcinogen. The report helped to accelerate the trend to enact local clean indoor air ordinances and, in particular, local ordinances that went beyond restricting smoking to designated areas to eliminating smoking altogether in certain settings. Anticipating the report's potential impact, cigarette manufacturers made a concerted effort to block or delay its publication (Bero and Glantz 1993; Muggli et al. 2004) and filed a lawsuit challenging its conclusions once it was published (*Flue-Cured Tobacco Cooperative Stabilization Corp. v. United States Environmental Protection Agency* [M.D.N.C. June 22, 1993], *cited in* 8.2 TPLR 3.97 [1993]). A 1998 U.S. District Court ruling vacated the report with regard to lung cancer based on procedural and scientific concerns (*Flue-Cured Tobacco Cooperative Stabilization Corp. v. United States Environmental Protection Agency*, 4 F. Supp. 2d 435 [M.D.N.C. 1998]). However, this court ruling was voided in 2002 when the U.S. Court of Appeals found that the report was not subject to judicial review, and the legal action was subsequently dismissed (*Flue-Cured Tobacco Cooperative Stabilization Corp. v. The United States Environmental Protection Agency*, No. 98-2407 [4th Cir., December 11, 2002], *cited in* 17.7 TPLR 2.472 [2003]).

A third milestone in assessing the evidence on secondhand smoke was the 1997 publication of the California Environmental Protection Agency (Cal/EPA) report, *Health Effects of Exposure to Environmental Tobacco Smoke* (Cal/EPA 1997), which was also disseminated in 1999 as a NCI monograph (NCI 1999). This was the first major report to conclude definitively that secondhand smoke exposure is a cause of heart disease in nonsmokers. The report also quantified the health burden that secondhand smoke imposes by providing ranges of estimates for the annual morbidity and mortality among U.S. nonsmokers from various health conditions attributable to secondhand smoke exposure. The estimates of deaths attributed to secondhand smoke in this report were widely cited in local policy debates. In addition, the finding that secondhand smoke exposure was a cause of heart disease was particularly significant because the potential impact on heart disease morbidity and mortality rates was greater than the impact as a cause of lung cancer. This conclusion was also a source of concern among persons already diagnosed with heart disease and persons with a family history of other risk factors for heart disease. A new, yet large, constituency thus became concerned about the risks from secondhand smoke exposure.

The 2001 report of the Surgeon General on women and smoking concluded that epidemiologic and other data support a causal relationship between secondhand tobacco smoke exposure from their spouse and CHD mortality among women who were nonsmokers. In addition, a 2002 CDC report estimated that secondhand smoke exposure causes more than 35,000 deaths annually of U.S. nonsmokers, which was the lower endpoint of the estimate in the Cal/EPA report (Cal/EPA 1997; USDHHS 2001; CDC 2002). A 2004 commentary published in the *British Medical Journal* reviewed recent evidence on the acute

cardiovascular effects of even brief secondhand smoke exposures and suggested that clinicians should advise patients who already have or are at special risk for heart disease to avoid indoor environments where there are likely to be smokers (Pechacek and Babb 2004).

International reports reached similar conclusions on the causation of disease and other adverse health effects from exposure to secondhand smoke (National Health and Medical Research Council 1997; Scientific Committee on Tobacco and Health 1998; World Health Organization [WHO] 1999). By 2000, there was little debate within the scientific community as to whether secondhand smoke causes diseases and other adverse health effects in children and adults. Two reports, the 2000 National Toxicology Program's *9th Report on Carcinogens* (USDHHS 2000b) and the 2004 International Agency for Research on Cancer (IARC) Monograph, *Evaluation of Carcinogenic Risks to Humans: Tobacco Smoke and Involuntary Smoking* (IARC 2004), further buttressed the case that secondhand smoke exposure poses serious health risks. Both reports concluded that secondhand smoke is a human carcinogen and a cause of lung cancer in humans. Although estimates differ on the magnitude of the excess risk, researchers continue to study the potential role of secondhand smoke as a cause of other diseases.

A growing number of local communities and, more recently, states have adopted increasingly comprehensive clean indoor air laws. This momentum drew on the strong body of scientific evidence and related conclusions; the efforts of public health officials at the local, state, and national levels who stepped forward as champions of this issue; and the nongovernmental organizations and grassroots advocates who built the case for "nonsmokers' rights." Numerous employers have also implemented voluntary smoke-free workplace policies.

The tobacco industry has attempted to counter this movement toward widespread control of exposure to secondhand smoke. The industry recognized as early as 1978 that the secondhand smoke issue posed a serious threat to its interests. In 1978, the Roper Organization surveyed the public for the Tobacco Institute and characterized the increasing public concern about the health risks posed by secondhand smoke as "the most dangerous development to the viability of the tobacco industry that has yet occurred" (Roper 1978, p. 4). The report also noted the concern that "What the smoker does to himself may be his business, but what the smoker does to the non-smoker is quite a different matter" (p. 4) and predicted that, as the belief that secondhand smoke exposure could harm nonsmokers became more widespread, public support for smoking restrictions would continue to grow (Roper 1978). In 1998, the Minnesota Tobacco Document Depository was created as a result of the tobacco industry settlement with the state of Minnesota and BlueCross BlueShield of Minnesota. U.S. tobacco companies were required to maintain and provide public access to more than 32 million pages of previously secret internal documents. A review of these documents revealed that the tobacco industry feared that governmental regulations on smoking in public places would affect profits (Muggli et al. 2001). This same report and many others based on the documents showed that the industry attempted to influence worldwide public opinion on the health effects of secondhand smoke by producing its own scientific research. Other tobacco industry documents also indicate that cigarette manufacturers feared that increasingly stringent smoking restrictions in workplaces would prompt some smokers to quit or reduce their smoking (Hirschhorn and Bialous 2001; Fichtenberg and Glantz 2002; Drope et al. 2004).

The tobacco industry documents suggest that this concern has been a major underlying motivation for efforts by cigarette manufacturers to prevent or reverse the adoption of any restrictions on smoking. These efforts have included casting doubts on scientific findings regarding the health effects of secondhand smoke and characterizing smoking restrictions as unnecessary and as infringements on the rights of smokers. The tobacco industry has maintained that hospitality businesses would suffer economically from the restrictions themselves, which are also characterized as burdensome and difficult to implement. At the same time, the tobacco industry has presented "common courtesy," separate nonsmoking and smoking sections, and, more recently, ventilation approaches as sufficient and less intrusive alternatives to smoke-free policies (Davis et al. 1990; Barnes and Bero 1996; Hirschhorn and Bialous 2001; Drope et al. 2004). When local clean indoor air ordinances have been adopted, cigarette manufacturers have sought to reverse them by working with organizations such as state and local restaurant associations and other hospitality business interests to organize petition drives and place the ordinances on the ballot (Traynor et al. 1993; NCI 2000b; Ritch and Begay 2001; Tsoukalas and Glantz 2003). Other tobacco industry efforts include filing lawsuits challenging the ordinances on a variety of grounds, organizing media campaigns attacking the ordinances, undermining implementation of local and state smoke-free laws, and securing passage of state laws that preempt local smoking restrictions that exceed the state standard (Kluger 1996; Siegel

et al. 1997; Dearlove et al. 2002; Nixon et al. 2004; NCI 2005). Cigarette manufacturers also collaborated with other organizations to defeat or weaken statewide clean indoor air legislation (Kluger 1996; Magzamen and Glantz 2001). At one time, cigarette firms also tried to discourage private employers from adopting voluntary smoke-free workplace policies, but those efforts seem to have ended (Landman 2000).

Smoking Restrictions in Public Places and Workplaces

Although some states and cities had already passed measures to reduce secondhand smoke exposure, the momentum to regulate smoking in public places increased in 1986 when reports by the Surgeon General (USDHHS 1986) and the NRC (1986b) concluded that secondhand smoke is a cause of lung cancer in nonsmokers. These reports became an impetus to increasingly common and restrictive government and private business policies limiting smoking in public places (Rigotti and Pashos 1991; NCI 2000a; ALA 2005; ANR 2005d). The designation of secondhand smoke as a Group A carcinogen by the EPA stimulated even further restrictions on smoking in public places and workplaces (USEPA 1992; Brownson et al. 1995).

Federal Government Smoking Restrictions

In the United States, the most progress in adopting comprehensive laws making public places and workplaces smoke-free has occurred at the local level and, more recently, at the state level. Progress has been far more rapid at the local level, particularly in the early years of the campaign for smoke-free environments. Federal initiatives in this area have been relatively limited. Federal smoking restrictions adopted to date are limited to a few settings, most notably airplanes, facilities providing federally funded services to children, and federally owned facilities, including military installations (see "Federal Laws and Regulations" later in this chapter). Although these policies affect a large number of people and carry symbolic importance, the policies cover only a small portion of the public places and workplaces where people are exposed to secondhand smoke.

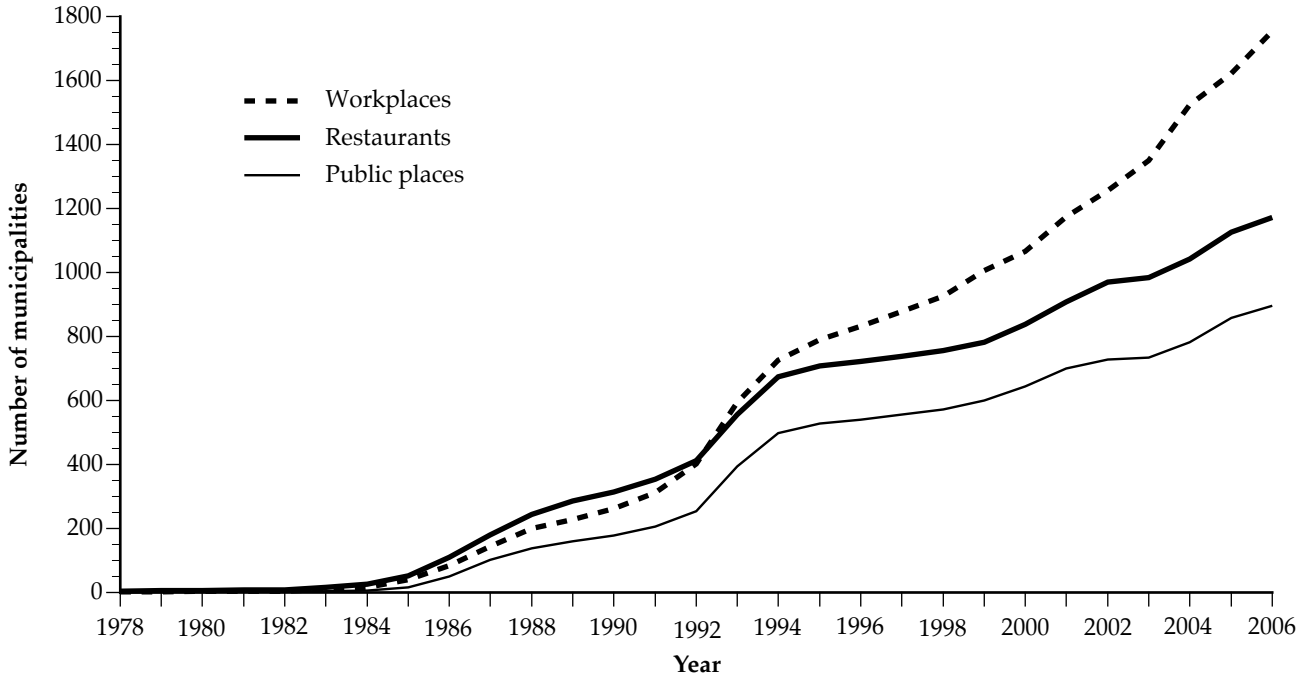
Local Ordinances

The strongest, most comprehensive smoke-free laws have typically originated at the local level (NCI 2000b; USDHHS 2000c). Local smoke-free policy efforts have generally met with greater success than federal or—until recently—state initiatives (NCI 2000b). More than 110 local ordinances with 100 percent smoke-free provisions had been adopted in the United States before the first state law with such a provision (for restaurants) was enacted in Vermont in 1993. One reason for this is that local governmental bodies tend to be relatively responsive to public sentiment, which increasingly favors comprehensive smoke-free legislation. Local smoke-free policy initiatives also typically engage communities in an intensive process of public education and debate. This process raises public awareness regarding the health risks that secondhand smoke exposure poses to nonsmokers, increases public support for policy measures that provide protections from these risks, and changes public attitudes and norms regarding the social acceptability of smoking. These changes, in turn, lay the groundwork for successfully enacting and implementing the proposed policy, which reinforces and accelerates these changes in the norm (NCI 2000b). Several states, some with and some without previous experience with local smoke-free laws, have attempted in recent years to follow a similar process at the state level and have successfully enacted and implemented statewide smoke-free laws, some of which are quite comprehensive (CDC 2005b). However, local smoke-free air laws continue to play an important role in allowing comprehensive protections to be put in place in communities in states that are not prepared to enact comprehensive smoke-free legislation on a statewide basis (Jacobson and Wasserman 1997; NCI 2000b).

Until recently, state clean indoor air laws lagged behind their local counterparts in terms of strength and breadth of settings covered. Despite this progress at the state level, comprehensive clean indoor air laws at the local level continue to be more numerous, more widespread, and more successful.

The modern era of local ordinances for clean indoor air began in the early 1980s, following the enactment of clean indoor air laws in cities and in several states (Table 10.1) (NCI 2000b). In 1977, Berkeley, California became the first community to limit smoking in restaurants and in other public places. After the release of the 1986 Surgeon General's report on the health consequences of secondhand smoke, the rates at which local smoking restrictions were adopted accelerated (Figure 10.1). By 1988, nearly 400 local clean indoor air ordinances had been enacted throughout the United States (Pertschuk and Shopland 1989). Since 1989, this trend has become even more pronounced (Rigotti and Pashos 1991; USDHHS 2000c),

Figure 10.1 Number of municipalities with local laws covering smoking in workplaces, restaurants, and enclosed public places, generally, 1978–2006



Source: American Nonsmokers' Rights Foundation, unpublished data, March 31, 2006.

and, as noted earlier, the publication of the 1992 EPA report provided an additional impetus.

A key factor in the widespread adoption of clean indoor air ordinances in U.S. communities during the past 20 years has been the emergence of a grassroots nonsmokers' rights movement (Kluger 1996; Glantz and Balbach 2000; NCI 2000b). Originating in California and gradually spreading nationwide, this movement initially consisted of community activists who were concerned about having to breathe secondhand smoke in restaurants and other public places and workplaces (Kluger 1996; NCI 2000b). Over time, the movement drew on the growing scientific evidence that was becoming available showing that secondhand smoke is not just an annoyance but a health hazard. In addition, the nonsmokers' rights activists increasingly joined forces with public health practitioners who were becoming aware of this fact. These practitioners were also beginning to realize that approaches that focused on fostering changes in social environments and norms were likely to have a greater impact in reducing tobacco use than strategies that focused on changing individual behavior. The movement mobilized increasing numbers of nonsmokers who insisted that measures be taken to protect them (Kluger 1996; NCI 2000b). These efforts were spearheaded by organizations such as ANR, the three voluntaries—American Cancer Society (ACS), American Heart Association, and ALA—and loosely organized grassroots groups such as the Group Against Smoking Pollution (GASP). The groups behind this movement realized that the best chance of success lay at the local level after efforts at the state level had yielded disappointing results. Public health practitioners and advocates closely observed the experience in California, where efforts to adopt statewide clean indoor air protections were defeated in the California Legislature, and two statewide ballot initiatives (Propositions 5 and 10) were defeated in 1978 and 1980. Cigarette manufacturers had heavily financed opposition campaigns against all of those efforts (Kluger 1996; Glantz and Balbach 2000).

A model approach then emerged, first in California and subsequently in other states (Glantz 1987). The state tobacco control movement organized local coalitions of public health practitioners and

advocates who engaged in an intensive process of public education and community mobilization. Most of these efforts were in place before launching a public campaign supporting a particular ordinance. The local coalitions assessed attitudes of the public and policymakers and often initiated a campaign when public support for the proposed ordinance was evident. On the other hand, ordinances were also introduced with less readiness to push tobacco control, as a process for change and as an educational approach. The ordinance itself was drafted to conform to the level of public readiness, with provisions only as strong as the public was willing to support. Similarly, the local coalitions did not bring an ordinance before a local governmental body until there was clear support from a majority of the policymakers. The vigorous debate that typically occurred after an ordinance was officially introduced provided substantial opportunities for health advocates to generate unpaid media coverage, further contributing to public education and public support. Public education and awareness contributed to changes in social norms regarding the acceptability of smoking in public places and workplaces—changes that were then solidified by the implementation of the ordinance. In the words of Stanton Glantz, one of the founders of ANR, "Ordinances only work to the extent that they sanctify a change in public attitudes" (Glantz 1998, p. 31).

In some states, once several communities had adopted ordinances, a number of other communities followed fairly quickly. The ordinances spread as residents and policymakers elsewhere in the state learned from the experiences of others that these measures were popular and workable and that the problems the opponents predicted—most notably economic hardship and enforcement difficulties—did not occur. In addition, as more communities in a state adopted ordinances, it became easier for one community to find and use a successful experience with an ordinance in a similar community as a model or example.

This model, first applied in California, was later applied to varying extents and with varying degrees of success in a number of other states, including Massachusetts, New Mexico, New York, Oregon, Texas, West Virginia, and Wisconsin. Ultimately, the majority of states where local smoke-free ordinances were not precluded by preemptive provisions in state law saw at least some communities enact such ordinances (NCI 2000b; Siegel 2002; Rogers 2003; ANR 2005d).

The first national organization to focus on the need for a local clean indoor air policy was ANR, which is still the recognized leader in the field. ANR has supported local efforts in a number of ways: providing technical assistance, training, and strategic guidance to local coalitions; keeping them informed of the latest policy trends and opposition tactics; linking a coalition with local coalitions in other parts of the country that were encountering similar experiences; developing "best practices" guidelines (ANR 2002); and disseminating model ordinances. ANR maintains a database of local ordinances and their provisions in order to track progress in eliminating unintended loopholes and addressing legal issues (<http://no-smoke.org>).

In recent years, local progress in enacting clean indoor air policies has been furthered in some states by support from state tobacco control programs and other state organizations to develop and maintain a network of local coalitions through technical assistance and training on evidence-based tobacco control approaches, and through funding and a dedicated staff. California, Massachusetts, and Oregon were among the first states to achieve this level of organization, and other states followed suit (Siegel 2002). The American Stop Smoking Intervention Study for Cancer Prevention (ASSIST) was a major federal tobacco control initiative carried out during the 1990s, under the auspices of the NCI and the ACS (NCI 2005; see also <http://dccps.nci.nih.gov/tcrb/monographs/16/index.html>). Seventeen states received funding to conduct population-based policy interventions in four areas, including smoke-free air. State tobacco control programs in the ASSIST states were encouraged to support local and regional smoke-free policy efforts that included developing and maintaining community coalitions and providing technical assistance and dedicated staff. As a result of this focus, several ASSIST states made significant gains, such as enacting strong local smoke-free ordinances. Examples include Colorado, Maine, Minnesota, New Jersey, New Mexico, New York, and West Virginia (ANR 2005a). The experiences of these ASSIST states during this initiative also laid the groundwork for other subsequent smoke-free policy successes at local and state levels, once these states had transitioned to funding through CDC's National Tobacco Control Program. Robert Wood Johnson Foundation's SmokeLess States program also made a significant contribution to local progress in this area by highlighting a local clean indoor air policy as one of its priorities, by encouraging the state coalitions it funded to work with state tobacco control programs and other state organizations to support local clean indoor air policy efforts, and by providing these coalitions with sophisticated guidance (AMA 1998). In addition, studies in Massachusetts found that state funding of local boards of health was correlated with

the adoption of local tobacco control ordinances, including local clean indoor air ordinances (Bartosch and Pope 2002; Skeer et al. 2004).

As a result of these local clean indoor air policy efforts, hundreds of U.S. communities have adopted some type of local smoking restriction. ANR reported that as of April 17, 2006, a total of 2,216 U.S. municipalities had some sort of smoking restriction in place, including 352 municipalities with smoke-free workplace ordinances, 292 municipalities with smoke-free restaurant ordinances, and 215 municipalities with smoke-free bar ordinances. In addition, 135 municipalities have adopted ordinances requiring all three settings to be smoke-free (ANR 2006a). These numbers mean that in the United States at that time, 29.0 percent of the people were covered by a local or state smoke-free workplace law, 40.3 percent were covered by a local or state smoke-free restaurant law, 31.3 percent were covered by a local or state smoke-free bar law, and 16.9 percent were covered by a comprehensive local or state law that made workplaces, restaurants, and bars smoke-free (ANR 2006b). Local jurisdictions that have recently enacted relatively comprehensive smoke-free legislation include several major metropolitan areas: Austin, Boston, Chicago, Columbus, Dallas, Indianapolis, Lincoln, and New York city. In the case of the first two cities, the municipal legislation was followed by a comprehensive statewide law (ANR 2006c).

As of March 2006, 896 local ordinances restrict or ban smoking in public places other than restaurants and workplaces (Figure 10.1). These ordinances specifically designate which agencies are responsible for enforcement: 27 percent of the ordinances cite health departments, 23 percent cite boards of health, 18 percent cite city or county administrators, 24 percent cite law enforcement, and 21 percent cite other agencies; 17 percent do not specify an enforcement agency or mechanism (ANR unpublished data, March 31, 2006). Because some municipalities have designated more than one enforcement agency, the percentages are not expected to add up to 100 percent. The implementation and enforcement of this legislation are just as important as its passage in achieving the policy goals (Nordstrom and DeStefano 1995; Weber et al. 2003).

The tobacco industry was quick to recognize the progress that advocates were making in advancing smoking restrictions at the local level. As early as 1986, Raymond Pritchard, Chairman of the Board of Brown and Williamson Tobacco Company, acknowledged that "our record in defeating state smoking restrictions has been reasonably good. Unfortunately, our record with respect to local measures—that is, in cities and counties across the country—has been somewhat less encouraging.…We must somehow do a better job than we have in the past in getting our side of the story told to City Councils and County Commissions. Over time we can lose the battle over smoking restrictions as decisively in bits and pieces—at the local level—as with state or federal measures" (Pritchard 1986, pp. 86, 88). As noted above, the tobacco industry has responded to local clean indoor air policy efforts by working with hospitality and gaming interests and other organizations to prevent local ordinances from being adopted and to attempt to reverse them once they have been enacted (Kluger 1996; Dearlove et al. 2002; Mandel and Glantz 2004; Nixon et al. 2004). One major approach that the industry has employed to accomplish both goals is supporting state laws that preempt local smoking restrictions that are stronger than the state standard (Siegel et al. 1997; Henson et al. 2002). During the mid-1990s, the tobacco industry made the passage of state preemption laws one of its major political objectives and experienced significant success in this area (Siegel et al. 1997; CDC 1999). Once in place, these laws have proved difficult to repeal, although there has been more success in this regard in recent years. To date, two states—Delaware and Illinois—have completely repealed a state preemption provision precluding local smoking restrictions (CDC 2005a). Delaware did so in 2002 in conjunction with enacting a comprehensive statewide smoke-free law, while Illinois did so in 2005 as a stand-alone action. In addition, several other states, including Louisiana, Nevada, North Carolina, and Tennessee, rescinded such preemptive provisions for certain settings. As of December 31, 2004, a total of 19 states had a preemptive provision in place for at least one of three settings—government worksites, private-sector worksites, and restaurants—up from 17 states at the end of 1998 (CDC 2005a). A *Healthy People 2010* objective calls for no states to have preemptive tobacco control laws in place by 2010 (USDHHS 2000a). Selected recent legislative and legal developments in this area are listed in Table 10.1.

In general, advocacy and public health organizations have resisted efforts to seek a statewide clean indoor air law until a state has had a critical mass of local ordinances in place for some time. This position is based on the concern that, in the absence of experience with implementing such ordinances and the grassroots support they generate, the final state legislation adopted is likely to be weak and, in many cases, to preempt stronger local ordinances. Moreover, even in cases where state smoke-free laws are not preemptive, they may lead to a decrease in the enactment of

local smoke-free ordinances, perhaps because local policymakers perceive that the issue of secondhand smoke protection has been adequately addressed at the state level (Jacobson and Wasserman 1997). This concern has been borne out by experience in a number of states. The opposition to what were perceived as premature state clean indoor air laws was also based on the concern that even if a state that lacked pre-existing local ordinances succeeded in enacting a strong, nonpreemptive state law, the public would not be prepared to accept it because of the absence of the intensive public education, debate, and changes in norms that typically occur before the adoption of local ordinances, making it difficult to implement the law (Jacobson and Wasserman 1999; NCI 2000b; USDHHS 2000b).

Recent progress in enacting statewide smoke-free laws suggests that these concerns, while remaining valid in many cases, may not apply in certain situations (CDC 2005a,b). Several states (e.g., Connecticut, Delaware, Florida, and Rhode Island) that had little or no prior experience with local smoke-free ordinances have recently been able to enact relatively comprehensive statewide smoke-free laws (although in most cases these laws have retained preemption provisions where these provisions were already in place). Other states (e.g., Maine, Massachusetts, and New York) that have recently enacted relatively comprehensive statewide smoke-free laws had had previous experience with local ordinances. With time, the relative success experienced by these two categories of states in implementing their laws will provide insights into the issues described above. The experiences of these states will also shed light on a related question: whether states where local clean indoor air ordinances are preempted can achieve superior public health protections by first seeking to reverse the preemptive provision and pursue local smoke-free ordinances, or by skipping this step and proceeding directly to the pursuit of a comprehensive statewide smoke-free law (CDC 2005a,b).

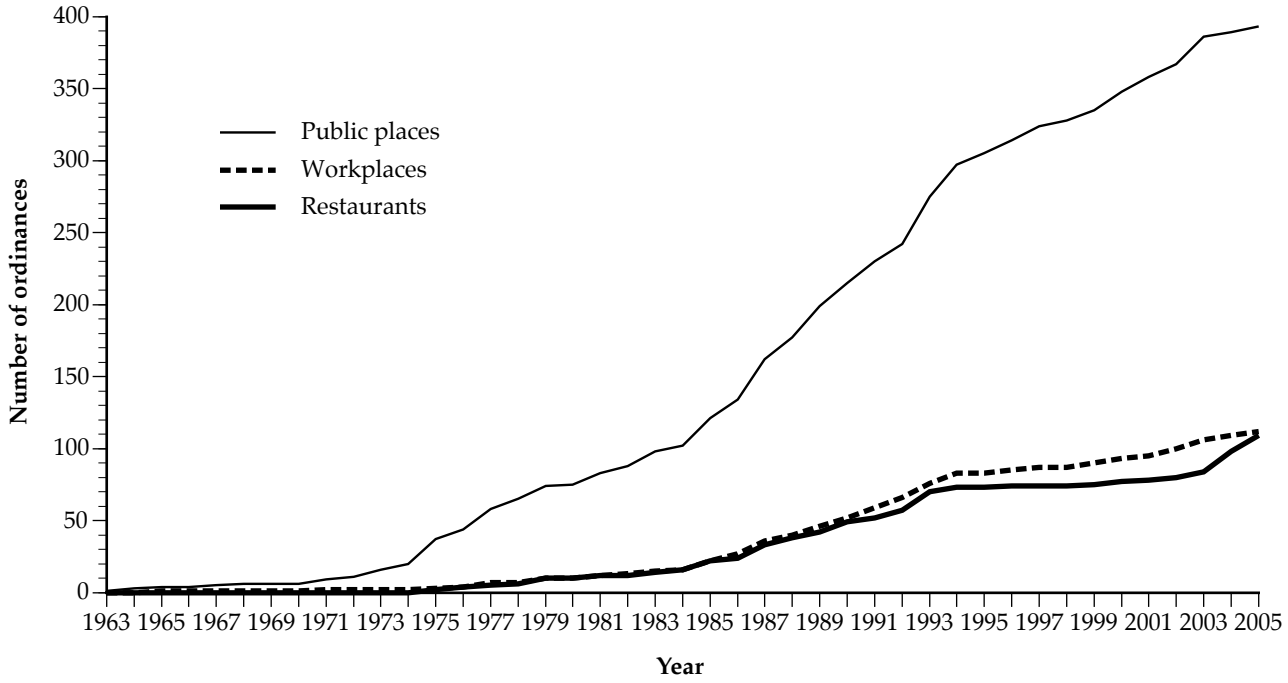
State Laws and Regulations

Healthy People 2010 objective 27-13 calls for all states to adopt laws making enclosed workplaces and public places smoke-free (USDHHS 2000a). The first substantive modern state laws restricting smoking in public places were enacted in Arizona, Connecticut, and Minnesota in 1973–1975 (Table 10.1). Over the years, many other states enacted smoking restrictions (Kluger 1996; CDC 2005b). However, few of these restrictions were strong or comprehensive in coverage. As recently as 2001, only a single state—California—had a statewide law in place making most enclosed workplaces and public places, including restaurants and bars, smoke-free (CDC 2005b). In 2002, Delaware became the second state to enact a comprehensive state law of this kind; this law also rescinded a preemption provision that had prevented communities from adopting local ordinances that were more stringent than the state standard. Since 2002, there has been rapid progress in this area, with a number of other states enacting and implementing similarly comprehensive smoke-free laws.

As of December 31, 2005, 49 states and the District of Columbia have mandated smoke-free indoor air to some degree or in some public places. These restrictions vary widely, from limited restrictions on public transportation to comprehensive restrictions in other public places and in worksites (Figure 10.2) (CDC, Office on Smoking and Health [OSH], State Tobacco Activities Tracking and Evaluation System, unpublished data; <http://www.cdc.gov/tobacco/statesystem>).

In addition (also as of December 31, 2005), 44 states and the District of Columbia have restricted smoking in government worksites: 22 states limit smoking to designated areas, 6 states require either no smoking or designated smoking areas with separate ventilation, and 16 states prohibit smoking entirely. Of the 31 states that restrict smoking in private worksites, 16 limit smoking to designated areas, 11 require a complete ban, and 4 require separate ventilation for smoking areas. Of the 34 states that regulate smoking in restaurants, only 11 states completely prohibit smoking (Delaware, Florida, Idaho, Maine, Massachusetts, Montana, New York, North Dakota, Rhode Island, Utah, and Washington). California and Connecticut require either a complete ban or separate ventilation for smoking areas (CDC, OSH, State Tobacco Activities Evaluation System, unpublished data; <http://www.cdc.gov/tobacco/statesystem>). As of April 2006, 11 states plus the District of Columbia have enacted comprehensive smoke-free laws throughout their jurisdictions that, when the laws take full effect as implemented in practice, will require almost all enclosed workplaces and public places, including restaurants and bars, to be smoke-free: California, Colorado, Connecticut, Delaware, Maine, Massachusetts, New Jersey, New York, Rhode Island, Utah, and Washington. The Colorado and New Jersey laws exempt casino floor areas. Together, these locales account for approximately 31 percent of the U.S. population. This estimate does not include the population covered by comprehensive local smoke-free laws in states

Figure 10.2 Cumulative number of state laws and amendments enacted for clean indoor air, 1963–2005



Source: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute, State Cancer Legislative Database, unpublished data, June 30, 2005.

that have not implemented comparable statewide legislation.

Of the numerous factors that appear to have contributed to this progress, perhaps the most important has been the adoption of comprehensive local clean indoor air ordinances in hundreds of communities across the United States, including high-profile cities such as New York City and Boston. These localities have demonstrated that the ordinances are popular, can be implemented with little difficulty, are met with high levels of compliance, and do not have a negative economic impact on restaurants and bars (New York City Department of Finance 2004) (see "Trends in Public Support for Smoking Restrictions," "Compliance with Workplace Smoking Policies," and "Economic Impact of Smoking Restrictions on the Hospitality Industry," later in this chapter). The trend toward these ordinances has also led some state restaurant associations and other hospitality interests to conclude that smoke-free laws were inevitable and it was preferable that these laws be implemented at the state level, where they would apply to all communities. As a result, state restaurant associations in several states have shifted from opposing state clean indoor air legislation to taking a neutral or even a supportive position (Lindsay 2003; von Zielbauer 2003). The same concern that these laws should apply across the board has also led restaurant associations and proprietors in some states to advocate for state laws that applied to all types of hospitality businesses, including not only restaurants but also bars and gaming venues. More recently, the experiences of other states and even other countries (such as Ireland) in implementing comprehensive smoke-free laws should help to allay concerns, discredit opponents' claims, foster the sense of a natural and inevitable progression toward making workplaces and public places smoke-free, and convince state policymakers to emulate these examples.

Another major contributing factor to the adoption of comprehensive state laws has been the growing tendency to view smoke-free policies in hospitality businesses in the context of worker protection and workplace safety (beginning with the California state

law), rather than as measures designed primarily to protect patrons. When framed in this context, a majority of the public and policymakers in many jurisdictions has come to the conclusion that restaurant and bar workers should be afforded the same health protections as employees in other occupations. Finally, the mounting scientific evidence regarding the health effects of secondhand smoke has clearly played a role in convincing the public and policymakers that strong steps needed to be taken to protect nonsmokers, including nonsmoking employees, from harm.

Even earlier, Maryland and Washington had implemented statewide workplace smoking restrictions through regulations, as opposed to legislation. In 1994, the Maryland Occupational Safety and Health Advisory Board proposed a regulation that would prohibit smoking in most workplaces in the state, including restaurants and bars (*Maryland Register* 1994). Despite strong statewide public support from both nonsmokers and smokers for these restrictions, the tobacco industry aggressively challenged this proposal and questioned the legal authority of the state to regulate smoking through an administrative rule rather than by statute (Shopland et al. 1995). In 1995, the original regulation was modified by legislative action to permit some exceptions for the hospitality industry, and the rules then went into effect. Also in 1994, the Washington State Department of Labor and Industries enacted an extensive indoor workplace smoking ban. Unlike the Maryland regulation, the Washington regulation applied only to office workplaces and did not cover hospitality workplaces such as restaurants and bars. A 1985 Washington state law restricting smoking in public places had specified exemptions for hospitality workplaces, and a temporary injunction aimed at removing the exemptions was dismissed by the state court. The ban went into effect without litigation (LeMier 1999). Health advocates in Washington have recently utilized several different approaches to attempt to extend the state's workplace smoking ban to cover hospitality settings, including the most recent effort to place a comprehensive measure that passed on the November 2005 ballot that makes almost all public places and workplaces in the state smoke-free. In 1990, the governor of North Dakota issued an executive order requiring state buildings under his jurisdiction to be smoke-free (George A. Sinner, memorandum, April 25, 1990).

California is currently considering regulating secondhand smoke as a toxic air contaminant. The process began in 2001 when Cal/EPA initiated an evaluation of the extent of Californians' secondhand smoke exposure and of the health effects associated with this exposure. In September 2005, Cal/EPA's Air Resources Board (ARB) released a report, *Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant* (Cal/EPA 2005). This report updates and expands on a previous report on the health effects of secondhand smoke that Cal/EPA had published in 1997 (Cal/EPA 1997). NCI recognized the importance of the report and saw the need to disseminate it broadly as part of the NCI Smoking and Tobacco Control Monograph Series (NCI 1999). The report included revisions made in response to suggestions received during a public comment period following a 2003 release of a draft version of the report, as well as a section containing these comments and the agency's responses. The final report also incorporated revisions made in response to recommendations received from the California Scientific Review Panel on Toxic Air Contaminants, which had reviewed the document. The panel has approved the report and has recommended that ARB list secondhand smoke as a toxic air contaminant. The panel has also recommended that the California Office of Environmental Health Hazard Assessment list secondhand smoke as a toxic air contaminant that may disproportionately impact children. In January 2006, following a public hearing, the ARB formally designated secondhand smoke as a toxic air contaminant. This means that secondhand smoke will be listed as such a contaminant in the California Code of Regulations, and that the ARB is required by law to assess whether there is a need to further regulate outdoor secondhand smoke exposure among California residents.

Federal Laws and Regulations

As already noted, federal actions in this area have been comparatively few and relatively narrow in scope. Initial efforts at the federal level to control secondhand smoke exposure were largely directed at commercial airline flights. The flight attendants took an early and important role in advocating for smoke-free aircraft (Holm and Davis 2004). Their efforts began as early as 1966 and continued for decades, until smoke-free air travel was finally achieved in 2000.

In 1969, Ralph Nader petitioned the Federal Aviation Administration (FAA) to completely ban smoking on all passenger flights. Nader argued that smoking not only annoyed nonsmokers but also posed a significant danger to the health and safety of everyone on the airplane. Attorney John Banzhaf III then called for the FAA to separate smokers from nonsmokers on all domestic flights. The FAA rejected both requests. However, Surgeon General Jesse Steinfeld's 1971

public announcement about the harmfulness of indoor smoking and his call for a national nonsmokers' bill of rights (Steinfeld 1983) was received positively by the American public, possibly, in part, because most of the U.S. population did not smoke. Legislation was introduced in the U.S. Congress in 1971 (Holm and Davis 2004) to restrict smoking aboard all commercial aircraft, but the measure died in committee. However, that same year United Airlines voluntarily began to offer smoking and nonsmoking seating, and within a year most major U.S. carriers had followed suit, although not all airlines offered this option and open smoking was still the norm on many commercial flights. Furthermore, because these policies were voluntary, they were subject to change.

Using the conclusions of the 1972 Surgeon General's report (USDHEW 1972), Nader petitioned the Civil Aeronautics Board (CAB) to ban smoking aboard commercial aircraft on health grounds. The CAB at that time controlled most aspects of commercial aviation and was considered more consumer-oriented than the FAA. However, a December 1971 study examined the health effects of smoking aboard military and civilian transport aircraft and found, counter to data collected subsequently, no "persuasive evidence that exposure to tobacco smoke, in concentrations likely to occur in aircraft (assuming normal ventilation rates), is injurious to the health of nonsmokers" (Kluger 1996, p. 373). Despite low levels of measured pollutants, the study found that more than 60 percent of all nonsmoking passengers and 38 percent of smokers indicated they were annoyed by tobacco smoke from other passengers during a flight. The study was conducted jointly by several agencies within the U.S. DHEW, the U.S. Department of Transportation, and the FAA.

Citing a lack of supporting health data, the CAB rejected a complete ban on smoking and instead issued a rule based on passenger "comfort" that required all airlines to provide nonsmoking seating sections, effective July 1, 1973 (CAB 1972). This was the first federal regulation of secondhand smoke. The CAB ruling, however, only required that airlines set aside a limited number of nonsmoking seats. At the time of its implementation, only the last few rows of seats were reserved for this purpose and were available on a first-come, first-served basis. Once these seats were filled, remaining passengers were seated in the smoking section. The CAB later revised this rule to require more flexible seating arrangements, so that any passengers who requested it would be guaranteed a nonsmoking seat if they arrived at the gate at least 10 minutes before departure. With this change, the airlines could no longer assign a fixed number of seats for smoking and nonsmoking passengers, and the smoking section aboard most flights became progressively smaller as more and more passengers requested nonsmoking seats.

In 1983, the CAB issued new regulations that banned smoking on flights of two hours or less, but revised that decision almost immediately. However, pressure for the ban increased as the evidence mounted on adverse health consequences from exposure to secondhand smoke. In 1986, NRC appointed a committee to examine issues of air quality in airplanes, and their report recommended a ban on smoking on all commercial flights within the United States (NRC 1986a). Congress passed legislation in 1987 (*Appropriations for the Fiscal Year 1988, and for Other Purposes* [Prohibition Against Smoking] 1987) prohibiting smoking on all regularly scheduled flights of two hours or less, which became effective in 1988. In 1990, federal law mandated that all domestic flights of six hours or less be smoke-free. In 2000, all flights to and from the United States were required to be smoke-free (Holm and Davis 2004).

The efforts of grassroots advocates and advocacy groups, including individual flight attendants, the flight attendants' union, ANR, and several local chapters of GASP, were instrumental in achieving this outcome. These groups effectively conveyed the perspective of flight attendants who were expected to accept exposure to a hazardous substance for long periods of time in a confined environment as part of their job description. This effort put a human face on the mounting scientific evidence that secondhand smoke exposure was harmful to nonsmokers and framed the issue as one of worker safety (Holm and Davis 2004). Another important factor contributing to the outcome of this effort was the mounting evidence that was emerging from a series of scientific studies showing that flight attendants were exposed to high levels of secondhand smoke and that neither ventilation nor separate smoking and nonsmoking sections were effectively reducing this exposure (Repace 2004a). For example, a 1988 study sponsored by NCI that used personal air nicotine monitors and measurement of cotinine in urine to assess nonsmoking flight attendants' exposure found that the secondhand smoke levels present on the aircraft produced measurable levels of cotinine in the urine of passengers and flight attendants, and that flight attendants assigned to work in nonsmoking sections were not protected from secondhand smoke exposure (Mattson et al. 1989).

In 1994, the Occupational Safety and Health Administration (OSHA) proposed regulations that would either prohibit smoking or limit it to separately

ventilated areas in all U.S. workplaces (*Federal Register* 1994b), but ultimately withdrew the proposed rule in December 2001 (*Federal Register* 2001). The tobacco industry had orchestrated a concerted and intensive campaign to block it (Bryan-Jones and Bero 2003). In withdrawing the rule, OSHA suggested that the issue of secondhand smoke was being adequately addressed at the local and state levels, noting that "in the years since the proposal was issued, a great many state and local governments and private employers have taken action to curtail smoking in public areas and in workplaces" (*Federal Register* 2001, p. 64946). Public health groups acquiesced in the decision to withdraw the rule because they were concerned that the rule might turn out to contain weak smoking restrictions and to preempt stronger state and local action (Girion 2001).

However, the federal government has instituted increasingly broad and stringent regulations on smoking in its own facilities, culminating in a 1997 executive order making most federally owned buildings under the jurisdiction of the Executive Branch smoke-free. In addition, the *Pro-Children Act of 1994*, which was reauthorized under the *No Child Left Behind Act of 2001*, prohibits smoking in facilities that routinely provide federally funded services to children (see "Smoking Restrictions in Other Settings" later in this chapter). In November 2004, U.S. DHHS announced that it would move toward prohibiting tobacco use on the outdoor grounds of its facilities in 2005 (USDHHS 2004). In 2004, the Federal Bureau of Prisons implemented a nearly across-the-board smoke-free policy in 105 federal prisons (U.S. Department of Justice [USDOJ] 2004).

Smoking Restrictions in the Military

One arena in which the federal government has made significant progress in restricting indoor smoking is in the armed services. The U.S. military has imposed progressively more stringent smoking restrictions in its facilities. In 1994, the U.S. Department of Defense (DOD) issued an Instruction making all workplace settings under its control smoke-free (USDOD 1994). However, this Instruction exempted recreational and living facilities. The 1997 Executive Order issued by President Clinton, which made all indoor federally owned facilities smoke-free, extended the military policy to all indoor facilities except living quarters. A policy letter issued by Defense Secretary William Cohen in December 1999 gave morale, welfare, and recreational facilities such as bars, bowling alleys, and golf course clubhouses on military bases and installations a three-year grace period to become smoke-free or to restrict smoking to separately ventilated smoking areas (Cole 2003). The deadline expired in December 2002, and most of these facilities have reportedly complied. Indoor military facilities where smoking continued to be permitted included barracks and housing. As of 2001, all guest rooms and common areas in Air Force lodging facilities were required to be smoke-free. As of March 2005, guest rooms at Army lodging facilities were also required to implement smoke-free policies. The Navy designated new and renovated lodging facilities as smoke-free, but existing guest smoking rooms will retain that designation until they undergo renovation (Tyler 2005).

In addition to protecting military personnel from secondhand smoke exposure, these smoking restrictions are intended to encourage cessation among military personnel who smoke and to discourage recruits from initiating smoking. Smoking prevalence among military personnel is higher than among the general population. DOD reported that 33.8 percent of military personnel (35.3 percent of men and 26.3 percent of women) smoked in 2002 (USDOD 2004). According to the 2002 National Health Interview Survey (NHIS), the corresponding figure for the general U.S. adult population was 22.5 percent (CDC 2004a). A DOD survey found that approximately 27 percent of U.S. Air Force personnel aged 17 through 64 years were smokers in 2002 (CDC 2004a). The same survey found that 35.6 percent of Army personnel, 36.0 percent of Navy personnel, and 38.7 percent of Marine personnel were smokers in 2002 (CDC 2004a). CDC estimated that current smoking cost the Air Force approximately $107.2 million that year, including $20 million for medical care expenditures and $87 million for lost workdays. DOD also estimated that current smoking among all beneficiaries of the U.S. military health care system costs an estimated $930 million in 1995, including $584 million for health care expenditures and $346 million in lost productivity (CDC 2000).

The military has set ambitious goals for reducing smoking to improve health and well-being among military personnel. Benefits include enhanced military readiness and reduced smoking-related health care costs. To achieve these goals, all four services now prohibit recruits from using tobacco products during basic training (Giordono 2002), the discounts on tobacco products in military commissaries have been reduced since 1996 (USDOD 1996), and all military personnel can choose from a range of smoking cessation services (see the sections on "Hospitals and Health Care Facilities" and "Nursing Homes" later in this chapter).

Private Sector Workplace Smoking Restrictions

In some cases, private employers have been required to implement workplace smoking restrictions in response to state or local laws or regulations. In other cases, employers have chosen to implement voluntary workplace smoking restrictions to protect their employees' health; increase productivity; reduce health care costs, other insurance costs, and maintenance and cleaning costs; or lessen legal liability for employee health conditions. A *Healthy People 2010* objective calls for all workplaces to adopt smoke-free workplace policies (USDHHS 2000a).

National data sets can be used to ascertain the level of workplace smoking restrictions among private firms in the United States. A survey conducted by the Bureau of National Affairs (1991) estimated that 85 percent of large workplaces had policies restricting smoking. The percentage of smoke-free workplaces increased substantially from 2 percent in 1986 to 7 percent in 1987 and to 34 percent in 1991. Similarly, data from the 1992 National Survey of Worksite Health Promotion Activities indicated that 87 percent of workplaces with 50 or more employees regulated smoking in some manner, and 34 percent prohibited it altogether (USDHHS 1993). In 1999, 79 percent of worksites with 50 or more employees had a policy that banned or limited smoking (USDHHS 1999).

There are fewer studies on the prevalence of smoking policies in small workplaces, where the majority of Americans work (U.S. Department of Commerce [USDOC] 2006). Smaller workplaces have been less likely than larger workplaces to implement smoking policies (CDC 1987b; USDHHS 1989). According to a comprehensive examination of workplace smoking policies in 1992–1993 from NCI's Tobacco Use Supplement to the U.S. Census Bureau Current Population Survey (CPS) (n = 100,561) (USDOC 1995), most indoor workers surveyed (81.6 percent) reported that an official policy governed smoking at their workplaces; nearly half reported that the policy could be classified as smoke-free—smoking was not permitted either in workplace areas or in common public use areas (Gerlach et al. 1997). This proportion varied by gender, age, ethnicity, and occupation. Respondents in blue-collar and service occupations, for example, were significantly less likely to report a smoke-free workplace policy. Although data were not specifically categorized by workplace size, the range of occupations suggests that the survey included a substantial proportion of persons who worked in smaller workplace environments. However, the data suggest that there is substantial room for improvement among all workplace sizes in terms of smoke-free policy coverage.

A study drawing on data from the 1999 CPS Tobacco Use Supplement found that 69.3 percent of all U.S. indoor workers reported that they were covered by a workplace policy that made all public or common areas and work areas smoke-free, up from 46.5 percent in 1993 and 63.7 percent in 1996 (Shopland et al. 2004). A greater proportion of women (73.8 percent) than men (64.2 percent) reported working under such a policy. Substantial disparities in coverage by a smoke-free workplace policy were evident between white-collar workers (76.3 percent coverage) and blue-collar (52.2 percent coverage) and service workers (57.5 percent coverage), although these disparities have narrowed over time.

As part of the national Community Intervention Trial for Smoking Cessation (COMMIT), worksites in 22 communities were surveyed in 1989 and 1993 (Glasgow et al. 1992, 1996). In 1993, of the original sample, 66 percent of the worksites had developed written smoking policies, 76 percent had either smoke-free policies (no smoking anywhere indoors) or restrictive smoking policies (smoking allowed in only one or two areas), and 43 percent had smoking bans. These data reflect an increase of approximately 20 percentage points in the number of worksites with bans and a decrease of 7 percentage points in the number with restrictions during the five-year observation period (Glasgow et al. 1996).

A notable recent trend in this area is the tendency of some large private employers to adopt voluntary smoke-free or, in some cases, tobacco-free workplace campus policies that extend smoking and tobacco use policies to outdoor grounds. The policies are typically not primarily intended to reduce employees' secondhand smoke exposure, but to motivate and help employees who smoke or use other tobacco products to quit in the interests of promoting a healthy workforce and reducing employers' health care costs (Romero 2004). To this end, the policies are also typically coupled with an employer provision of expanded employee cessation services. Such policies have recently been adopted by a number of large companies. In particular, the policy adopted by Lowe's Home Improvement Company (Center for Health Improvement 2004) generated extensive publicity, perhaps in part because its corporate headquarters are located in a tobacco-growing state. These policies appear to be most likely adopted by organizations with a health-related mission (especially hospitals), as well as schools, colleges, and universities.

In November 2004, U.S. DHHS Secretary Tommy Thompson announced that U.S. DHHS would implement a tobacco-free campus policy in its facilities beginning in 2005 (USDHHS 2004). Other U.S. organizations have also adopted smoke-free or tobacco-free campus policies, including manufacturing companies and restaurant chains (<http://www.no-smoke.org/goingsmokefree.php?id=452>).

Attitudes and Beliefs About Secondhand Smoke

A number of nationally representative studies that assessed public attitudes toward smoking in public places have been published since the 1960s. The 1989 report of the Surgeon General considered studies from the previous three decades (USDHHS 1989). The most recent studies are the NCI's Tobacco Use Supplement to the CPS (USDOC 1985, 2004) and the NHIS (National Center for Health Statistics [NCHS] 2004). CPS is a monthly survey of about 50,000 households. Questions on smoking were included in September 1992, January 1993, and May 1993 (Gerlach et al. 1997), and the questions were repeated during the same months in 1995–1996, 1998–1999, and 2001–2002 (Shopland et al. 2001; CDC, NCHS, NHIS, public use data tapes, 2001–2002). In the text that follows, the dates of surveys are referred to as 1993, 1996, 1999, and 2002, respectively. The NHIS is a multipurpose health survey conducted by CDC. Because the CPS and NHIS represent the most recent data available using nationally representative samples, this Surgeon General's report includes extensive analyses of these data.

Trends in Beliefs About Health Risks of Secondhand Smoke

Surveys conducted in recent years consistently show that substantial majorities of the U.S. public believe that secondhand smoke exposure is a health hazard for nonsmokers. In both 1992 and 2000, NHIS asked respondents if they agreed with the statement that secondhand smoke is harmful. In both years, more than 80 percent of respondents agreed (Table 10.2). Individuals with more years of education were more likely to believe that secondhand smoke is harmful. According to data from the 2001 annual Social Climate Survey of Tobacco Control, 95 percent of the adults agreed that parental secondhand smoke was harmful to children, and 96 percent considered tobacco company claims that secondhand smoke is not harmful to be untruthful (McMillen et al. 2003).

The Gallup Organization surveyed U.S. adults in 2002–2004. A summary of the results reported that 54 percent considered secondhand smoke very harmful to adults, 32 percent considered secondhand smoke somewhat harmful, 9 percent believed that secondhand smoke was not too harmful, and 4 percent felt that it was not at all harmful (Blizzard 2004). Women were more likely than men to believe that secondhand smoke was very harmful (63 percent versus 44 percent, respectively). Groups aged 18 to 29 years were the most likely to believe that secondhand smoke was very harmful (61 percent), compared with 55 percent for respondents aged 30 to 49 years, 48 percent for respondents aged 50 to 64 years, and 53 percent for respondents aged 65 or more years.

Yañez (2002) cited results from a 2002 national survey commissioned by the Robert Wood Johnson Foundation, which found that Hispanic/Latino (63 percent) and African American (66 percent) voters were more likely than White voters (53 percent) to believe that secondhand smoke is a serious health hazard.

Trends in Public Support for Smoking Restrictions

The CPS data were examined to assess changes in public support for smoking restrictions in six specific indoor settings: hospitals, worksites, malls, restaurants, bars/cocktail lounges, and sports arenas (Gower et al. 2000; Hartman et al. 2002). Data from these settings are cited throughout this section. For each survey, respondents were queried, "In (setting)

Table 10.2 Percentage of respondents aged 18 years or older who believe that secondhand smoke is harmful, by selected characteristics, United States, 1992 and 2000

Characteristic	1992 (%)	2000 (%)
Geographic region		
Midwest	86.8	83.7
Northeast	87.0	85.3
South	84.9	81.6
West	86.6	84.6
Age (years)		
18–24	92.4	86.6
18–24 (smokers only)	83.2	76.8
25–44	88.4	85.2
25–44 (smokers only)	75.4	70.3
45–64	84.2	81.9
45–64 (smokers only)	65.6	59.4
≥65	78.5	78.4
≥65 (smokers only)	48.6	43.2
Smoking status		
Smokers	71.4	66.8
Nonsmokers	91.6	88.5
Gender		
Men	84.0	80.2
Women	88.2	86.4
Education (number of years)		
≤8	72.9	76.2
9–11	77.1	74.3
12	84.9	79.7
13–15	88.6	84.9
≥16	92.0	90.8
Income		
Below poverty	83.0	79.1
At or above poverty	87.7	84.8

Sources: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey, public use data tapes, 1992, 2000.

do you think that smoking should be: (1) allowed in all areas; (2) allowed in some areas; or (3) not allowed at all?" (USDOC 1995, pp. 9–22).

Nationally, the proportion of people who think indoor public places should be smoke-free increased between 1993 and 2002 for most settings. By 2002, there was a significant level of support among the public for banning smoking in a number of public settings, including indoor work areas, hospitals, indoor sports arenas, and malls; about 58 percent of respondents favored total smoking bans in restaurants (Table 10.3), and 34 percent favored bans in bars (Table 10.4). Factors associated with restrictions in each of the six indoor areas are presented below. Across most of the specific settings, unless exceptions are noted, women were more supportive of smoking bans than men, white-collar workers were more supportive than blue-collar workers, and older respondents were more supportive than younger respondents.

According to the Gallup survey of U.S. adults in 2004, 58 percent favored a statewide smoking ban that would make it illegal to smoke in all workplaces, restaurants, and bars; 40 percent opposed such a restrictive measure (Mason 2004). Nonsmokers were substantially more likely than smokers to favor the policy in question; 66 percent of the respondents who reported smoking in the past week opposed the policy.

Some evidence suggests that Hispanics and African Americans are more likely than non-Hispanic Whites to support smoking restrictions in certain settings. In the analysis by Yañez of the 2002 national survey commissioned by the Robert Wood Johnson Foundation, Hispanic and African American voters were more likely than White voters to believe that secondhand smoke poses serious health risks to restaurant waitstaff and office workers; that restaurant workers have no choice about being exposed to secondhand smoke and deserve the same protections as other workers; and that nonsmokers have the right to breathe clean air where they shop, work, and eat (Yañez 2002). The survey also found that Hispanic and African American voters were more likely than White voters to support laws prohibiting smoking in indoor workplaces, public buildings, and restaurants.

Using CPS data for 1993, 1996, and 1999, Gilpin and colleagues (2004) compared attitudes toward secondhand smoke between residents of California and the rest of the United States. California has had a large and comprehensive tobacco control program since 1988 that emphasized changing social norms around tobacco use. A 1995 law mandated smoke-free workplaces including restaurants; in 1998, smoking was prohibited in bars, clubs, and gaming rooms. In 1993, 58.5 percent of Californians agreed that smoking should be eliminated in at least four of six

Table 10.3 Percentage of respondents aged 18 years or older who support smoke-free restaurants, by selected characteristics, United States, 1992–2002

Characteristic	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	45.09	51.93	57.57
Geographic region			
Midwest	40.66	45.34	49.94
Northeast	45.15	51.63	58.77
South	43.52	48.31	52.90
West	52.57	64.88	71.61
Age (years)			
18–24	39.58	45.53	51.10
25–44	44.19	51.62	57.01
45–64	46.25	53.01	58.49
≥65	49.93	55.65	61.98
Smoking status			
Smokers	16.39	22.38	26.60
Nonsmokers	54.37	60.28	65.38
Gender			
Men	43.61	48.94	54.40
Women	46.36	54.64	60.49
Education			
Less than high school	45.33	51.95	57.68
High school diploma	39.91	46.27	52.14
Some college	44.91	51.70	56.70
Bachelor's/postgraduate	53.72	59.54	65.03
Income			
Below poverty	41.98	50.61	55.51
Borderline	44.69	50.38	54.67
Above poverty	45.53	52.08	57.79
Occupational status			
White collar	47.76	54.19	59.79
Blue collar	37.98	44.08	49.12
Farm	44.11	52.26	54.64
Service	39.50	47.98	53.38
Race/ethnicity			
Non-Hispanic White	43.40	49.40	55.11
Non-Hispanic Black	45.79	51.33	56.87
Hispanic	59.06	66.85	70.93
Non-Hispanic American Indian	41.51	47.11	55.79
Non-Hispanic Asian	55.34	64.82	69.33

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

Table 10.4 Percentage of respondents aged 18 years or older who support smoke-free bars, by selected characteristics, United States, 1992–2002

Characteristic	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	24.19	29.78	34.03
Geographic region			
Midwest	21.19	23.29	26.14
Northeast	25.23	31.24	35.63
South	25.29	29.12	32.32
West	24.75	36.33	43.31
Age (years)			
18–24	15.87	21.26	25.43
25–44	21.03	26.48	30.73
45–64	26.99	32.62	36.34
≥65	34.56	40.34	44.84
Smoking status			
Smokers	5.19	8.36	9.81
Nonsmokers	30.34	35.92	40.19
Gender			
Men	22.10	27.05	31.09
Women	25.96	32.30	36.77
Education			
Less than high school	28.99	35.54	38.79
High school diploma	21.63	26.75	30.92
Some college	21.55	27.51	31.07
Bachelor's/postgraduate	27.30	32.41	36.93
Income			
Below poverty	23.97	31.59	35.42
Borderline	26.34	32.18	34.83
Above poverty	23.86	28.79	32.90
Occupational status			
White collar	23.24	28.16	32.54
Blue collar	18.71	23.61	27.11
Farm	23.31	32.10	31.04
Service	20.23	27.17	30.87
Race/ethnicity			
Non-Hispanic White	22.97	27.28	31.17
Non-Hispanic Black	26.08	32.11	36.36
Hispanic	31.63	41.44	46.13
Non-Hispanic American Indian	20.95	25.52	31.45
Non-Hispanic Asian	30.58	40.76	45.19

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

venues they were queried about (restaurants, hospitals, work areas, bars, indoor sports venues, and indoor shopping malls) versus 46.5 percent of U.S. residents. By 1999, 75.8 percent of California residents were in agreement for at least four of the venues, but only 57.3 percent of other U.S. respondents showed similar support. Moreover, differences in support among demographic groups and by race and ethnicity were less pronounced in California by 1999 than in the rest of the United States. In 1999, Californians with a high school education or less (73.9 percent) showed more support for smoke-free policies compared with college graduates (65.9 percent) in all other states. The use of mass media by the California Tobacco Control Program to educate the public on the dangers of secondhand smoke included special efforts to reach racial and ethnic groups and appears to have reached all education levels (Gilpin et al. 2004). This and other studies and surveys have suggested that the presence of smoking restrictions itself contributes to public support for such restrictions, perhaps by contributing to changes in social norms. Once such restrictions have been implemented, this support appears to grow with the passage of time (Borland et al. 1990; Tang et al. 2003; RTI International 2004). This phenomenon appears to be especially pronounced among smokers. For example, an evaluation of the New York state tobacco control program found that the proportion of adults who supported the state's smoke-free law had increased from 64 percent in 2003 (before the law took effect) to 79 percent in 2005. Support among smokers nearly doubled, from 25 percent in 2003 to 46 percent in 2005. Support among nonsmokers increased from 74 to 84 percent during this same period (New York State Department of Health 2005).

Hospitals

Across all indoor settings, support for smoking bans was highest for hospitals. In fact, most hospitals in the United States have had smoking bans since 1992, when the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) required accredited hospitals to be smoke-free (JCAHO 1992). By 2001, more than 83 percent of respondents to the CPS survey favored smoking bans in hospitals (Hartman et al. 2004). Individuals living in the West were most likely to support hospital smoking bans, and people in the South and Midwest were least likely. Support increased with increasing levels of education of the respondent (USDOC, U.S. Census Bureau, NCI Tobacco Use Supplement to the CPS, public use data tape, 2002).

Restaurants

Public support for smoke-free restaurants increased from 45 percent in 1993 to 58 percent in 2002 (Table 10.3). Support for smoke-free restaurants was highest in California (which had banned smoking in restaurants and bars in 1998) and Utah, while tobacco-producing states (Kentucky, North Carolina, Tennessee, and West Virginia) reported the lowest levels of support (USDOC, U.S. Census Bureau, NCI Tobacco Use Supplement to the CPS, public use data tapes, 2001–2002). In general, support was higher in the Northeast and West than in the South and Midwest. In 2002, significantly more nonsmokers than smokers supported smoke-free restaurants (65 percent versus 27 percent, respectively). Support for smoke-free restaurants increased with higher income and education levels and higher occupational status.

Bars

Support for smoke-free bars also increased from 1993 to 2002, but remained lower than support for smoke-free policies in other settings (Table 10.4). In 1999, only California and a handful of U.S. communities outside California had implemented smoking bans in bars. In most locations, respondents would probably not have experienced this type of smoking restriction. Among states, support for smoking bans in bars in 2002 was highest in California; even before the 1998 statewide ban there had been ordinances banning smoking in bars in a number of California communities. In California, 54 percent of residents favored a total ban; among regions, support was highest among respondents from the West and Northeast. Overall, support for a ban on smoking in bars was four times higher among nonsmokers than among smokers (CDC 2005b). Studies also examined support for restricting but not eliminating smoking in bars (Table 10.5).

As of April 17, 2006, 10 states (California, Connecticut, Delaware, Maine, Massachusetts, New Jersey, New York, Rhode Island, Vermont, and Washington) have enacted and implemented state laws making bars smoke-free (ANR 2006a). In addition, as of April 17, 2006, 215 municipalities had ordinances in place requiring bars to be smoke-free (ANR 2006a).

Table 10.5 Percentage of respondents aged 18 years or older who believe smoking should be allowed in some areas of bars, by selected characteristics, United States, 1992–2002

Characteristic	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	44.18	42.65	40.64
Geographic region			
Midwest	44.37	44.57	42.55
Northeast	48.58	45.14	43.48
South	41.64	42.16	40.33
West	43.76	39.24	36.83
Age (years)			
18–24	46.20	43.19	42.34
25–44	46.53	44.77	42.19
45–64	42.54	41.83	39.89
≥65	38.82	37.94	35.44
Smoking status			
Smokers	41.84	40.45	40.00
Nonsmokers	44.94	43.28	40.80
Gender			
Men	42.16	41.67	40.28
Women	45.88	43.54	40.97
Education			
Less than high school	37.28	35.72	36.72
High school diploma	42.73	41.62	39.11
Some college	46.34	43.45	41.81
Bachelor's/postgraduate	50.11	47.65	44.52
Income			
Below poverty	38.75	37.53	36.68
Borderline	39.74	37.69	37.30
Above poverty	45.38	43.96	41.77
Occupational status			
White collar	48.48	46.15	43.78
Blue collar	40.51	40.60	38.90
Farm	39.52	38.13	39.58
Service	43.80	41.55	40.26
Race/ethnicity			
Non-Hispanic White	44.61	43.33	41.45
Non-Hispanic Black	44.99	44.60	42.09
Hispanic	39.32	35.91	35.10
Non-Hispanic American Indian	37.11	39.34	36.77
Non-Hispanic Asian	46.88	41.79	40.22

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

Other data collected after local and state bans were in place have suggested increased levels of support for these restrictions after their implementation. For example, in a poll conducted by the Field Research Corporation in 1998, when California's law prohibiting smoking in bars first went into effect, only 24 percent of smokers and 59 percent of all bar patrons supported the ban. However, a poll conducted in 2000 found that the level of support among smokers had almost doubled to 44 percent and support among all patrons had increased to 73 percent (California Department of Health Services 2000). This poll also found that 72 percent of bar patrons were concerned about the effects of secondhand smoke on their health and that 75 percent felt that it was important to have a smoke-free environment inside bars (Tang et al. 2003). Researchers found that approval among bar patrons of the California smoke-free bar law had increased from 60 percent three months after the law took effect in 1998 to 73 percent in 2000 (Tang et al. 2003). Compliance with the law has also increased over time (Weber et al. 2003). Approval for the law also increased among bar owners, managers, and employees. A study based on a telephone survey of randomly selected respondents reported that 50.9 percent of 650 bar owners, managers, and staff surveyed in 2002 stated that they preferred to work in a smoke-free environment, up from 17.3 percent of 651 surveyed in 1998 ($p < 0.001$) (Tang et al. 2004). The study also found that 45.5 percent of respondents surveyed stated that they were concerned about the effects of secondhand smoke on their health, up from 21.6 percent in 1998 ($p < 0.001$). Tang and colleagues (2004) concluded that a positive and significant attitudinal change occurred among California's bar owners, managers, and bartenders regarding the law.

Sports Arenas

Support for total smoking bans in indoor sports arenas also increased from 1993 to 2002; support was highest in the West and Northeast (Table 10.6). Support for a total ban on smoking in sports arenas was second only to support for smoke-free hospital policies among indoor public places. Blacks had lower levels of support than did Whites or Hispanics. Overall, individuals with a higher socioeconomic status (SES) were more likely to support smoke-free indoor sports arenas.

Malls

The percentage of individuals supporting a total ban on smoking in malls increased substantially from 1993 to 2002 (Table 10.7). Support was highest in the West and Northeast, while respondents from the South and Midwest expressed lower levels of support. Smokers were significantly less likely than nonsmokers to support smoke-free malls (59 percent versus 81 percent, respectively), although it is notable that by 2002, an overall 59 percent of smokers supported smoke-free malls; the youngest (18 through 24 years) and oldest (≥65 years) age groups had similar levels of support and were more supportive than the two intermediate age groups. Hispanics and Asians were the most supportive, while African Americans, American Indians, and Whites had lower (but still high) levels of support. Support generally increased with increasing levels of education. Similar levels of support were seen across income levels.

Indoor Work Areas

Support for policies prohibiting smoking in indoor work areas also increased from 1993 to 2002. By 2002, nearly 75 percent of the respondents supported having smoke-free workplaces. The lowest levels of support were in the tobacco-producing states. Support was similar across age groups and increased with increasing levels of education. A large increase in support was seen between those with a high school diploma or some college education and those with a college degree or higher educational attainment (Table 10.8).

Table 10.6 Percentage of respondents aged 18 years or older who support smoke-free sports arenas, by selected characteristics, United States, 1992–2002

Characteristic	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	66.98	71.67	77.21
Geographic region			
Midwest	66.11	69.81	75.72
Northeast	67.12	72.52	79.09
South	64.43	67.83	72.91
West	71.96	79.01	83.92
Age (years)			
18–24	64.01	69.80	75.56
25–44	65.37	70.04	75.46
45–64	68.55	73.14	77.42
≥65	71.04	74.70	80.06
Smoking status			
Smokers	48.71	53.41	59.68
Nonsmokers	72.88	76.82	81.64
Gender			
Men	63.44	67.84	73.56
Women	69.97	75.17	80.60
Education			
Less than high school	64.75	69.60	77.37
High school diploma	64.71	68.42	73.79
Some college	67.07	72.03	76.83
Bachelor's/postgraduate	72.63	76.86	81.68
Income			
Below poverty	64.02	70.03	75.56
Borderline	65.73	69.71	74.25
Above poverty	67.53	72.17	77.72
Occupational status			
White collar	68.97	73.67	79.15
Blue collar	60.01	64.69	70.01
Farm	67.11	70.95	75.10
Service	64.47	70.57	76.50
Race/ethnicity			
Non-Hispanic White	66.48	70.83	76.67
Non-Hispanic Black	65.38	68.96	74.30
Hispanic	73.47	78.30	81.99
Non-Hispanic American Indian	68.12	69.64	75.75
Non-Hispanic Asian	73.84	79.96	84.29

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

Table 10.7 Percentage of respondents aged 18 years or older who support smoke-free malls, by selected characteristics, United States, 1992–2002

Characteristic	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	54.62	69.40	76.40
Geographic region			
Midwest	51.00	64.87	73.33
Northeast	56.46	71.55	78.15
South	51.52	65.60	72.31
West	61.92	78.37	84.48
Age (years)			
18–24	49.90	71.12	78.57
25–44	52.19	68.67	75.86
45–64	55.95	68.81	74.53
≥65	62.54	71.02	77.10
Smoking status			
Smokers	31.77	50.24	59.22
Nonsmokers	61.99	74.83	80.74
Gender			
Men	51.55	66.01	73.29
Women	57.21	72.49	79.28
Education			
Less than high school	57.54	68.86	77.35
High school diploma	51.64	65.82	72.63
Some college	53.02	69.63	76.19
Bachelor's/postgraduate	58.87	74.19	80.43
Income			
Below poverty	54.94	68.63	75.52
Borderline	56.27	68.03	73.85
Above poverty	54.42	69.72	76.82
Occupational status			
White collar	54.67	71.68	78.67
Blue collar	48.53	63.24	70.41
Farm	54.30	68.42	74.32
Service	51.76	68.50	76.10
Race/ethnicity			
Non-Hispanic White	53.05	67.97	75.38
Non-Hispanic Black	55.08	67.55	74.05
Hispanic	67.86	79.28	83.59
Non-Hispanic American Indian	51.35	66.01	74.73
Non-Hispanic Asian	63.84	78.15	83.59

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

Table 10.8 Percentage of respondents aged 18 years or older who support smoke-free indoor workplaces, by selected characteristics, United States, 1992–2002

Characteristic	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	58.06	68.17	74.48
Geographic region			
Midwest	52.72	61.85	68.39
Northeast	57.07	69.00	75.42
South	56.49	65.77	72.17
West	67.59	77.89	83.45
Age (years)			
18–24	55.02	67.27	72.78
25–44	56.68	68.46	75.25
45–64	58.79	67.75	73.64
≥65	62.92	68.77	74.60
Smoking status			
Smokers	30.60	43.82	51.11
Nonsmokers	66.92	75.05	80.37
Gender			
Men	53.48	63.37	70.14
Women	61.93	72.54	78.49
Education			
Less than high school	54.68	63.41	71.69
High school diploma	52.61	62.34	68.65
Some college	59.44	69.46	75.24
Bachelor's/postgraduate	68.46	77.52	83.13
Income			
Below poverty	52.73	63.83	70.14
Borderline	55.80	63.79	68.93
Above poverty	58.96	69.12	75.40
Occupational status			
White collar	63.60	74.59	80.75
Blue collar	46.46	56.98	63.78
Farm	52.56	63.92	67.95
Service	53.05	65.21	71.87
Race/ethnicity			
Non-Hispanic White	56.40	66.22	72.81
Non-Hispanic Black	57.97	67.81	73.70
Hispanic	71.99	78.81	83.18
Non-Hispanic American Indian	51.26	62.09	70.65
Non-Hispanic Asian	73.48	81.06	85.74

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

Policy Approaches

During the past 30 years, policies to restrict smoking in public places and in workplaces have been implemented with increasing success. Over time, the number, strength, and coverage of these policies have steadily increased. Although not subject to regulation, exposure in the home (the main source of exposure for most children at present) has also been the focus of intervention research designed, to the extent possible, to help smoking parents protect their children from secondhand smoke exposure and to help smokers protect nonsmoking spouses and other adult nonsmokers who live with them.

Smoke-Free Workplace Policies

Workplace smoking restrictions are implemented by employers for a variety of reasons, including responding to a local or state law or regulation; promoting a healthier workforce; protecting employees and patrons from secondhand smoke exposure; reducing health, life, disability, and fire insurance costs; and many others (CDC, Wellness Councils of America, ACS 1996; Task Force on Community Preventive Services 2005). These restrictions may apply to work areas, public or common areas (e.g., lobbies, cafeterias, or restrooms), or to all locations (Gerlach et al. 1997) and can take a variety of forms. For example, they may

- prohibit smoking or use of all tobacco products (including smokeless tobacco) on the entire workplace campus, including both indoor areas and outdoors areas such as parking lots;
- prohibit smoking or use of all tobacco products in indoor areas and restrict smoking outdoors to certain designated areas;
- prohibit smoking or use of all tobacco products in indoor areas and in specified outdoor areas;
- prohibit smoking or use of all tobacco products in indoor areas and outdoors within a designated distance from building entrances, exits, windows, and air ducts;
- prohibit smoking in indoor areas only;
- restrict smoking indoors to designated areas that are separately enclosed and ventilated; and
- restrict smoking indoors to designated areas that are not required to be separately enclosed and ventilated (CDC, ACS, Wellness Councils of America 1996).

Only policies that (at a minimum) require indoor facilities to be completely smoke-free provide effective protection from secondhand smoke exposure (USDHHS 2000c; Task Force on Community Preventive Services 2005). Such policies are also more effective in prompting employees who smoke to quit or to reduce their cigarette consumption (Fichtenberg and Glantz 2002; Bauer et al. 2005).

Smoking Restrictions in Private Workplaces

Data from NCI's Tobacco Use Supplement to the CPS for 1993, 1996, 1999, and 2002 (U.S. DOC, U.S. Census Bureau, NCI Sponsored Tobacco Use Supplement to the CPS, public use data tapes, 1993, 1996, 1999, 2002; Shopland et al. 2001; Hartman et al. 2002) track trends in worker protection from secondhand smoke exposure based on the percentage of indoor workers reporting that they work under a smoke-free workplace policy—defined as an official employer policy that prohibits smoking in both public or common areas and work areas. Nationally, coverage of workers by smoke-free policies increased substantially from 1993 to 2002. According to CPS data, 71 percent of all indoor workers were covered by a smoke-free policy in 2002, compared with 64 percent in 1996 and 47 percent in 1993. According to NHIS data from 2000 (USDHHS, CDC, NCHS, NHIS, public use data tape, 2000), 87 percent of respondents reported an employer workplace policy restricting smoking in some fashion, compared with only 44 percent in 1992. By 2000, 92 percent of workers who reported an employer workplace policy to restrict smoking described the policy as a smoking ban in all work areas. Between 1993 and 2002, the proportion of U.S. indoor workers reporting a smoke-free workplace policy increased more than 50 percent. Between 1999 and 2002,

however, the rate of increase slowed, most likely reflecting the overall high levels of workplace smoking bans already achieved.

As already noted, a study drawing on 1999 CPS Tobacco Use Supplement data found that 69.3 percent of all U.S. workers reported a workplace policy that made all public or common areas and work areas smoke-free (Shopland et al. 2004). A greater proportion of women (73.8 percent) than men (64.2 percent) reported working under such a policy. Substantial disparities in smoke-free workplace policy coverage were evident between white-collar workers on the one hand and blue-collar and service workers on the other hand, with 76.3 percent, 52.2 percent, and 57.5 percent of these occupational groups, respectively, reporting that they were covered by a policy of this type, although the data reported indicate that these disparities have narrowed somewhat over time.

Variations by State

The CPS data showed significant variations among states in the proportion of indoor workers who reported coverage by a smoke-free workplace policy (Table 10.9) (Shopland et al. 2002). In 2002, this proportion ranged from a high of 85 percent among workers in Utah to 51 percent in Nevada. In 1993, less than 50 percent of indoor workers in 33 states reported working in smoke-free workplaces. In 1996, only two states—Arkansas and Nevada—still reported coverage rates of under 50 percent. In 2002, there were no states below this mark. At the other end of the spectrum, in 1993 only three states—Idaho, Utah, and Washington—documented that at least 60 percent of all indoor workers reported smoke-free policies. In 1996, 32 states plus the District of Columbia had achieved this level of coverage, and in 2002 the number had increased to 48 states plus the District of Columbia (Table 10.9). States with a significant tobacco growing or manufacturing presence, such as Georgia, Kentucky, North Carolina, South Carolina, and Virginia, have also experienced significant progress in the level of worker protection. The states that experienced the greatest proportional increases in smoke-free workplace policy coverage between 1993 and 1999 were North Carolina (>98 percent), Kentucky (>95 percent), and Arkansas (>92 percent), although this proportionally high gain reflects these states having levels of worker protection significantly below the rest of the nation in 1993 (Shopland et al. 2001).

Variations by Geographic Region

Some studies have also shown regional differences in workplace smoking policies. According to the CPS data, workers in the Midwest and the South had the lowest rates of smoke-free indoor workplace policies, whereas workers in the Northeast and the West had the highest rates (Figure 10.3 and Table 10.10). Between 1993 and 2002, however, indoor workers in the West reported the smallest relative increase in smoke-free workplace policies compared with workers in other regions. Nationwide, most of the observed gains occurred between 1993 and 1996 (Table 10.10).

Variations by Gender

Using CPS data, Sweeney and colleagues (2000) found that the prevalence of smoke-free indoor workplace policies also varied considerably by gender, with women significantly more likely than men to report working under a smoke-free workplace policy regardless of geographic region (Figure 10.4). This pattern occurred across all assessment periods.

Variations by Occupational Status

White-collar indoor workers reported significantly higher rates of smoke-free workplace policies compared with blue-collar or service workers (Figure 10.5). By 2002, more than 77 percent of white-collar workers in the United States reported working under a smoke-free policy, compared with just over 50 percent of blue-collar workers. Among all workers, however, Shopland and colleagues (2002) noted that there was a significant decline in the rate of increase in smoke-free policy coverage between 1996 and 1999 compared with 1993 and 1996. This decline could reflect reaching a ceiling effect at high levels of overall coverage (Shopland et al. 2002).

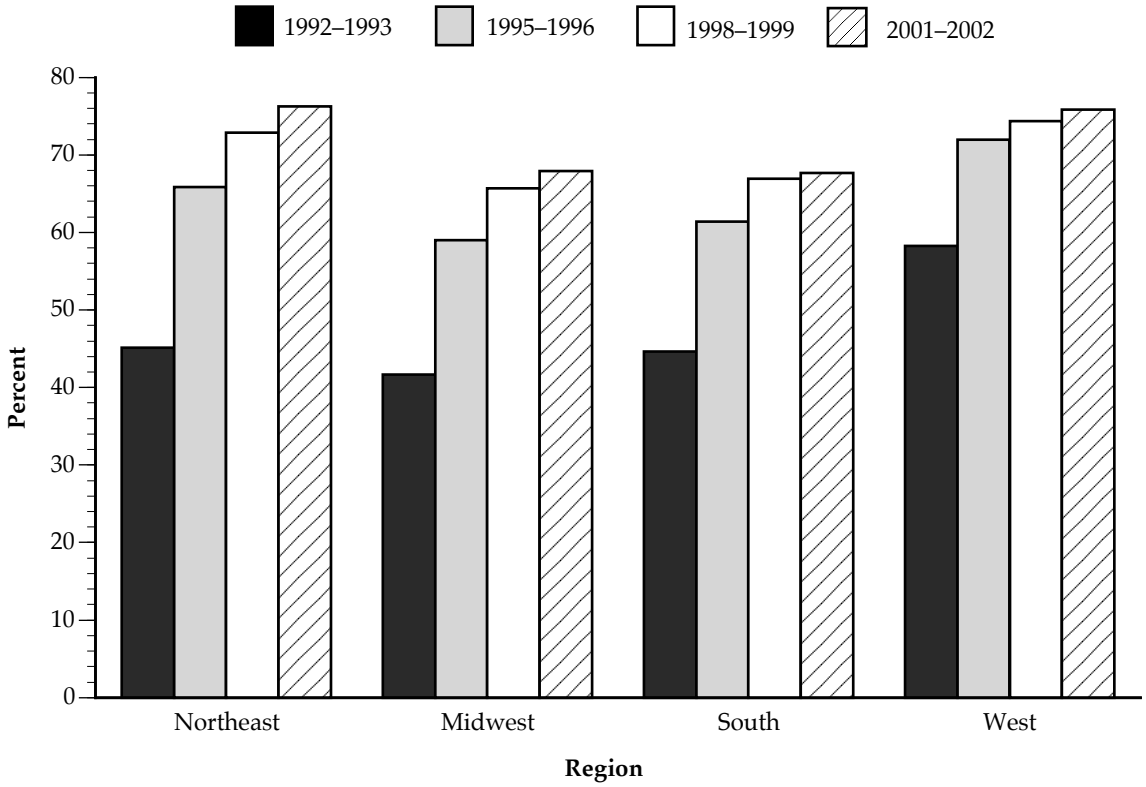
In 1999, only 43 percent of food service workers reported working in a smoke-free environment, of whom waiters and waitresses had the least protection (12.9 percent) of all job classifications among food service workers. One out of five workers in the occupational category of food service workers is a teenager, and more than half are female; wages paid to these full-time workers are among the lowest of any occupational group (Shopland et al. 2004). A study of serum cotinine concentration by occupation found

Table 10.9 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace smoking policies by state, United States, 1992–2002

State	1992–1993 (%)	1995–1996 (%)	1998–1999 (%)	2001–2002 (%)
Alabama	38.98	55.46	64.50	66.80
Alaska	58.71	69.53	73.61	77.00
Arizona	57.30	64.96	68.67	72.19
Arkansas	33.27	48.77	63.79	64.56
California	58.77	75.84	77.57	80.09
Colorado	53.87	71.51	73.07	69.35
Connecticut	48.82	67.48	74.00	73.95
Delaware	50.30	65.51	71.33	72.54
District of Columbia	52.76	74.78	74.55	76.12
Florida	53.83	66.39	69.70	65.72
Georgia	48.28	57.10	67.00	63.51
Hawaii	47.06	60.71	72.39	62.20
Idaho	60.35	70.48	71.55	71.83
Illinois	40.24	60.91	67.91	69.55
Indiana	35.83	52.43	58.75	61.14
Iowa	44.92	61.78	70.32	70.72
Kansas	49.68	63.03	74.23	72.51
Kentucky	29.34	50.56	57.21	59.24
Louisiana	39.91	56.51	64.64	64.60
Maine	55.25	73.36	75.71	81.83
Maryland	53.30	82.58	81.99	77.81
Massachusetts	48.74	71.13	77.32	81.49
Michigan	39.70	53.54	61.54	65.67
Minnesota	54.82	68.49	74.30	75.05
Mississippi	40.72	53.84	62.34	66.93
Missouri	40.32	58.78	65.92	66.10
Montana	43.77	58.15	68.74	71.05
Nebraska	44.88	63.39	68.22	70.92
Nevada	33.84	40.14	48.65	50.94
New Hampshire	53.03	73.14	74.34	76.89
New Jersey	46.37	67.90	73.06	75.25
New Mexico	55.28	65.58	68.32	71.02
New York	42.91	64.96	72.91	77.06
North Carolina	30.90	55.34	61.23	67.87
North Dakota	47.69	61.22	67.27	72.63
Ohio	37.60	56.85	63.98	66.41
Oklahoma	41.62	58.26	67.93	70.96
Oregon	59.98	66.96	66.98	74.47
Pennsylvania	41.72	59.90	69.16	72.43
Rhode Island	45.69	69.75	72.12	77.00
South Carolina	38.57	59.16	63.88	65.97
South Dakota	43.61	62.36	60.99	65.45
Tennessee	36.23	53.96	63.62	66.21
Texas	51.35	65.02	66.49	68.19
Utah	65.54	83.70	84.56	84.86
Vermont	58.65	78.24	77.74	78.46
Virginia	43.83	62.92	71.08	72.39
Washington	67.93	72.67	74.74	71.94
West Virginia	38.11	59.63	64.17	69.84
Wisconsin	44.69	62.25	64.74	69.26
Wyoming	48.37	61.33	66.12	67.57

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

Figure 10.3 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by region, United States, 1992–2002



Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

that nonsmoking waiters and waitresses had the highest cotinine levels of any occupational group (Wortley et al. 2002).

Variations by Age

In the 1993 CPS data, younger workers, particularly males, were the least protected of all age groups; this trend persisted across survey years through 2002. Generally, smoke-free policy coverage for indoor workers increased with an increase in age except in the oldest age group (Table 10.11) (Shopland et al. 2002). The NHIS data (USDHHS, CDC, NCHS, NHIS, public use data tapes, 1992, 2000) showed a similar pattern.

Variations by Race and Ethnicity

Few differences were noted with respect to race and ethnicity among indoor workers (Figure 10.6). Hispanic workers who responded to the CPS reported slightly lower rates of coverage compared with Whites or Blacks in both 1996 and 1999, whereas the 1993 rates of all three groups were similar (Shopland et al. 2002). NHIS data yielded similar results (USDHHS, CDC, NCHS, NHIS, public use data tapes, 1992, 2000).

Variations by Smoking Status

In the 1993, 1996, 1999, and 2002 CPS data, indoor workers classified as lifetime nonsmokers and former

Table 10.10 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by geographic region and gender, United States, 1992–2002

Geographic region and gender	1992–1993 (%)	1995–1996 (%)	1998–1999 (%)	2001–2002 (%)
Overall	46.65	63.85	69.34	71.15
Men	40.46	58.05	63.95	66.41
Women	51.70	69.02	74.08	75.21
Northeast	45.13	65.87	72.85	76.22
Men	38.45	60.75	68.46	72.19
Women	50.95	70.48	76.72	79.62
Midwest	41.69	58.99	65.70	67.94
Men	34.82	51.20	58.31	61.48
Women	47.37	65.99	72.23	73.54
South	44.64	61.43	66.96	67.64
Men	38.53	55.47	61.13	62.14
Women	49.13	66.41	71.82	72.11
West	58.28	72.00	74.35	75.86
Men	52.75	67.69	70.72	73.24
Women	63.16	76.20	77.81	78.28

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

smokers reported significantly higher rates of smoke-free policy coverage compared with current smokers (Table 10.12). In both 1992 and 2000, a larger percentage of nonsmokers than smokers reported employer policies that restricted smoking in work areas, but this question was only asked of individuals who had reported the existence of an employer smoking policy (USDHHS, CDC, NCHS, NHIS, public use data tapes, 1992, 2000).

Variations by Educational Attainment

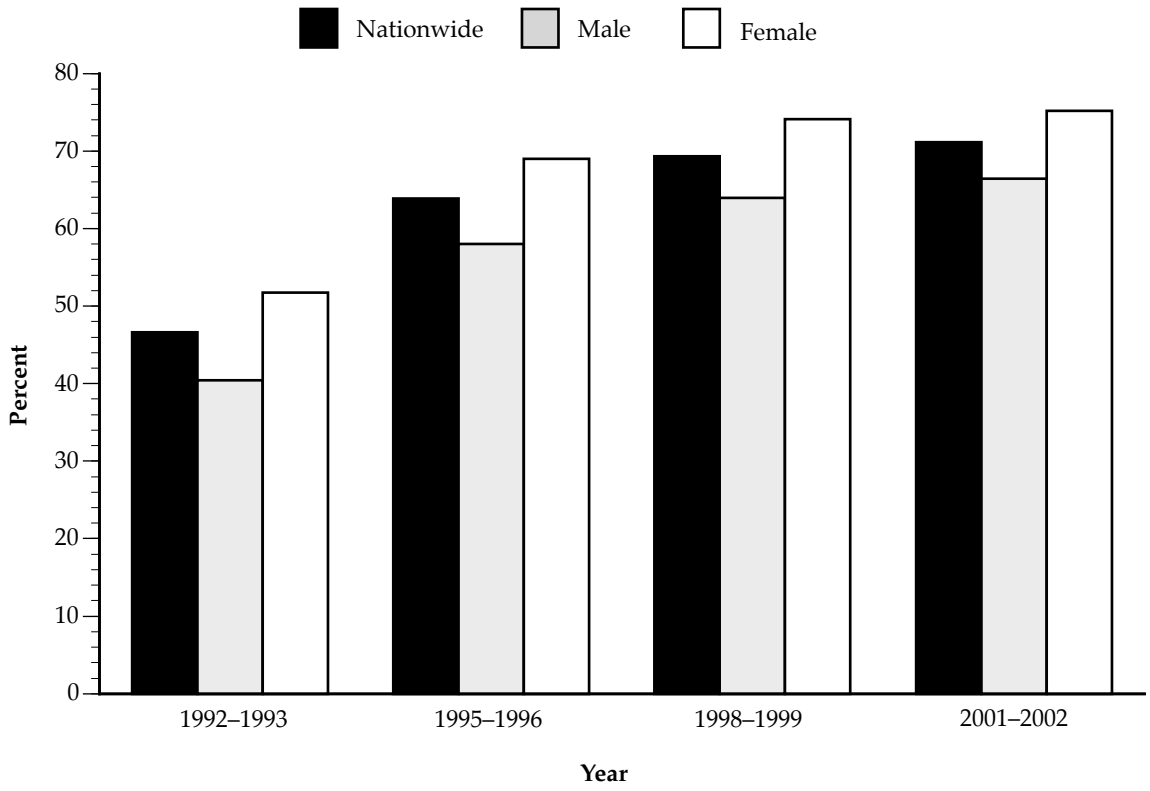
Using the CPS data across all years (Shopland et al. 2002), smoke-free worksite coverage was strongly associated with the worker's level of education (Figure 10.7). In 2002, about 57 percent of indoor workers with less than a high school education reported a smoke-free worksite, compared with 71 percent with some college education, and 81 percent with 16 or more years of education. The same trends were observed in the NHIS data (USDHHS, CDC, NCHS, NHIS, public use data tape, 2000), although the reported levels of smoke-free worksite policy coverage were higher for each educational category in the 2000 NHIS data (except those with less than a high school diploma) compared with the 1999 CPS data.

Workplace Settings with High Exposure Potential

A number of workplaces related to the entertainment and hospitality industries, including restaurants, bars, and casinos, continue to present the potential for high levels of worker exposure to secondhand smoke. This potential for higher exposure reflects the frequent exemption of these settings from state and local clean indoor air laws and the generally higher levels of smoking, primarily by patrons, in such locations.

Restaurant and bar workers are far less likely than other workers to be protected by smoke-free workplace policies, more likely than other workers to have these policies violated where they do exist, and more likely to be exposed to high levels of secondhand smoke on the job. Data from the CPS Tobacco Use Supplement document that workers in the food preparation and services occupation were less likely than employees in any other occupational category to report a workplace policy in place that designated both work areas and public or common areas as smoke-free (Shopland et al. 2004). As of 1999, only 42.9 percent of food preparation and service workers surveyed reported such a policy compared with 69.3 percent of U.S. indoor workers overall. For the more specific food service job categories of waiters/

Figure 10.4 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by gender, United States, 1992–2002



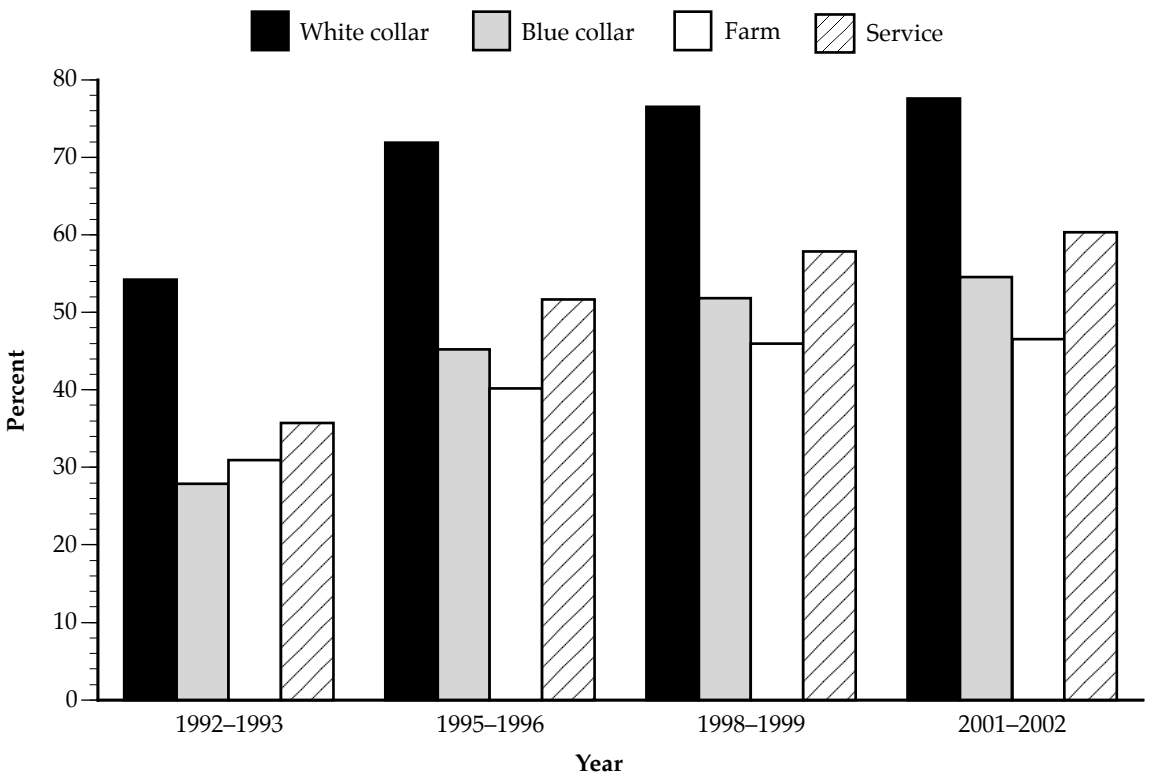
Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

waitresses and bartenders, the proportions of employees reporting such a policy were even lower: 27.7 percent and 12.9 percent, respectively. Moreover, while only 3.8 percent of all U.S. workers who worked under a smoke-free workplace policy reported that someone had smoked in their work area during the two weeks preceding the interview, the corresponding figure for food service workers was 6.4 percent (compared with 3.7 percent for nonfood service workers), and the figures for waiters/waitresses and bartenders were 12.9 percent and 32.2 percent, respectively (although in the latter two cases the confidence intervals [CIs] are quite wide).

Wortley and colleagues (2002) analyzed the objective indicator of cotinine levels among nonsmoking adult workers surveyed in the 1988–1994 Third National Health and Nutrition Examination Survey (NHANES III) who reported no home exposure to cigarette smoke; their findings are consistent with these results. The study found that waiters/waitresses had the highest geometric mean serum cotinine level and the highest proportion of workers with a cotinine level above the accepted cutoff point used to indicate secondhand smoke exposure compared with any of the occupational categories examined. The study also reported higher cotinine levels among blue collar and service occupations and lower cotinine levels among white collar occupations. Occupations with higher worker cotinine levels tended to be those in which other studies have reported that smaller proportions of workers were protected by smoke-free workplace policies (Wortley et al. 2002).

In a review of studies with reported mean concentrations of several relevant airborne substances, such as CO, nicotine, and respirable suspended particulates, Siegel (1993) found that the levels of

Figure 10.5 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by occupational status, United States, 1992–2002



Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

secondhand smoke in restaurants were 1.6 to 2.0 times higher than in offices and 1.5 times higher than in homes with at least one smoker. Levels in bars were 3.9 to 6.1 times higher than in typical office settings and 4.4 to 4.5 times higher than in homes with at least one smoker. Siegel (1993) also reviewed epidemiologic studies that provided lung cancer risk estimates for food service workers. He concluded that compared with the general population, these workers have an estimated 50 percent greater risk of developing lung cancer, in part attributable to secondhand smoke exposure on the job.

Workers in casinos that allow smoking comprise another group at high risk for exposure to secondhand smoke (Davis 1998). A 1995 study of casino workers documented the presence of nicotine in the air inhaled by the workers and an increase in serum cotinine levels across the work shift (Trout et al. 1998). The mean cotinine level in these workers was higher than for participants in NHANES III (1988–1991) who reported secondhand smoke exposure at work. A recent study found that patrons who had spent four hours in a casino where smoking was allowed experienced statistically significant increases in 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol, a tobacco-specific lung carcinogen (Anderson et al. 2003). The study concluded that exposure of a nonsmoker to secondhand smoke in a casino results in the uptake of this carcinogen. This finding has implications for casino employees who are likely to spend significantly more time than patrons in these environments. The authors noted that "on the basis of our results and other studies, one would expect that carcinogen levels in nonsmoking casino

Table 10.11 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by age and gender, United States, 1992–2002

Characteristic (years)	1992–1993 (%)	1995–1996 (%)	1998–1999 (%)	2001–2002 (%)
Age				
18–24	39.65	55.54	60.34	63.19
25–44	47.40	64.17	69.16	70.93
45–64	48.82	67.35	73.82	74.91
≥65	46.51	63.49	69.77	72.85
Men				
18–24	33.29	50.12	54.92	58.52
25–44	40.83	58.29	63.74	66.05
45–64	43.35	61.61	68.66	70.31
≥65	41.94	58.02	62.86	68.26
Women				
18–24	44.64	60.43	64.86	66.89
25–44	52.89	69.57	74.17	75.34
45–64	53.15	72.18	78.09	78.65
≥65	49.77	67.97	75.63	76.46

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

employees would increase as a result of ETS [environmental tobacco smoke] exposure at their worksite" (Anderson et al. 2003, p. 1545).

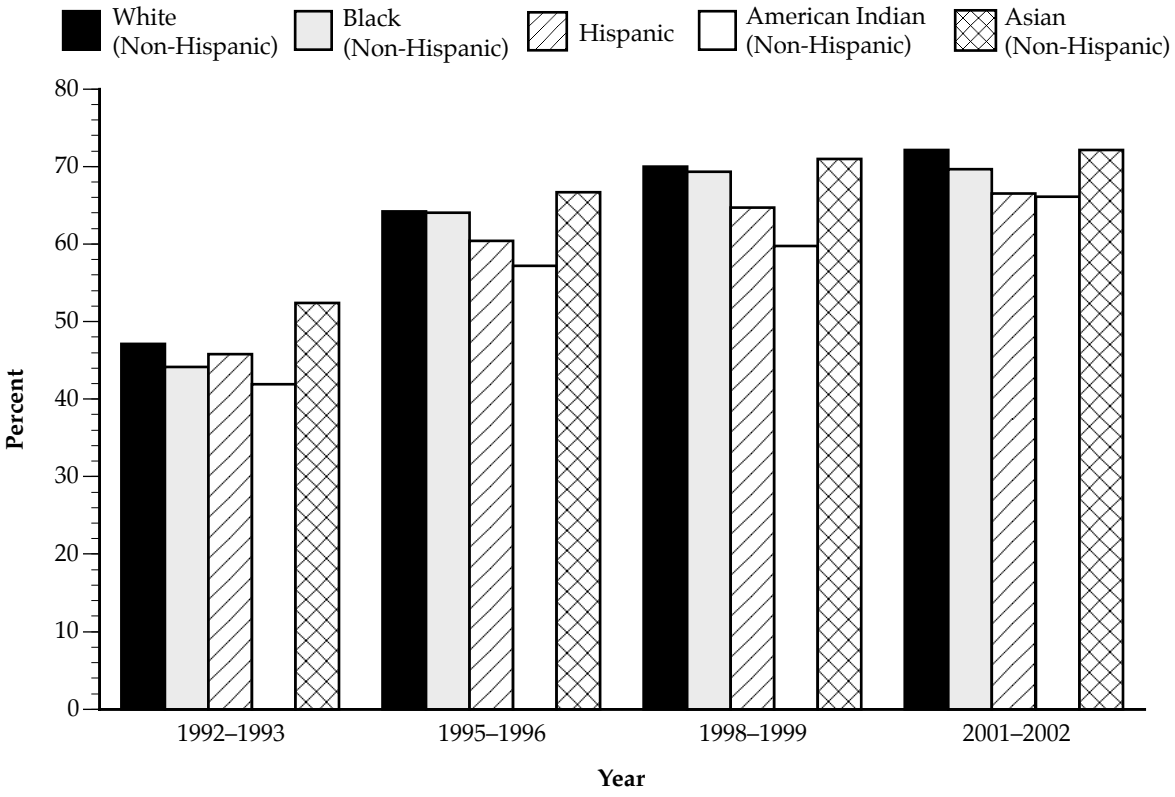
Siegel and Skeer (2003) identified additional specialized workplace settings that appear to have high potential for worker secondhand smoke exposure. The authors reviewed existing data on secondhand smoke exposure in bars, bowling alleys, billiard halls, betting establishments, and bingo parlors, measured by ambient nicotine air concentrations. Nicotine concentrations in these venues were 2.4 to 18.5 times higher than concentrations in offices or residences and 1.5 to 11.7 times higher than concentrations in restaurants. The authors concluded that these exposure levels may subject workers in those venues to (working) lifetime excess lung cancer mortality risks that substantially exceed the typical de manifestis risk level that triggers regulatory action (Siegel and Skeer 2003).

Data from the CPS Tobacco Use Supplement suggest that certain population groups are more likely to work in food preparation and service jobs and in other occupations where they are less likely than other workers to be covered by smoke-free workplace policies. These groups include teens and young adults (Gerlach et al. 1997), persons of low SES (Shopland et al. 2004), and Hispanics (Shopland et al. 2004).

Compliance with Workplace Smoking Policies

In the past, most studies focused on assessing whether workplace smoking policies were in place and describing the provisions of those policies. Less emphasis had been placed on assessing compliance with the policies. To ascertain worksite compliance with smoking policies, the 1996 and 1999 CPS asked all employees who reported working under an official policy that prohibited smoking in work areas and in public or common areas whether anyone had smoked in their work area at any time during the two-week period before their interview (USDOC 2004). In both 1996 and 1999, Shopland and colleagues (2001) noted very low rates of infractions overall (Table 10.13) and few differences by geographic region. In 1999, 3.8 percent of all U.S. workers covered by a smoke-free workplace policy reported that someone had smoked in their work area during the two weeks preceding the interview (Shopland et al. 2004). As noted earlier, this figure was substantially higher for food preparation and service workers (6.4 percent) compared with nonfood service workers (3.7 percent). The figures for waiters/waitresses and bartenders were 12.9 percent and 32.2 percent, respectively.

Figure 10.6 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by race and ethnicity, United States, 1992–2002



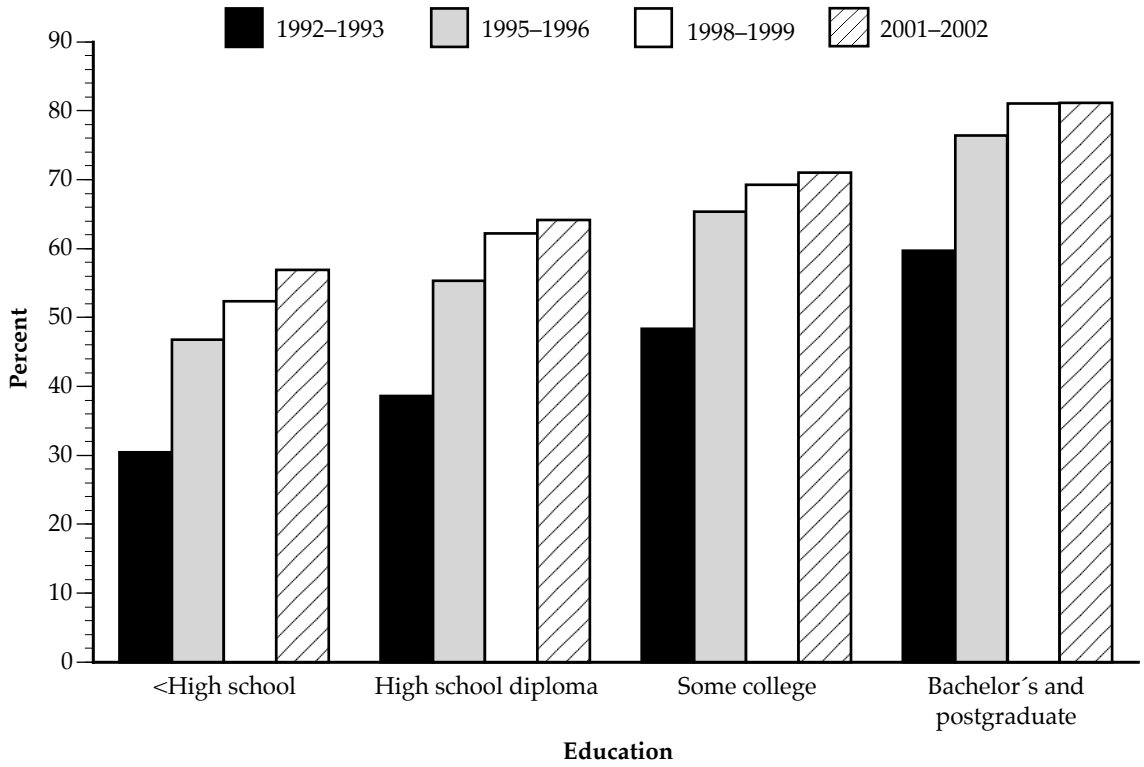
Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

Table 10.12 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by smoking status, United States, 1992–2002

Smoking status	1992–1993 (%)	1995–1996 (%)	1998–1999 (%)	2001–2002 (%)
Smokers	36.9	53.7	59.2	61.2
Nonsmokers*	49.9	67.0	72.3	73.9

*Includes lifetime nonsmokers and former smokers.
Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

Figure 10.7 Percentage of indoor workers aged 18 years or older who reported smoke-free workplace policies, by level of education, United States, 1992–2002



Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1995–1996, 1998–1999, 2001–2002.

Hyland and colleagues (1999b) assessed compliance in New York restaurants with an earlier, less stringent clean indoor air law that took effect in 1995. The study relied on three data sources: a population-based telephone survey of restaurant owners and managers, independent restaurant inspections conducted by the New York City Health Department, and complaint records maintained by the department. On the basis of the first two measures, the authors estimated that between 65 and 80 percent of restaurants were in full compliance with the law. The study found that 89 percent of restaurant proprietors reported that their indoor dining area was smoke-free and that inspections detected evidence of smoking in only 2 percent of the restaurants. Moreover, more than 80 percent of the restaurant proprietors reported that they were able to comply with the law with little or moderate effort, and 75 percent reported that they did not need to spend any money to achieve compliance. The complaint records showed a decline over the longer term. The authors concluded that restaurants were able to comply with the law with relative ease and at little expense (Hyland et al. 1999b).

Weber and colleagues (2003) looked at long-term compliance trends under California's 1998 smoke-free bars law; some studies have suggested that rates of noncompliance with smoke-free policies may be especially high in this setting (Shopland et al. 2004). Weber and colleagues (2003) examined the results of a population-based annual inspection survey of free-standing bars and of bars within restaurants in Los Angeles County. The study found that the major problem at the outset of implementation was patron smoking in freestanding bars; only 45.7 percent of freestanding bars were in compliance in 1998. Patron smoking in bars within restaurants (92.2 percent compliance) and employee smoking in freestanding bars (86.2 percent compliance) and in bars within

Table 10.13 Percentage of indoor workers aged 18 years or older who reported compliance with workplace smoking bans, by geographic region and occupational status, United States, 1995–2002

Geographic region and occupational status	1995–1996 (%)	1998–1999 (%)	2001–2002 (%)
Northeast			
White collar	95.13	96.34	96.97
Blue collar	89.31	91.55	94.44
Farm*	86.51	79.98	90.93
Service	93.24	93.07	93.74
Midwest			
White collar	95.73	96.85	97.42
Blue collar	93.37	93.85	93.75
Farm*	95.41	97.51	83.88
Service	93.07	93.63	94.28
South			
White collar	95.71	97.04	97.76
Blue collar	92.36	94.85	95.10
Farm*	96.41	96.90	91.31
Service	92.16	95.30	95.60
West			
White collar	96.71	97.38	97.55
Blue collar	94.12	94.36	94.63
Farm*	100.00	95.78	96.74
Service	93.76	93.84	95.36

Note: Compliance with workplace smoking bans is defined as no one has smoked during the past two weeks in the area in which the respondent works.
*Data were statistically unreliable.
Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1995–1996, 1998–1999, 2001–2002.

restaurants (96.5 percent compliance) were much less of a problem at baseline. By 2002, compliance (measured by the absence of patron smoking) had increased significantly in both freestanding bars (to 75.8 percent) and bars attached to restaurants (to 98.5 percent). Compliance (measured by the absence of employee smoking) had also increased by 2002 in both settings to 94.7 percent and 99.2 percent, respectively, although these increases were not significant. The authors concluded that the California law mandating smoke-free bars had effectively reduced patron and employee smoking in freestanding and attached bars in Los Angeles County and that laws of this type can be successfully implemented (Weber et al. 2003). Another study of the California smoke-free bar law found that the self-reported compliance of bar patrons who were current smokers increased from 75 percent three months after it took effect in 1998 to 86 percent in 2000 (Tang et al. 2003). The level of compliance that bar patrons who were surveyed reported observing among other bar patrons increased from 71 to 80 percent (Tang et al. 2003).

An official report documenting compliance with a New York City smoke-free workplace law that took effect in 2003 concluded that compliance was high among restaurants and bars (New York City Department of Finance 2004). The New York City Health Department inspected 22,000 establishments and found that 97 percent were in compliance with the law. Compliance was measured by the absence of observed smoking by patrons or employees, the absence of ashtrays, and the presence of properly posted "No Smoking" signs. Similarly, an observational study found that within one month after the New York state smoke-free law took effect, the proportion of smoke-free restaurants, bars, and bowling facilities statewide increased from 31 to 93 percent (New York State Department of Health 2004).

Taken together, the Los Angeles and New York findings suggest that high rates of compliance with smoke-free workplace laws can be achieved even in bars, one of the settings where a higher level of resistance to such laws would be expected.

Evidence suggests that public education and public debate before the adoption of a smoke-free law, as well as during the period leading up to its implementation, can play an important role in paving the way for successful implementation of the law and achieving high compliance rates, especially in hospitality venues. To be effective, a smoke-free law should designate an appropriate and willing enforcement agency and establish a public complaint mechanism and make the complaints received through this mechanism be the driving force for enforcement (Jacobson and Wasserman 1997; California Department of Health Services 1998, 2001a; NCI 2000b; Emerson 2001; Kiser and Boschert 2001). In addition, the law should hold business proprietors, instead of or in addition to individual patrons, responsible for violations and should treat these violations as civil, as opposed to criminal, matters. Experience suggests that laws are likely to be easier to enforce if they are drafted simply and if they contain consistent provisions that apply to all similar settings and to all persons at all times with few, if any, exemptions and ambiguities. Local clean indoor air laws also may be easier to implement because of higher levels of public awareness and cooperation from local enforcement agencies (Jacobson and Wasserman 1997). Evidence indicates that with careful drafting, proper preparation, and the passage of time, clean indoor air laws—especially at the local level—can become largely self-enforcing.

Effect of Workplace Smoking Restrictions

Air Quality

A number of studies have assessed the impact of smoke-free air laws on air quality in restaurants, bars, and other hospitality venues, determined by levels of various markers, most commonly of particulate matter. These studies have consistently found that air quality has improved markedly following the implementation of clean indoor air laws. Repace (2004b) found that levels of respirable particles and particulate polycyclic aromatic hydrocarbons fell sharply in hospitality venues following the implementation of a statewide comprehensive clean indoor air law in Delaware. Similarly, a 2004 study (CDC 2004c) documented similar findings: particulate matter levels fell substantially in hospitality venues in New York state after a comprehensive state law took effect; levels fell in every venue where smoking had been occurring at baseline.

Secondhand Smoke Exposure

The 2000 Surgeon General's report concluded that "smoking bans are the most effective method for reducing ETS exposure," and that "Optimal protection of nonsmokers and smokers requires a smoke-free environment" (USDHHS 2000c, p. 261). The 2005 *Guide to Community Preventive Services* concluded that "smoking bans and restrictions were effective in decreasing the amount of ETS by approximately 72%" and that "bans and restrictions were also effective in reducing exposure to ETS by approximately 60%" (Task Force on Community Preventive Services 2005, p. 48). The guide went on to say that it "recommends smoking bans and restrictions on the basis of strong evidence of effectiveness in decreasing both the amount of, and exposure to, environmental tobacco smoke" (p. 50).

Studies evaluating objective markers of secondhand smoke exposure among nonsmokers have confirmed self-reported data that suggest that smoke-free air policies in workplaces lead to reduced exposure. Marcus and colleagues (1992) published findings from a pilot study (n = 106) and from a larger study (n = 881) that examined the relationship between a workplace smoking policy, self-reported secondhand smoke exposure, and salivary cotinine concentrations in nonsmoking workers. In both studies, more restrictive workplace smoking policies were associated with a lower proportion of nonsmoking volunteers with detectable salivary cotinine levels. A recent study in New York City reported similar findings: cotinine levels decreased by 85 percent among nonsmoking restaurant and bar employees following the implementation of a statewide comprehensive clean indoor air law (New York City Department of Finance 2004).

A study that assessed air nicotine concentrations before and after implementation of a workplace smoking policy demonstrated a 98 percent reduction in nicotine concentrations following policy implementation (Vaughan and Hammond 1990). Hammond and colleagues (1995) collected 359 air nicotine samples at workstations of nonsmokers across 25 workplaces and found strong associations between workplace policies and nicotine concentrations. For example, the median nicotine concentration in open offices that allowed smoking was 8.6 micrograms per cubic meter ($\mu g/m^3$), compared with 1.3 $\mu g/m^3$ in workplaces that restricted smoking, and 0.3 $\mu g/m^3$ in sites that banned smoking.

A recent study from Massachusetts assessed data from a random-digit telephone dialing survey and found that adults living in towns with stronger restaurant and bar smoking regulations were more likely to report no exposure to secondhand smoke in restaurants and bars (Albers et al. 2004b). Another recent study, also from Massachusetts, documented similar findings: youth living in towns with stronger restaurant smoking restrictions were also more likely to report no exposure to secondhand smoke in restaurants (Siegel et al. 2004).

Farrelly and colleagues (2005) assessed secondhand smoke exposure levels among employees in restaurants, bars, and bowling facilities in New York state before and after implementation of a comprehensive state smoke-free law. Secondhand smoke exposure was assessed both by self-reported information collected through a telephone survey and by saliva cotinine levels. A total of 24 nonsmoking workers were included in the study. The study found that the proportion of workers reporting exposure to secondhand smoke at work fell by 85 percent from baseline to one year after the law took effect, from 91 percent (95 percent CI, 67–98) to 14 percent (95 percent CI, 4–37). Self-reported hours of secondhand smoke exposure at work during the past four days fell by 98 percent from 12.1 hours (95 percent CI, 8.0–16.3) to 0.2 hours (95 percent CI, -0.1–0.5 hours) ($p < 0.01$). Average cotinine levels fell from 3.6 nanograms per milliliter (ng/mL) (95 percent CI, 2.6–4.7 ng/mL) to 0.8 ng/mL (95 percent CI , 0.4–1.2) over this same period. The proportion of workers reporting sensory irritation symptoms (including eye, nose, or throat irritation) in the past four weeks fell from 88 percent (95 percent CI, 66–96) to 38 percent (95 percent CI, 20–59) ($p < 0.01$). In contrast, the proportion of workers reporting respiratory symptoms (including wheezing/whistling in the chest, shortness of breath, coughing in the morning, coughing during the day or at night, or bringing up phlegm) did not decrease significantly. Farrelly and colleagues (2005) concluded that the New York state smoke-free law has had its intended effect of protecting hospitality workers from secondhand smoke exposure.

Skeer and colleagues (2005) assessed self-reported workplace secondhand smoke exposure among a cross-sectional sample of 3,650 adults in Massachusetts who were employed outside the home. The data source was a larger longitudinal random digit-dialed telephone survey. Eighty-one percent of respondents reported working under a complete smoke-free workplace policy, 16 percent reported working under a policy that restricted smoking to designated areas, and 3 percent reported no workplace smoking restrictions. The study found that, overall, 27 percent of respondents reported being exposed to secondhand smoke in the workplace during the preceding week. Self-reported exposure was inversely related to the comprehensiveness of workplace smoking policies: 19.6 percent of workers reporting working under a smoke-free workplace policy reported exposure, compared with 49.9 percent of those covered by a workplace policy limiting smoking to designated areas and 75.1 percent reporting no workplace smoking policy or one that allowed smoking in most areas. Compared with employees who worked under a complete smoke-free workplace policy, employees whose workplace had no smoking restrictions in place had 10.27 times the odds of being exposed to secondhand smoke at work and 6.34 times the duration of exposure; employees who worked under a workplace smoking policy that limited smoking to designated areas had 2.9 times the odds of being exposed to secondhand smoke at work and 1.74 times the duration of exposure. Skeer and colleagues (2005) concluded that smoke-free workplace policies substantially reduce both the likelihood and the duration of workers' on-the-job secondhand smoke exposure. This appears to be one of the first studies to examine the relationship between workplace smoking policies and duration of workplace secondhand smoke exposure.

Studies thus demonstrate a strong relationship between the level of policy restriction and secondhand smoke exposure using three different measures of exposure: cotinine levels, air measurements, and self-reports.

Health Outcomes

Several studies have gone beyond assessing the impact of workplace smoking restrictions on secondhand smoke exposure and have examined their impact on actual health outcomes. These studies have found that smoke-free workplace laws appear to yield health benefits soon after implementation.

Eisner and colleagues (1998) examined the impact of the California smoke-free bars law on the respiratory health of bartenders. The investigators assessed respiratory symptoms and pulmonary function in 53 bartenders from a random sample of bars in San Francisco, California, before and eight weeks after the law took effect. Self-reported exposure to secondhand smoke at work declined from a median of 28 hours per week at baseline to 2 hours per week after the ban. Of the bartenders (74 percent) who reported

respiratory symptoms such as cough or wheeze at baseline, 59 percent reported no symptoms at follow-up. There was a statistically significant improvement in pulmonary function using measurements of mean forced vital capacity and forced expiratory volume in one second following the ban. This finding suggests that the long-term exposure to secondhand smoke experienced by bartenders does have an adverse health effect, and smoking bans can effectively protect the health of these workers (Eisner et al. 1998).

Fichtenberg and Glantz (2000) assessed the impact of California's statewide tobacco control program, implemented in 1989, on heart disease mortality from 1980 to 1997, when heart disease mortality rates were steadily declining. The authors found a significant decrease in mortality after 1989 and estimated that there were 58,900 fewer deaths from heart disease between 1989 and 1997 because of the program (Fichtenberg and Glantz 2001). This benefit of the program might reflect reduction not only of active smoking but of involuntary smoking.

Sargent and colleagues (2004) reported that a comprehensive clean indoor air law in Helena, Montana, appeared to be associated with a significant reduction in the number of monthly hospital heart attack admissions during the six months that it was in effect (16 fewer admissions, 95 percent CI, -31.7 to -0.3). A commentary on the study reviewed recent literature on the acute cardiovascular effects of brief secondhand smoke exposures and noted that, although the study had important limitations and needed to be replicated, its findings were broadly plausible and suggest that comprehensive smoke-free measures might potentially produce quick and substantial reductions in heart disease morbidity and mortality (Pechacek and Babb 2004).

Smoking Behavior

Workplace smoking restrictions have the potential to change employees' smoking patterns by reducing opportunities to smoke, by altering workplace norms, and, in some cases, by providing more access to employer-provided cessation services. A series of studies described below examined the impact of smoking restrictions on the number of cigarettes smoked and on smoking rates among employees who are current smokers. Studies have found an association between workplace smoking policies, particularly more restrictive policies, and decreases in the number of cigarettes smoked per day, increases in attempts to stop smoking, and increases in smoking cessation rates.

An analysis of data from a five-year COMMIT follow-up of 8,271 employed adult smokers examined changes in the number of cigarettes smoked per day relative to workplace smoking policies. These self-reported surveys were conducted in 1988 and 1993 (Glasgow et al. 1997). Using multiple linear regression techniques, the investigators found a statistically significant reduction in the number of cigarettes smoked per day over the five-year period in workplaces where smoking was restricted to designated areas compared with workplaces without smoking restrictions. There was an even greater reduction in daily cigarette use among workers whose workplaces completely prohibited smoking; those employees were 25 percent more likely to make a cessation attempt and 25 percent more likely to successfully quit compared with workers in workplaces without smoking bans.

A similar analysis of the California Tobacco Survey data found that current daily smokers who worked in workplaces with some smoking restrictions were more likely to reduce the number of cigarettes they smoked per day compared with smokers who worked in workplaces with no smoking restrictions (odds ratio [OR] = 1.38 [95 percent CI, 0.95–2.00]) (Moskowitz et al. 2000). A greater effect was noted for daily smokers whose workplaces banned smoking (OR = 1.52 [95 percent CI, 1.14–1.71]). The study controlled for gender, age, race, ethnicity, education level, family income, and the number of cigarettes smoked per day one year before the survey (Moskowitz et al. 2000). Using 1993 and 1996 CPS data, Burns and colleagues (2000) collected data from indoor workers who were 25 through 64 years of age and who had smoked daily one year before their interviews in both surveys. Comparing smokers who worked in smoke-free workplaces with smokers who worked in workplaces with less stringent or no restrictions, the investigators found a statistically significant ($p < 0.001$) shift toward smoking fewer cigarettes per day among workers in smoke-free workplaces. However, the authors were unable to directly attribute these reductions to workplace smoking restrictions because the CPS did not ask for the number of cigarettes smoked per day one year before the interview (Burns et al. 2000). Working in a smoke-free environment was also associated with a greater likelihood of being a former smoker or quitting for at least three months. A recent review of studies examining the impact of smoke-free workplaces on smoking behavior concluded, using a pooled estimate of the reviewed studies, that totally smoke-free workplaces were associated with a reduction in smoking prevalence of 3.8 percent and with a

reduction in daily smoking among continuing smokers of 3.1 cigarettes per day (Fichtenberg and Glantz 2002). Extrapolating these findings to the U.S. workforce, Fichtenberg and Glantz (2002) estimated that if all U.S. workplaces became smoke-free, the per capita U.S. cigarette consumption would drop by 4.5 percent.

A cohort study drawing on telephone survey data collected as part of COMMIT found that employees in workplaces that changed to or maintained smoke-free workplace policies between 1993 and 2001 were 1.9 times more likely (OR = 1.92 [95 percent CI, 1.11–3.32]) than employees whose workplaces allowed smoking everywhere to have quit smoking by 2001 (Bauer et al. 2005). Continuing smokers reported consuming 2.57 fewer cigarettes daily on average. Employees working under smoke-free workplace policies in both 1993 and 2001 were 2.3 times more likely (OR = 2.29 [95 percent CI, 1.08–4.45]) than employees whose workplace allowed smoking everywhere to have quit by 2001, with continuing smokers reporting consuming 3.85 fewer cigarettes daily on average. Workplace policies that restricted smoking to designated areas did not have a significant effect on cessation. Worksite smoking policies were not related to the number of quit attempts reported. The proportion of respondents who reported working under a smoke-free workplace policy increased from 27 percent in 1993 to 76 percent in 2001. Bauer and colleagues (2005) concluded that smoke-free worksite policies help employees reduce their cigarette consumption and quit smoking.

A recent NCI monograph summarized the evidence on the impact of smoke-free workplace policies on the smoking behavior of employees:

> [Smoke-free workplace policies] … have two effects on smokers as they are implemented. They increase the rate at which smokers attempt to quit, and they reduce the number of cigarettes smoked per day. Once restrictions on smoking in the workplace have been successfully implemented, they continue to have the effect of reducing the number of cigarettes smoked per day, and they increase the success rate of smokers who are attempting to quit. There may also be a small effect of increasing the frequency with which smokers attempt to quit (NCI 2000a, p. 118).

Additional benefits of these interventions (smoking bans and restrictions) include reductions in daily consumption of cigarettes among workers exposed to bans or restrictions and increases in tobacco use cessation by smokers exposed to workplace smoking bans (Task Force on Community Preventive Services 2005).

Recent evidence suggests that comprehensive smoke-free laws may have an effect on smoking behavior that extends beyond employees of the affected workplaces. Recent findings from New York City and Delaware indicate that, when implemented in conjunction with other evidence-based tobacco control activities, including cigarette excise tax increases, such laws may contribute to substantial and quick reductions in adult smoking prevalence among the general population (State of Delaware 2004; Frieden et al. 2005). In both cases, adult smoking prevalence fell by 11 percent in one year, with even sharper decreases in the smoking prevalence among young adults.

Based on a review of the applicable evidence, the *Guide to Community Preventive Services* concluded that "additional benefits of these interventions [smoking bans and restrictions] include reductions in daily consumption of cigarettes among workers exposed to bans or restrictions and increases in tobacco use cessation by smokers exposed to workplace smoking bans" (Task Force on Community Preventive Services 2005, pp. 50–51). The publication also concluded that smoking bans and restrictions … helped to reduce cigarette consumption and to increase the number of people who quit smoking" (Task Force on Community Preventive Services 2005, p. 49).

Some studies have also found that smoke-free laws contribute to decreases in smoking among youth. For example, a national study found that adolescents who work in smoke-free workplaces are significantly less likely to be smokers than adolescents who work in workplaces with no smoking restrictions or with restrictions less than a smoking ban in a full work area (Farkas et al. 2000). A Massachusetts study found that youth living in towns with smoke-free restaurant laws were less than 50 percent as likely to progress to established smoking behaviors compared with youth living in towns with weak smoking restrictions in restaurants (Siegel et al. 2005). The *Guide to Community Preventive Services* found that "smoke-free policies also challenge the perception of smoking as a normal adult behavior. By changing this perception, these policies can change the attitudes and behaviors of adolescents, resulting in a reduction in tobacco use initiation" (Task Force on Community Preventive Services 2005, p. 48).

As noted earlier, numerous tobacco industry documents suggest that cigarette manufacturers have also recognized that workplace smoking restrictions, especially smoke-free policies, prompt some smokers to quit and lead continuing smokers to reduce

their smoking. For example, one document states that "smoking bans are the biggest challenge we have ever faced. Quit rate goes from 5% to 21% when smokers work in non-smoking environments" (<http://legacy.library.ucsf.edu/tid/nyg12a00>). Another document states that "total prohibition of smoking in the workplace strongly affects industry volume. Smokers facing these restrictions consume 11%–15% less than average and quit at a rate that is 84% higher than average" (John Heironimus, memo to Louis Suwarna, January 22, 1992; <http://legacy.library.ucsf.edu/tid/rvv24e00>). The document goes on to note that "milder workplace restrictions, such as smoking only in designated areas, have much less impact on quitting rates and very little effect on consumption." The document concludes that "clearly, it is most important for PM [Philip Morris] to continue to support accommodation for smokers in the workplace." Finally, a third document states that "financial impact of smoking bans will be tremendous. Three to five fewer cigarettes per day per smoker will reduce annual manufacturer profits a billion dollars plus per year" (<http://legacy.library.ucsf.edu/tid/ijo42e00>). In fact, industry documents suggest that the concern that workplace smoking restrictions will cause smokers to quit or reduce their tobacco use is a major motivation for the industry's repeated efforts to prevent or reverse the adoption of such restrictions.

Social Norms

In addition to protecting nonsmokers from secondhand smoke and helping smokers to quit or reduce their cigarette use, it is also likely that smoking restrictions contribute to changes in public norms regarding the social acceptability of smoking, although relatively few studies have examined this issue. A study that relied on a random-digit telephone dialing survey in Massachusetts, which had a comprehensive program in place, examined the relationship between the strength of local restaurant smoking regulations and the perceived social acceptability of smoking in restaurants, bars, and in general among adults and youth (Albers et al. 2004a). The study also assessed the relationship between the strength of these regulations and perceptions of adult smoking prevalence and found that in towns with strong regulations, adults (but not youth) were more likely to consider smoking in restaurants and bars as unacceptable. In addition, adults and youth living in towns with strong regulations were generally more likely to think that most adults in their town perceived smoking in restaurants as unacceptable compared with their counterparts in towns with less stringent or no regulations. Youth who lived in towns with strong regulations were also more likely to perceive that most adults in their town disapproved of smoking in general (i.e., not just in restaurants).

Finally, in towns with strong regulations, youth, but not adults, were more likely to perceive a lower prevalence of adult smoking. The 2005 *Guide to Community Preventive Services* states that "smoke-free policies also challenge the perception of smoking as a normal adult behavior. By changing this perception, these policies can change the attitudes and behaviors of adolescents, resulting in a reduction in tobacco use initiation" (Task Force on Community Preventive Services 2005, p. 48).

A number of studies have suggested that smoke-free laws, which depend for their successful implementation on prior changes in social norms, contribute to further changes in these norms over time once they are in place (NCI 2000b; Tang et al. 2003; Gilpin et al. 2004). One implication is that the presence of smoke-free policies leads to further public support for such policies (Borland et al. 1990; Tang et al. 2003; Gilpin et al. 2004; RTI International 2004).

Economic Impact of Smoking Restrictions on the Hospitality Industry

The economic impact of smoke-free regulations on restaurants and bars has been the subject of intense debate, often at local or state levels as bans have been considered. Owners of establishments who view regulations as negatively affecting sales or other aspects of how they conduct their business are reluctant to support such measures or may oppose them. The tobacco industry has consistently claimed that such measures lead to an approximate 30 percent or greater decline in sales (Traynor et al. 1993; Glantz and Charlesworth 1999; Dearlove et al. 2002). However, the industry claims are countered by many studies published during the last decade in the peer-reviewed scientific literature that assessed various objective economic impacts of these regulations on bars and restaurants. A number of these studies are described below. Regardless of the outcome measured, the studies found no evidence of negative economic impacts.

Studies that assessed the economic impact of clean indoor air laws have generally focused on restaurants and bars. Objective indicators of an economic impact on these establishments include sales tax receipts and revenues, employment, and the number of restaurant and bar licenses issued by state health departments and state liquor authorities. Although

most of the studies have looked at sales tax data, employment and license data have the advantage of being available more quickly. Some studies have also included surveys that assessed self-reported intentions and behaviors of the customers of these food and beverage establishments. Economic impact studies have assessed the effects of both local and state clean indoor air laws.

Two of the first studies on the economic impact of clean indoor air laws on restaurants and bars were carried out by Glantz and Smith (1994, 1997). Both studies used sales tax data to assess the impact of local ordinances in California and Colorado. The first study found no effect on the fraction of total retail sales that went to restaurants or on the ratio of restaurant sales in communities with ordinances compared with restaurant sales in control communities without such ordinances that were also matched for population, income, smoking prevalence, and geographic location. The communities varied in population size from a few thousand to more than 300,000, and the length of time that the ordinances were in effect ranged from a few months to more than 10 years (Glantz and Smith 1994).

In a follow-up study that included additional analyses of sales data from the 15 cities included in the original study, Glantz and Smith (1997) again examined restaurant sales as a fraction of total retail sales before and after implementation of the ordinances. The investigators compared the ratio of restaurant sales in communities that had enacted ordinances with restaurant sales in communities without ordinances and found that local smoke-free restaurant ordinances did not have a significant effect on restaurant sales. This study also included data from seven communities in California (five cities and two counties) that had enacted ordinances requiring smoke-free bars that were matched with communities without such ordinances. The study examined sales from specific eating and drinking establishments with licenses to serve all types of liquor as a fraction of all retail sales and as a fraction of all sales by eating and drinking establishments. The authors detected no significant effect on bar sales as a fraction of total retail sales, on the ratio between bar sales in cities with and without ordinances, or on the ratio of sales from eating and drinking establishments that were licensed to serve all types of liquor compared with all sales from eating and drinking establishments (Glantz and Smith 1997). The length of time that smoke-free ordinances in bars had been in effect ranged from 25 to 65 months.

Other studies have reached similar findings. One study analyzed restaurant sales after a local ban on smoking had taken effect in a small suburb of Austin, Texas, and found, contrary to prior claims, no indication of reduced restaurant sales (CDC 1995). Other analyses of sales tax receipts have also found that over time, such ordinances had no effect on the fraction of total retail sales for eating and drinking establishments. A more recent study examined whether a smoking ban in El Paso, Texas, affected restaurant and bar revenues (CDC 2004b). In January 2002, the city implemented an ordinance banning smoking in all public places and workplaces, including restaurants and bars. The study, which examined sales tax and mixed-beverage tax data from 12 years before and 1 year after the ordinance was implemented, found that there were no statistically significant changes in restaurant and bar revenues after the ordinance was implemented.

Using taxable sales data from eating and drinking establishments in New York City, Hyland and colleagues (1999a) observed a 2.1 percent increase in sales following implementation of a citywide smoking ban in restaurants compared with sales two years before the law took effect. At the same time, taxable sales in eating and drinking establishments in the rest of the state declined by 3.8 percent. Using a nonrandomized pretest/posttest design and controlling for seasonal effects, Bartosch and Pope (1999) examined the impact of smoke-free restaurant ordinances in 35 cities and towns in Massachusetts between January 1992 and December 1995. The authors used aggregate meal tax data collected by the Massachusetts Department of Revenue before and after the ordinances took effect. The number of restaurants per community varied considerably, from less than 10 to more than 150. Cities and towns without a smoke-free restaurant policy served as comparison communities. The study documented that the enactment of a local smoke-free restaurant ordinance was not followed by a statistically significant changes in the taxable meals revenue that the town collected (Bartosch and Pope 1999).

An in-depth analysis of California tax revenue data from 1990 to 2002 found that the 1995 statewide smoke-free restaurant law was associated with an increase in restaurant revenues. The analysis also found that the 1998 statewide smoke-free bar law was associated with an increase in bar revenues (Cowling and Bond 2005).

Finally, a study of the California smoke-free bar law found that the proportion of bar patrons who reported that they were just as likely or more likely to visit bars that had become smoke-free increased from 86 percent three months after the law took effect in 1998 to 91 percent in 2000 (Tang et al. 2003).

A recent report from New York City assessed all four economic indicators (sales tax receipts, revenues, employment, and the number of licenses issued) and found no negative impact on restaurants and bars from city and state clean indoor air laws (New York City Department of Finance 2004). This study specifically examined various time periods before and after the laws took effect and reported increases in all four economic measures. Restaurant and bar business tax receipts had increased by 8.7 percent; employment in restaurants and bars had increased by about 2,800 seasonally adjusted jobs, amounting to an absolute gain of about 10,600 jobs; and there was a net gain of 234 active liquor licenses for restaurants and bars out of a total of 9,747 such licenses. In addition, a majority of respondents to a Zagat survey and a Zogby poll reported that the smoking restrictions would not have any effect on their patronage of restaurants and bars (New York City Department of Finance 2004). Moreover, the number of respondents who would patronize these establishments more frequently as a result of these restrictions exceeded the number of respondents who said their patronage would decrease. An evaluation of the New York state tobacco control program reached similar findings regarding the economic impact of New York's statewide smoke-free law. The report found that this law had no impact on sales in full-service restaurants and bars (New York State Department of Health 2005).

Studies have also assessed the economic impact of smoke-free restaurant laws on tourism. Glantz and Charlesworth (1999) examined hotel revenues and tourism rates in six cities before and after passage of 100 percent smoke-free restaurant ordinances and compared these revenues and rates with those of U.S. hotels overall. The results indicated that smoke-free restaurant ordinances do not adversely affect tourism revenues and may, in fact, increase tourism (Glantz 2000). More recently, Dai and colleagues (2004) used a variety of measures to assess the impact of a state clean indoor air law in Florida on gross sales and employment levels in the leisure and hospitality industry throughout the state and, more specifically, on restaurants, hotels, and tourism (Dai et al. 2004). The study found increases in the fraction of retail sales from restaurants, lunchrooms, and catering services and increases in the fraction of employment in drinking and eating places and the fraction of employment in the leisure and hospitality industry as a whole following implementation of the law. There were no significant changes in the fraction of retail sales from taverns, night clubs, bars, liquor stores, and recreational admissions or in the fraction of employment in the hospitality industry after the law took effect. The authors concluded that they were not able to detect a significant negative effect of the state law on sales and employment in the leisure and hospitality industry. The study analyzed sales data from restaurants, lunchrooms, and catering services separately from sales data for taverns, night clubs, and bars, thus addressing a concern that analyzing sales data from eating and drinking places combined could potentially blur differential impacts on these sectors. Interestingly, the study found that the fraction of retail sales for restaurants, lunchrooms, and catering services (which were covered by the law) increased following implementation of the law, but the corresponding fraction did not increase for taverns, night clubs, and bars (which were not covered by the law). These findings suggest that there was no shift in patronage from hospitality venues that were required to be smoke-free to hospitality venues where smoking was still allowed.

Few studies have examined the impact of smoking restrictions on gaming venues (such as casinos), which may be due in part to the fact that, until recently, few gaming venues in the United States have been included in governmental smoking restrictions; some venues have implemented significant voluntary smoking policies of their own. A linear regression analysis of the economic impact of a comprehensive state smoke-free law on casinos in Delaware that drew on revenue data from the Delaware Video Lottery found that the law had no significant effect either on total revenues ($p = 0.126$) or the average revenue per video lottery terminal ($p = 0.314$) (Mandel et al. 2005). The study controlled for economic activity and seasonal effects. In another study, researchers analyzed financial information reported to the State Lottery Commission. Local ordinances in Massachusetts that made charitable bingo venues smoke-free did not appear to negatively affect the profits from those venues (Glantz and Wilson-Loots 2003).

Discrepancies between economic impact studies of clean indoor air laws conducted either by the tobacco industry or by non-industry–supported scientists can be traced in part to variations in the types of data analyzed. Studies commissioned by or for the tobacco industry to assess the economic impact of smoke-free restaurant and bar regulations have generally relied on proprietor predictions or estimates of changes in sales, rather than on actual sales or revenue data. Such estimates are subject to significant reporting bias and are viewed with skepticism because they do not constitute empirical data. Scollo and colleagues (2003) investigated the possible causes of these discrepancies by examining the quality of studies on

economic effects of smoke-free policies. Studies showing a negative economic impact that was attributed to clean indoor air laws were 4 times more likely to have used a subjective outcome measure and 20 times more likely not to have been subject to peer review than studies that found no adverse economic impact. All of the studies that found a negative economic impact were supported by the tobacco industry (Scollo et al. 2003). No peer-reviewed study using objective indicators such as sales tax revenues and employment levels found an adverse economic impact of smoke-free laws on restaurants and bars.

In assessing the economic impact of smoke-free policies and laws, their beneficial effect in reducing health care costs must also be weighed. One study using a simulation model projected that implementation of smoke-free policies in all U.S. workplaces would result in 1.3 million smokers quitting, 950 million fewer cigarette packs being smoked, 1,540 myocardial infarctions and 360 strokes being averted, and $49 million in direct medical cost savings being realized, all within the first year (Ong and Glantz 2004). The number of acute health events averted and the costs saved would increase over time. The model took into account both the impact of smokers quitting and the impact of the elimination of workplace secondhand smoke exposure among nonsmoking employees, with reduced secondhand smoke exposure accounting for 59 percent of the averted myocardial infarctions and 50 percent of the cost savings from averted myocardial infarctions during the first year (Ong and Glantz 2004).

The 2005 *Guide to Community Preventive Services* concluded that "we found no adverse impacts on business or tourism as a result of these policies" (Task Force on Community Preventive Services 2005, p. 49). Recently, some business organizations have come to the conclusion that smoke-free policies and laws can actually have a positive economic impact, as reflected not only in increased productivity and savings in employee health care costs, other insurance costs, and cleaning and maintenance costs, but also in the image and business climate of a community. For example, the Chamber of Commerce in Louisville, Kentucky, recently came out in support of a proposed municipal smoke-free ordinance. The president of the Chamber explained that "We believe that this piece of legislation … has reasonable controls and is responsible in terms of really making a difference in the community and ultimately helping us reach our vision of becoming an economic hot spot" (Gerth 2005). "We would generally be in favor of less regulation," said Carmen Hickerson, a spokeswoman. "But quality-of-life issues are decisions that factor in to economic development. Those things have as much, or more, weight than traditional economic development tools, such as tax breaks" (Vereckey 2005).

Household Smoking Rules

Home smoking restrictions are private household rules that are adopted voluntarily by household members. They can include comprehensive rules that make homes smokefree in all areas at all times and less comprehensive rules that restrict smoking to certain places or times (e.g., allowing smoking only in specific rooms, designating certain rooms as smoke-free, allowing smoking only when no children are present, etc.) (Pyle et al. 2005). The only approach that effectively protects nonsmokers from secondhand smoke exposure is a rule making the home completely smoke-free (Levy et al. 2004).

Smoke-free home rules and other home smoking restrictions may be implemented for a variety of reasons, including

- to protect children in the household from secondhand smoke exposure;
- to protect pregnant women in the household from secondhand smoke exposure;
- to protect nonsmoking spouses or other nonsmoking adult household members from secondhand smoke exposure;
- to protect children or adults who have health conditions that are exacerbated by secondhand smoke exposure or who are at risk for health conditions that can be triggered by secondhand smoke (e.g., a child with asthma, an adult with or at special risk for heart disease);
- to help smokers in the household cut down their cigarette consumption;
- to help smokers quit;
- to help smokers who have quit maintain abstinence;
- to set a positive example for children and youth in the household, to prevent them from becoming smokers themselves;

- aesthetic, hygienic, economic, and safety considerations, including eliminating the odor of secondhand smoke, eliminating cigarette burns, and eliminating the risk of fires caused by discarded cigarettes; and

- simply because no one in the household smokes anymore (Ferrence et al. 2005).

Prevalence and Correlates

Reducing secondhand smoke exposure in the home is important because the home is a major source of exposure for children and for those nonsmoking adults who are not exposed elsewhere. Reducing exposure in this setting is challenging, however, because there are no clearly established interventions that effectively reduce exposure at home. In addition, because smoke-free home rules are adopted voluntarily, rather than imposed by government bodies or employers, the prevalence of these rules is an important indicator of changes in norms regarding the social acceptability of smoking. In the text that follows, the definition of "children" varies across the studies cited.

In the past decade, substantial increases have occurred in the number of U.S. households with private rules to limit secondhand smoke exposure within the home. Even smokers are increasingly adopting such rules. One of the best data sources available on children's secondhand smoke exposure in the home is the National Health Interview Survey (NHIS). This information can be derived from NHIS data by correlating data on smoking in the home with data on households with children. NHIS data shows that the proportion of children aged 6 years and younger who are regularly exposed to secondhand smoke in their homes fell from 27 percent in 1994 to 20 percent in 1998. A recent study by Soliman and colleagues (2004) examined data from the NHIS and found that the prevalence of secondhand smoke exposure in homes with children fell from 35.6 percent in 1992 to 25.1 percent in 2000. The prevalence of adult smoking fell by a smaller amount during this same period, from 26.5 to 23.3 percent, indicating that a portion of the reduced exposure can be explained by the increase in home smoking rules. Home exposures declined across all racial, ethnic, educational, and income groups that were analyzed. Farkas and colleagues (2000) analyzed data from adolescents aged 15 through 17 years from the 1993 and 1996 CPS. Of those respondents, 48 percent lived in smoke-free households in 1993 and 55 percent lived in smoke-free homes by 1996.

The CPS data show that the percentage of smoke-free homes increased by 40 percent between 1993 and 2002, from 43 to 66 percent (Table 10.14). Households with a smoker in the home had lower rates of smoke-free home rules than did households without a smoker; however, the prevalence of smoke-free rules in homes with smokers increased by 110 percent between 1993 and 1999. In a 1997 survey in Oregon, Pizacani and colleagues (2003) found similar differences in the prevalence of smoke-free home rules between nonsmoking households (85 percent) and households with one or more smokers (38 percent). These trends of smoke-free home rules were observed in all four regions of the country in the CPS data. Individuals living in the West reported higher rates of smoke-free homes, but the largest increases between 1993 and 2002 were in the South and the Midwest. Similarly, there were wide variations among states in the percentage of individuals reporting household smoking bans. Utah reported the highest rate (83 percent), followed by California (78 percent), Arizona (76 percent), and Idaho (74 percent) (Tables 10.14 and 10.15).

The presence of a child younger than 13 years of age was associated with only a slight increase in the rate of smoke-free homes compared with homes where there were no children under 13 years of age (Table 10.15). However, a survey of 598 adult smokers living in an inner-city neighborhood in Kansas City (Missouri) found that after adjusting for age, race, gender, and education, a rule banning smoking or restricting it to designated locations in the home was significantly more likely in households with a child (OR = 2.63 [95 percent CI, 1.70–4.08]) or a nonsmoking adult partner (OR = 2.07 [95 percent CI, 1.19–3.61]) (Okah et al. 2002).

Households with lower incomes reported lower rates of smoke-free home rules compared with higher income households. The amount smoked was higher in lower income homes, whether or not a smoker resided in the home (Okah et al. 2002).

EPA conducted a national telephone survey in 2003 on children's secondhand smoke exposure and childhood asthma among a random digit-dialed sample of U.S. households, involving 14,685 interviews (USEPA 2005). The survey yielded the following results:

- Approximately 11 percent of children aged six years and under were reported to be exposed to secondhand smoke on a regular basis (four or more days per week) in their home.

- Secondhand smoke exposure is significantly higher in households at and below the poverty level.

- Parents account for the vast majority of exposure in homes (almost 90 percent of the exposure), followed by grandparents and other relatives living in the home.

Table 10.14 Prevalence of smoke-free households, by state, United States, 1992–2002

State	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)
Overall	43.16	60.23	66.03
Alabama	38.94	59.13	62.11
Alaska	50.93	60.87	69.35
Arizona	54.38	71.60	75.93
Arkansas	33.21	53.02	57.05
California	59.07	72.71	77.51
Colorado	48.27	65.16	70.28
Connecticut	44.70	60.05	70.50
Delaware	40.13	55.36	64.31
District of Columbia	41.36	56.60	67.46
Florida	50.20	65.95	71.75
Georgia	41.75	61.88	69.06
Hawaii	51.46	64.99	68.26
Idaho	50.56	70.34	74.13
Illinois	38.56	54.56	60.27
Indiana	33.85	47.85	57.30
Iowa	36.05	52.92	61.65
Kansas	39.87	59.33	64.22
Kentucky	25.69	38.87	49.96
Louisiana	37.30	58.24	65.50
Maine	39.40	54.38	62.95
Maryland	42.99	64.32	67.71
Massachusetts	40.25	60.09	70.51
Michigan	35.35	51.19	58.01
Minnesota	39.70	61.52	66.25
Mississippi	41.15	54.93	61.97
Missouri	34.47	53.74	56.62
Montana	43.09	60.97	67.06
Nebraska	39.93	59.54	63.78
Nevada	45.52	63.66	68.65
New Hampshire	38.37	56.54	66.98
New Jersey	45.54	61.33	68.26
New Mexico	45.55	62.67	71.66
New York	41.59	58.25	63.44
North Carolina	34.32	52.95	57.07
North Dakota	41.16	56.38	62.79
Ohio	35.10	51.44	56.41
Oklahoma	39.23	54.06	60.86
Oregon	49.99	68.04	73.54
Pennsylvania	39.93	56.34	60.24
Rhode Island	38.87	60.40	65.52
South Carolina	40.20	58.62	67.56
South Dakota	36.80	57.13	61.08
Tennessee	34.09	51.96	56.10
Texas	46.32	65.29	71.09
Utah	69.58	81.13	83.13
Vermont	39.05	59.65	64.62
Virginia	39.27	58.35	64.49
Washington	54.25	68.92	71.26
West Virginia	27.78	42.75	50.16
Wisconsin	36.66	55.39	61.76
Wyoming	38.57	57.96	60.83

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

Table 10.15 Prevalence of smoke-free households, by geographic region, socioeconomic status, and household smoking status, United States, 1992–2002

Geographic region, socioeconomic status, and household smoking status	1992–1993 (%)	1998–1999 (%)	2001–2002 (%)	% change from 1992 to 2002
Overall	43.16	60.23	66.03	52.99
Geographic region				
Northeast	41.61	58.57	64.89	55.95
Midwest	36.55	53.63	59.51	62.82
South	41.07	59.13	65.19	58.73
West	55.80	70.59	75.20	34.77
Socioeconomic status				
Low	36.95	53.00	57.78	56.37
High	44.74	61.86	67.49	50.85
Smoking status				
No smokers in the home	56.80	73.65	78.88	38.87
Smokers in the home	9.56	20.05	25.58	167.57
Child aged <13 years	45.71	66.49	72.81	59.29
Smoker in the home and child <13 years	12.78	28.62	36.48	185.45
No smoker in the home and child <13 years	62.66	80.50	85.21	35.99

Sources: U.S. Department of Commerce, Census Bureau, National Cancer Institute Sponsored Tobacco Use Supplement to the Current Population Survey, public use data tapes, 1992–1993, 1998–1999, 2001–2002.

- The presence of a child with asthma in the home was not associated with reduced exposure, even in homes with younger children. Children with asthma were just as likely to be exposed to secondhand smoke as children in general.

- The contribution of visitors to the regular exposure of children to secondhand smoke was negligible. In households with children aged 6 years or younger, only 0.3 percent of children were exposed to secondhand smoke by visitors alone. Similarly, only 0.5 percent of children under 18 were exposed solely by visitors.

The prevalence of smoke-free household rules has been studied in California, which has undertaken a campaign to promote smoke-free homes as part of its comprehensive statewide tobacco control program (Gilpin et al. 2001). The 1999 California Tobacco Survey found that 73.2 percent of California homes had a smoke-free rule in place. This finding represented an increase of 30 percent from 1993. In addition, nearly half (47.2 percent) of the smokers lived in a smoke-free home—an increase of 135 percent from 1993. An additional 21.8 percent of smokers lived in homes with some smoking restrictions. Consistent with these increases, the percentage of children and adolescents protected from secondhand smoke exposure at home increased by 15 percent during that same time period to 88.6 percent (Gilpin et al. 2001).

Gilpin and colleagues (1999) used data from the 1996 California Tobacco Survey (n = 8,904) to evaluate factors associated with the adoption of smoke-free home rules. The data showed that male smokers were more likely than female smokers to report smoke-free homes, and household smoking bans were less likely with the increased age of current smokers in the household. Hispanic and Asian smokers were more likely to report smoke-free homes (58 percent and 43 percent, respectively) than were non-Hispanic Whites (32 percent); African Americans were the least likely to report smoke-free homes (23 percent). Living in a household with a child or with nonsmoking adults predicted a smoke-free household. After adjusting for demographics, the investigators noted that smokers were nearly six times more likely to report living in a smoke-free home if they lived with a nonsmoking adult and child compared with smokers who lived in homes without children or adult nonsmokers (59 percent versus 15 percent, respectively).

Effect of Household Smoking Rules on Secondhand Smoke Exposure

During the past two decades, several data sources have consistently shown that a large proportion of children in the United States were regularly exposed to secondhand smoke. For example, 1988 NHIS data revealed that 42.4 percent of children aged five years and younger lived with at least one smoker (Overpeck and Moss 1991). Data from the 1991 NHIS indicated that 31.2 percent of children aged 10 years and younger were exposed daily to secondhand smoke in their homes (Mannino et al. 1996). An important finding was that children from lower income families were significantly more likely to be exposed to secondhand smoke than were children from higher income families. For example, 41 percent of children from lower income families were exposed daily compared with only 21 percent of children from higher income families. CDC's 2005 *Third National Report on Human Exposure to Environmental Chemicals*, drawing on data from NHANES, reported that median cotinine levels measured during 1999–2002 have fallen by 68 percent among children, by 69 percent among adolescents, and by 75 percent among adults when compared with median levels from 1988–1991. However, the data also show that children's cotinine levels are twice as high as those of adults (CDC 2005d).

In an intervention study of low-income households with at least one child under three years of age, the median household nicotine concentration was 3.3 $\mu g/m^3$ (Emmons et al. 2001). A recent study that measured cotinine levels in infants and nicotine levels in household dust, in the air, and on household surfaces found that smoke-free home rules may substantially reduce, but may not completely eliminate, household contamination from secondhand smoke, including secondhand smoke exposure of infants (Matt et al. 2004). The study found that infants living with smokers in homes with smoke-free rules had lower cotinine levels compared with infants from homes with smokers without such rules, but cotinine levels were higher compared with infants from homes without smokers. The same was true of nicotine levels in household dust, in air, and on household surfaces. One possible explanation for this finding is that even with smoke-free home rules, secondhand smoke may enter the house in the air, on dust, or on the smoker's breath or clothing. And there is always the possibility that some smokers may not be consistently complying with the rules or may be overstating the rules. Exposure does not appear to be lower in homes with children who are at particular risk from secondhand smoke, such as children with asthma. Kane and colleagues (1999) conducted home visits of 828 households in a lower income section of Buffalo (New York) to identify 167 persons of all ages with asthma and 161 persons without asthma. Self-reported household secondhand smoke exposure levels were similar in both groups—half of the households reported exposure.

Interventions to Reduce Home-Based Secondhand Smoke Exposure of Children

Because secondhand smoke exposure poses serious health risks to children and because the home is the major source of exposure for children, a number of public health practitioners, tobacco control programs, and other organizations at the local, state, and national levels have carried out activities intended to reduce children's secondhand smoke exposure in the home. As the lead federal government agency in this area, EPA has played an especially significant role at the national level. EPA has collaborated with the health care community, state and local tobacco control programs, and other organizations to marshal efforts to institutionalize smoke-free home rules (USDHHS 2003). The American Legacy Foundation also launched a media initiative in 2005 to promote smoke-free homes and vehicles (American Legacy Foundation 2005).

However, few interventions to reduce children's secondhand smoke exposure have been systematically evaluated. The *Guide to Community Preventive Services* found insufficient evidence for the effectiveness of community educational initiatives designed to reduce secondhand smoke exposure in the home (Task Force on Community Preventive Services 2005). In a systematic review, the *Guide* was able to identify only three relevant studies and only one study that met its criteria.

Table 10.16 summarizes a number of relevant studies. The early studies did not show a significant effect on objective exposure measures, although some showed reductions of self-reported exposure.

Two trials in the United States found substantial reductions in secondhand smoke exposure among healthy children as a result of an intervention (Table 10.16) (Hovell et al. 2000a; Emmons et al. 2001). In a randomized controlled trial of 291 smoking parents of young children, Emmons and colleagues (2001) used a motivational intervention to reduce household secondhand smoke exposure. Participants were low-income families, recruited through primary care settings, with children younger than three years of age.

Participants were randomly assigned to either the motivational intervention group or a self-help comparison group; follow-up assessments were conducted at three months and six months. The motivational intervention consisted of one 30- to 45-minute motivational interview session at the participant's home with a trained health educator and four follow-up telephone counseling calls. The intervention included feedback to participants regarding baseline levels of airborne nicotine and CO in their homes. Families in the self-help group were mailed a copy of a smoking cessation manual, a secondhand smoke reduction tip sheet, and a resource guide. Household nicotine levels were measured by a passive diffusion monitor. The six-month nicotine levels were significantly lower in motivational intervention households than in the self-help households. Repeated measures of analysis of variance across baseline, three-month, and six-month time points showed a significant time-by-treatment interaction—indicating that patterns over time differ by treatment group—whereby nicotine levels for the motivational intervention group decreased significantly, and nicotine levels for the self-help group increased but were not significantly different from baseline.

Hovell and colleagues (2000a) evaluated a seven-session, three-month counseling intervention with a randomized trial design involving 108 mothers who had a child under four years of age. Reported exposure of children declined from 27.3 cigarettes per week at baseline to 4.5 cigarettes per week at 3 months and to 3.7 cigarettes per week at 12 months in the counseled group. The investigators also observed reductions in exposure among the controls, but the reductions among the intervention participants were significantly greater. At the 12-month follow-up comparison between the intervention group and the controls, the level of self-reported exposure in the intervention group was 41.2 percent of the exposure of the controls from maternal smoking and 46 percent of the exposure of the controls from all sources combined (Hovell et al. 2000a). Urinary cotinine concentrations among children decreased by 4 percent in the intervention group but increased by 85 percent in the control group.

Other studies have evaluated family interventions designed to reduce secondhand smoke exposure among children with asthma. Hovell and colleagues (2002) demonstrated a significant impact on self-reported exposure among a general population of families with children who have asthma and an impact on self-reported exposure and cotinine levels among Hispanic families (Table 10.16).

Gehrman and Hovell (2003) reviewed 19 studies of interventions to reduce secondhand smoke exposure among children in the home setting that were published between 1987 and 2002. The interventions fell into two categories: (1) physician-based interventions, which consisted of information and recommendations delivered orally by a physician or nurse during a regularly scheduled appointment (e.g., a well-baby or immunization visit) in a pediatrician's office or other health care facility, and (2) home-based interventions, which consisted of counseling delivered by a nurse or a trained research assistant during a home visit. The main outcome of interest was children's secondhand smoke exposure, with parental smoking cessation as a secondary outcome of interest in some studies. Children's exposure was primarily measured through parental self-report, with some studies also measuring children's urinary cotinine levels. Of the 19 studies, 11 reported significant reductions in secondhand smoke exposure. However, only one of the eight studies that monitored children's cotinine levels reported significant differences in cotinine levels between treatment and control groups. Effect sizes (measured as Cohen's d) ranged from -0.14 to 1.04, with a mean effect size of 0.34. The review suggests that interventions in this area can achieve at least small to moderate effects.

Gehrman and Hovell (2003) concluded that home-based interventions, which tended to be more intensive in terms of frequency and duration of contact, generally appeared to be more effective than physician-based interventions, which tended to be less intensive. Seven of the eight exclusively home-based interventions assessed yielded significant effects, compared with 4 of the 10 physician-based interventions. The review also found that interventions that were explicitly based on behavior change theory (e.g., behavior modification theory, social learning/cognitive theory) appeared to be more likely to be effective, with eight of the nine interventions that fell into this category registering significant secondhand smoke reductions.

Gehrman and Hovell (2003) suggest that optimal interventions should combine physician- and home-based approaches, combine immediate steps to reduce children's secondhand smoke exposure with cessation support for parents who want to quit, be based on behavior change theory (especially in terms of providing participants with concrete skills and strategies to help them achieve the desired outcomes), foster participants' self-efficacy and provide them with ongoing reinforcement for positive behavior changes, and be sustained over time. The study also suggests

Table 10.16 Studies assessing the effectiveness of interventions to reduce home-based secondhand smoke exposure of children

Study	Target population	Assessment of secondhand smoke exposure	Response rates Follow-up rates
Woodward et al. 1987	New mothers who smoked (n = 184)	Maternal reports and infant urinary cotinine	>95% 85%
Chilmonczyk et al. 1992	Mothers of pediatric patients (n = 103)	Maternal reports and urinary cotinine	NR* 55%
Greenberg et al. 1994	New mothers, smokers, and nonsmokers (n = 933)	Maternal reports and infant urinary cotinine	47% 71%
Hovell et al. 1994	Families of children with asthma aged 6–17 years, recruited from asthma clinics (n = 91)	Child's self-monitoring and environmental monitoring (air nicotine levels)	NR NR
McIntosh et al. 1994	Families of children with asthma aged 6 months to 17 years, recruited from asthma clinics (n = 72)	Maternal self-reports of indoor smoking; child's urinary cotinine level	NR 67%
Groner et al. 2000	Mothers of children <12 years of age (n = 479)	Knowledge of effects of secondhand smoke on children; maternal smoking status; location of maternal smoking	48% NR
Hovell et al. 2000a	Mothers of children <4 years of age (n = 108)	Children's urinary cotinine levels; maternal reports; nicotine monitors	92% 94%
Emmons et al. 2001	Smoking parents of children <3 years of age (n = 291)	Household nicotine, participant carbon monoxide level	81.2% at 3 months 85.1% at 6 months

Intervention conditions	Findings
• Intervention: self-help materials (Bringing Up Baby Smoke-Free); 1 telephone counseling follow-up call • Minimal contact control: baseline and 3-month assessment • Follow-up only: 3-month assessment	• No differences in infants' secondhand smoke exposure (parent-reported levels) • No differences in infant cotinine levels • No differences in maternal smoking status
• Intervention: feedback from pediatricians regarding infant levels of urinary cotinine; tips for reducing secondhand smoke exposure • Control: assessment only	• No difference in infant cotinine level
• Intervention: 4 home visits from a study nurse during 6 months; self-help materials • Control: assessments only at 3 weeks of age, 7 and 12 months of age	• For nonsmoking mothers: difference of 0.5 cigarettes in the number of parent-reported cigarettes that the infant was exposed to • For smoking mothers: decrease of 5.9 cigarettes in infant exposure; no differences in infant cotinine levels or maternal cessation
• Intervention: behavioral counseling sessions with parent and child; self-monitoring (feedback about child's pulmonary function and symptoms) • Monitoring only control: self-monitoring of exposures • Usual treatment control: baseline and follow-up assessments at 2, 6, 9, and 12 months	• Significantly greater self-reported exposure reduction in intervention group (70%) versus monitoring control (42%) and usual care (34%) groups • No differences in air nicotine levels
• Usual care: secondhand smoke reduction education and advice to quit smoking indoors • Intervention: usual care plus written feedback about child's cotinine level	• No difference in indoor smoking or child's cotinine level
• Intervention 1: brief cessation counseling focusing on child secondhand smoke exposure plus self-help manual, reminder cards, and telephone calls • Intervention 2: brief counseling session focused on smoking's effects on maternal health; self-help materials, reminder cards, and telephone calls • Control: no cessation advice	• No impact on quit rate • Significant difference in change of smoking location and knowledge of secondhand smoke effects
• Intervention: telephone and in-person sessions totaling 7 hours to decrease exposure; signs and rewards provided • Control: nutritional counseling; brief cessation advice; brief advice not to expose kids to secondhand smoke	• Significant differences between groups by the time of reported childhood exposures to secondhand smoke from maternal reports and for total exposures to secondhand smoke • Significant differences between groups by time in cotinine levels
• Intervention: motivation interview and 4 follow-up calls • Control: self-help mailed printed materials	• 6 months: significant effects • Significant time-by-treatment interactions

Table 10.16 Continued

Study	Target population	Assessment of secondhand smoke exposure	Response rates Follow-up rates
Wilson et al. 2001	Secondhand smoke-exposed Medicaid-eligible children aged 3–12 years, treated for asthma at a hospital (n = 87)	Urinary cotinine/creatinine ratio; number of acute asthma visits; hospitalizations; smoking restrictions in the home; amount smoked; reported exposures of children; asthma control	59% provided 12 months of cotinine data
Hovell et al. 2002	Hispanic children with asthma (n = 204)	Reported secondhand smoke exposure; child urinary cotinine; parent saliva cotinine; air nicotine monitor	98% of intervention group completed all sessions

*NR = Data were not reported.

that future studies should explore approaches to increasing the effectiveness of physician-based interventions, for example, equipping mothers with skills to deal with spouses or other household members who are contributing to children's secondhand smoke exposure. In addition, studies should examine efficacy of other interventions, including group interventions (as opposed to one-on-one interventions), the use of motivational interviewing, exploring the link between reducing children's secondhand smoke exposure and increasing parental cessation, and interventions directed at children (as opposed to interventions directed at parents). The authors also emphasize the importance of evaluating interventions; they note, for example, that while "home-based interventions may be particularly promising, . . .future research should be done in a systematic, replicable manner so that investigators can make more direct comparisons" (Gehrman and Hovell 2003, p. 297). Finally, in addition to refining interventions directed at individual behavior change, efforts should be continued to increase public awareness and smoking restrictions.

Hovell and colleagues (2000b) examined the effectiveness of available approaches to reducing secondhand smoke exposure among children. The study identified three trials reporting that repeated counseling reduced quantitative measures of secondhand smoke exposure in asthmatic children and one controlled trial reporting that repeated physician counseling directed toward reducing secondhand smoke exposure increased parental cessation. Controlled trials of clinicians' one-time counseling yielded null results. The study concluded that one-time clinical interventions appeared marginally effective or ineffective. Repeated minimal interventions, while not consistently yielding changes in secondhand smoke exposure, appeared to hold more promise. However, the study calls for further evaluations of this approach, specifically large-scale controlled trials.

Hovell and colleagues (2000b) also note that even the interventions that appeared to reduce secondhand smoke exposure rarely eliminated it completely and suggest that these interventions may need to be sustained over long periods of time. The study points to a need for further research on approaches that combine counseling to reduce children's secondhand smoke exposure with subsequent counseling to help parents quit smoking. Such counseling might include interventions to address situations where the mother, who typically is the patient receiving the counseling, is not the only smoker in the household or is not a smoker at all. Other interventions might be directed at children instead of parents. Still others might address the social disparities implicit in the increased prevalence of smoking and secondhand smoke exposure among low-SES populations and some racial/ethnic groups.

Hovell and colleagues (2000b) also examined a number of other strategies for reducing children's secondhand smoke exposure, including regulatory, policy, legal, and media approaches. The study concludes by noting the importance of pursuing interventions in this area within the context of a comprehensive approach to tobacco control.

Intervention conditions	Findings
• Intervention: behavioral counseling; review of cotinine results • Control: usual medical care	• Significant differences in acute asthma medical visits and hospitalizations • Nonsignificant differences in cotinine/creatinine ratios and home smoking policies
• Intervention: 1.5 hours of asthma management education; 7 sessions to reduce secondhand smoke exposure • Control: asthma management education	• Significant differences in reported exposures • Significant reductions in 4-month cotinine levels, but not in 13-month cotinine levels

In addition to the role of the health care sector in establishing smoke-free policies and changing norms related to smoking in health care settings, the role that pediatricians can play in reducing exposure of children to secondhand smoke has drawn increasing attention. The American Academy of Pediatrics has recommended that secondhand smoke exposure of children should be discussed as part of pediatric care, and providers should follow the Agency for Healthcare Research and Quality (formerly the Agency for Health Care Policy and Research) guidelines for working with parents to quit or reduce their smoking (Etzel and Balk 1999). The American Academy of Pediatrics has identified secondhand smoke exposure as a priority area and is collaborating with EPA and others to reduce childhood exposures.

Effect on Smoking Behavior

National data have confirmed findings from California that relate household smoking rules and workplace smoking policies to smoking status. Farkas and colleagues (1999) analyzed 1993 CPS data and found that, compared with smokers living under no household smoking restrictions, smokers living under a total household smoking ban were almost four times more likely to report an attempt to quit smoking during the previous 12 months compared with smokers with no household smoking restrictions (OR = 3.86 [95 percent CI, 3.57–4.18]). Smokers who lived in a home with a partial smoking ban were almost twice as likely to report an attempt to quit during the previous 12 months (OR = 1.83 [95 percent CI, 1.72–1.92]). The investigators also noted a weaker relationship between workplace smoking bans compared with workplaces with no restrictions or restrictions less than a ban on smoking in work areas, and reporting an attempt to quit (OR = 1.14 [95 percent CI, 1.05–1.24]). Among smokers who attempted to quit in the previous year, smokers who lived under a household smoking ban had an OR of 1.65 (95 percent CI, 1.43–1.91) of abstaining for at least six months compared with smokers with no household smoking restrictions, while smokers who lived under a partial household smoking ban had an OR of 1.20 (95 percent CI, 1.05–1.38). Smokers with a workplace smoking ban who tried to quit had an OR of 1.21 (95 percent CI, 1.00–1.45) for abstaining for at least six months compared with smokers working under no workplace restrictions or some form of restriction less than a work area ban (Farkas et al. 1999).

In a recent prospective study of a population-based cohort of smokers identified from a previous telephone survey, Pizacani and colleagues (2004) found that smokers living under a full household smoking ban at baseline were twice as likely as smokers living with no ban or with a partial ban to attempt to quit and to abstain for at least one day over follow-up of about two years. The study also found that among smokers who were preparing to quit at baseline, a full ban was associated with a lower relapse rate and with more than four times the odds of abstaining for seven or more days at follow-up. These associations were not found among smokers in the precontemplation/contemplation stage of quitting. The authors

concluded that full household smoking bans may facilitate cessation among smokers who are preparing to quit by increasing cessation attempts and may prolong the time to relapse among these smokers (Pizacani et al. 2004).

Important relationships have also been found between household and workplace smoking restrictions and smoking trends among adolescents. After adjusting for demographics, school enrollment, and having other smokers in the home, adolescents from smoke-free households were 26 percent less likely to be smokers than adolescents who lived in homes without smoking restrictions. Adolescents who worked indoors in smoke-free workplaces were 32 percent less likely to be smokers than adolescents whose indoor workplaces had a partial work area ban. Smoke-free home rules also increased the chances of quitting among adolescent smokers; respondents were 1.80 times more likely to be former smokers if they lived in smoke-free homes (Farkas et al. 2000). The findings of the surveys need to be interpreted with consideration of the difficulty in inferring causal directions from cross-sectional data. The cohort study of Pizacani and colleagues (2004) would not be subject to this potential limitation.

Smoking Restrictions in Institutional Settings

Institutional settings provide a particularly challenging venue for secondhand smoke control, because the rights of both those who live and those who work in the setting must be considered. Bans have been implemented in hospitals and other health care facilities over the last two decades. Prisons and nursing homes are two additional settings where restrictive smoking policies have been considered and enacted.

Hospitals and Health Care Facilities

Beginning in the 1980s, individual hospitals were made smoke-free. The experiences of two major medical institutions, the Johns Hopkins Hospital and the Mayo Medical Center, are well-documented (Hurt et al. 1989; Stillman et al. 1990) and demonstrate the importance of a comprehensive approach and provide a model for other institutions. In the early 1990s, smoking was systematically restricted in the inpatient health care setting as a result of two policy initiatives, one by the U.S. Department of Veterans Affairs (VA) and the other by JCAHO. In January 1991, VA, the nation's largest health care provider, announced that all 172 of its acute care hospitals would be smoke-free; at the time of implementation, the policy affected 4.5 million patients in the United States (Joseph and O'Neil 1992). The VA policy prohibited smoking by patients, visitors, and employees in acute care facilities but not in the 146 long-term and chronic care facilities. The VA policy also ended the distribution of free tobacco products, increased the price of cigarettes sold in VA facilities to market rates, and eventually halted the sale of cigarettes in these facilities altogether. However, Congress passed the *Veterans Health Care Act of 1992*, which required VA hospitals to establish "suitable" indoor or outdoor smoking areas with "appropriate" heating and air conditioning. This legislation, which was largely seen as reversing progress from the 1991 VA policy (Joseph 1994), required smoking facilities to be built or upgraded, but provided no additional funding. Current VA policy has moved beyond the use of indoor smoking areas and mandates that each VA health care facility establish and maintain a smoking area in a detached building that is accessible, heated, air-conditioned, and meets JCAHO and OSHA requirements for ventilation (USVA 2003). Only long-term care or mental health programs can have indoor smoking areas, which must be separately ventilated. Smoking is allowed on the grounds of all VA facilities as long as it does not interfere with safety and public access. Smoking has been similarly restricted or banned in other federal institutions that have a health care component, including the U.S. Army (Hagey 1989) and the Indian Health Service (CDC 1987a).

Perhaps the most influential smoking policy in the health care sector is the JCAHO accrediting standard that was issued in January 1991. This standard required hospitals to develop and implement policies prohibiting smoking in hospital buildings by patients, visitors, staff, employees, and volunteers no later than the end of 1993 (JCAHO 1992). This policy covers the 5,000 hospitals and 560 psychiatric institutions that are accredited by JCAHO, which include 85 percent of all acute care hospitals in the United States. Exceptions are allowed for patients receiving physician prescriptions, primarily for nicotine replacement therapies to assist with smoking cessation, that are based on medical criteria defined by the medical staff at each institution. This standard is just one of a number of standards considered by JCAHO in accrediting hospitals; a hospital may not be fully compliant with the standard and still receive accreditation (Longo et al. 1998).

After implementing the hospital-wide no-smoking policy at Johns Hopkins, a study was conducted to determine patient compliance by assessing whether inpatients refrained from smoking or went outside to smoke (Stillman et al. 1995). Using a prospective design from 1990 to 1992, 504 patients were interviewed when they were admitted to the hospital about their knowledge of, attitude toward, and adherence to the no-smoking policy. The researchers found that 77 percent of smokers had abstained from smoking while hospitalized; 88 percent of the patients complied with the policy. The study demonstrated that hospital policies that impose abstinence provide an opportunity to promote smoking cessation.

To evaluate compliance with smoke-free standards in health care facilities, Joseph and colleagues (1995) surveyed 1,278 hospitals accredited by JCAHO. The investigators assessed compliance 16 months after the implementation of the smoke-free standard and found that 65 percent of hospitals were in compliance; 55 percent of the smoke-free hospitals with smoke-free policies in place had provided outdoor shelters for smokers, 16 percent of the smoke-free hospitals regularly granted exceptions for indoor smoking, and 29 percent of the smoke-free hospitals never granted exceptions. Overall, patient complaints about smoke-free hospital policies were uncommon. Predictors of hospital compliance included administrative support for the policy and inpatient smoking cessation services. Predictors of hospital noncompliance included greater numbers of beds allocated for psychiatric treatment, greater numbers of beds allocated for substance abuse treatment, and the presence of an active task force to address smoking policy. The authors suggest that the last finding reflects that, while a task force may be needed to write the hospital smoking policy and formulate an implementation plan, it should not be needed once the policy has been implemented. In addition, experiences with local clean indoor air ordinances suggest that the formation of a task force may sometimes be employed as a delaying tactic and may indicate that policymakers are resistant to the proposed policy. The authors of the survey noted that "fear of the effect of restrictive smoking policies on psychiatric and substance abuse treatment populations is prevalent" (Joseph et al. 1995, p. 494). Furthermore, although the no-smoking standard did not apply to psychiatric and substance abuse treatment services, 43 percent of hospitals with psychiatric services had smoke-free psychiatric wards, and 35 percent of hospitals with inpatient substance abuse treatment programs had smoke-free substance abuse units (Joseph et al. 1995).

Two years following implementation of the JCAHO regulation, Longo and colleagues (1998) used annual survey data from the American Hospital Association and data from accreditation site visits by JCAHO to evaluate compliance with smoking bans among all U.S. hospitals except offshore military hospitals. For 1992–1993, they found that 96 percent of U.S. hospitals were in compliance with the JCAHO smoking ban. In fact, hospitals have the only industry-wide smoking ban in the United States (Brownson et al. 2002).

Another study drawing on data from a postal survey of administrators from a stratified random sample of 1,055 hospitals conducted in 1994 found that 55.2 percent of the hospitals surveyed met the standard, 41.4 percent exceeded the standard, and 3.4 percent were not in compliance with the standard (Longo et al. 1998). Of the hospitals that were found to meet or exceed the JCAHO standard, 53.7 percent had implemented their smoke-free policies before the standard was announced. Provisions of hospital policies that exceeded the JCAHO standard included provisions that prohibited smoking outdoors on hospital grounds or that allowed no exceptions for patients. Factors associated with exceeding the JCAHO standard included location in a non-tobacco-growing state, location in a metropolitan statistical area, having fewer than 100 beds, having unionized employees, being a children's hospital, and not having a psychiatric or substance abuse unit.

Most respondents rated their hospital's policy as very (60.3 percent) or moderately (36.6 percent) successful, with 3.3 percent rating the policy as only slightly successful or not at all successful (Longo et al. 1998). Hospitals that reported involving employees in planning or otherwise preparing for implementation (for example, by having employees serve on planning committees) were more likely to report having successful policies. The factors most frequently cited as prompting hospitals to implement smoke-free policies were the JCAHO standard (61.3 percent of respondents rated this factor as a very important influence), concern for employees' health (59.9 percent of respondents rated this as a very important influence), and public image (43.1 percent of respondents rated this as a very important influence). The factors most frequently cited as posing barriers to the successful implementation of smoke-free policies included negative employee morale (22.6 percent of respondents rated this as a moderate barrier and 2.4 percent as a severe barrier) and lack of acceptance of the policy by patients (22.2 percent of respondents rated this as a moderate barrier and 4.9 percent as a severe

barrier) and visitors (20.3 percent of respondents rated this as a moderate barrier and 3.9 percent as a severe barrier). Longo and colleagues (1998) concluded that the presence of a pre-existing social norm in hospitals favoring smoke-free policies and the external catalyst provided by the JCAHO standard combined to make it possible for most U.S. hospitals to successfully implement smoke-free policies that met or exceeded the JCAHO standard.

Several other studies of smoke-free policy implementation in psychiatric and substance abuse treatment settings suggest that smoking bans can be implemented in these settings with a minimal impact on client recruitment and retention (Sterling et al. 1994), physical assaults, security calls, and discharges against medical advice (Haller et al. 1996; Velasco et al. 1996). In 2002, el-Guebaly and colleagues (2002) reported findings of a systematic review on smoking bans in mental health and addiction settings and identified 22 relevant studies on the impact of partial or total smoking bans. The bans did not lead to adverse consequences for therapy, nor was noncompliance an issue. An assessment of a no-smoking policy at the Ochner Clinic reported very high levels of support from both patients and employees both before and after implementation (Hudzinski and Frohlich 1990).

A study examined how smoke-free hospital policies affect employee smoking behavior (Longo et al. 1996). The study compared progression to cessation among 1,469 current and former smokers working under smoke-free hospitals to 920 current and former smokers employed in other workplaces that were not covered by smoke-free workplace policies over a five-year period following implementation of the smoke-free policies in hospitals, adjusting for socioeconomic, demographic, and smoking intensity variables. The study found that the quit ratios for these groups were 0.506 and 0.377, respectively. Longo and colleagues (1996) concluded that smoke-free hospital policies appear to help hospital employees quit smoking.

In recent years, a number of hospitals have expanded their smoking policies to prohibit smoking on their outdoor grounds, as well as in their enclosed facilities. These campus-wide policies often also prohibit the use of other tobacco products besides cigarettes. Hospitals often present such policies not only as a way to protect patients and staff from secondhand smoke exposure (for example, at hospital entrances) but also as projecting a positive, healthy image; sending a consistent message; and encouraging and supporting tobacco use cessation among both patients and staff.

Prisons

In 2002, U.S. prisons and jails housed more than 2 million persons (Harrison and Karberg 2003), and there were nearly 800,000 full-time, sworn law enforcement officers in the United States; many of these officers worked in prison settings. Estimates of smoking prevalence among U.S. prisoners are between 60 and 80 percent (Carpenter et al. 2001). In addition, the level of ventilation in correctional facilities may be inadequate relative to the number of prisoners because of overcrowded conditions (Hoge et al. 1994). Thus, in correctional facilities where smoking is allowed indoors, nonsmoking prisoners and staff are likely to be exposed to high levels of secondhand smoke. At the national level, both the American Correctional Association and the National Commission on Correctional Health Care have offered recommendations for smoking policies, but smoking regulations within correctional facilities have been implemented primarily at the local or state level.

A 1993 survey of the 50 state departments of corrections found that no prison system entirely banned smoking. By 1996, 7 state prison systems had banned smoking and 44 had placed limits on where inmates and staff could smoke; 70 percent of the facility representatives reported that the smoking policy at their institution had changed in the previous four years (Patrick and Marsh 2001). A national survey conducted in 1997–1998 of more than 900 correctional facilities found that 45 percent of these facilities still permitted smoking by either inmates or staff (Falkin et al. 1998). A 2003 survey of medical directors at state prisons, jails, and juvenile detention facilities found that 77 of the 100 respondents reported having a tobacco-free policy in place (National Network on Tobacco Prevention and Poverty 2004). However, only 16 of these correctional facilities applied these policies to staff as well as inmates. Nearly two-thirds of the facilities with tobacco-free policies reported adopting the policies because they were mandated to do so by federal case law, state law, or local ordinance. Many of the policies had not been updated for years. The facilities with tobacco-free policies estimated compliance rates of 81 percent for staff and 71 percent for inmates. Although 63 percent of all respondents reported assessing inmate tobacco use upon intake, more than 80 percent of the respondents reported that they provided no cessation programming in their facilities. In 2004, California adopted a law making all California prisons smoke-free (California State Assembly 2004). The legislation was presented primarily as a way to reduce the cost of state-funded inmate health care.

Also in 2004, the state of Washington implemented a similar measure (Sullivan 2004; Turner 2004). A 2004 article in the *Seattle Times*, citing the Washington State Department of Corrections as a source, reported that 21 states now ban smoking within their prisons (Sullivan 2004).

As of October 2005, 38 of 50 state correctional departments had enacted full or partial smoke-free protection policies (ANR 2005c). In 2004, the Federal Bureau of Prisons implemented an almost complete smoke-free policy in 105 federal prisons housing 180,000 inmates; smoking is still permitted in faculty housing, towers, and vehicles inhabited by one person (USDOJ 2004).

A recent survey of correctional employees in Vermont revealed relatively low levels of support for complete indoor and outdoor bans on inmate smoking, but significantly greater support for policies that ban indoor smoking and provide restricted outdoor smoking areas (Carpenter et al. 2001). These types of smoking restrictions decreased secondhand smoke levels in two Vermont prisons (Hammond and Emmons 2005). In July 1992, the Vermont Department of Corrections banned smoking in its six correctional facilities. This ban, however, was modified in December 1992 to allow for smoking outdoors. To assess the effect of the indoor smoking ban on secondhand smoke levels, airborne nicotine levels were measured at two of these facilities before the ban and four and nine months after its implementation. Before the ban, the average concentrations of nicotine were high, ranging from 1.3 to 24.6 $\mu g/m^3$ in living areas and from 0.4 to 3.4 $\mu g/m^3$ in central facilities, including the dining room, visiting room, and learning center. The smoking ban significantly reduced nicotine concentrations in the living areas to averages of 1.2 to 2.2 $\mu g/m^3$, although the trends in the central facilities were less clear (Hammond and Emmons 2005).

A 1993 Supreme Court ruling that has been cited in a number of subsequent court decisions refused to dismiss a Nevada inmate's claim that exposure to secondhand smoke resulting from being housed in a cell with a smoker violated the Eighth Amendment of the Constitution, which bars "cruel and unusual punishment" (*Helling v. McKinney* 113 S.Ct. 2475, 509 U.S. 25). The court stated that, if sustained, the allegation that prison officials had "with deliberate indifference, exposed him to ETS levels that pose an unreasonable risk to his future health" (p. 25) (even in the absence of immediate medical symptoms) might constitute a violation of that standard.

Nursing Homes

Evidence on the extent of smoking and secondhand smoke exposure in nursing homes is very limited. Smoking is particularly problematic in this setting because of concerns about exposing medically ill nonsmokers to secondhand smoke and about fire safety. Kochersberger and Clipp (1996) surveyed 106 administrators of VA nursing home care units. All of the respondents reported that their facilities permitted smoking. Adler and colleagues (1997) surveyed 114 nursing home social workers selected at random from a statewide association of social workers. Slightly less than half (45 percent) of the facilities where these individuals worked were smoke-free. Most of the social workers (60 percent) who worked at facilities that permitted smoking did not want the policy to change. In contrast, more than 75 percent of social workers at smoke-free facilities supported the policy.

Despite the challenges, there is a slow but increasing movement toward laws and policies that restrict or ban smoking in health care and assisted living facilities, including nursing homes. In 2004, JCAHO issued revised accreditation standards for long-term care facilities that included a new standard regulating smoking (JCAHO 2004). The standard (EC.1.30) states that long-term care facilities should restrict resident smoking, if allowed at all, to designated locations that are separate from care, treatment, or service areas. For example, Rhode Island enacted a law that went into effect in July 2001 banning smoking entirely in health care and assisted living facilities or confining smoking to areas that are separately enclosed and separately ventilated from those used by the general public (*An Act Relating to Health and Safety—Smoking in Public Places* 2001). In fact, facilities that permitted smoking experienced greater conflicts over smoking between residents and staff.

Public support for smoking bans in nursing homes has grown in recent years. A 2001 public opinion survey conducted in California by the Field Research Corporation found that 88.7 percent of respondents felt that nursing homes and other long-term care facilities should be smoke-free (California Department of Health Services 2001b).

One obstacle to enacting smoking restrictions in nursing homes is the hesitance of some policymakers to impose such restrictions in a residential setting (i.e., places of residence). Nursing homes are workplaces and homes to nonsmokers, some of whom might be especially susceptible to health effects associated

with secondhand smoke exposure because of their advanced age. One study found traces of a tobacco-specific lung carcinogen in the urine of employees of a long-term care hospital; the employees were required as part of their jobs to spend time in a patient smoking lounge that was not separately ventilated (Parsons et al. 1998). In addition, fires caused by smoking pose a special hazard in nursing homes and other long-term care facilities (U.S. Fire Administration 2001).

Smoking Restrictions in Other Settings

Day Care

Day care settings present a potentially important source of secondhand smoke exposure for young children. In 1995, 75 percent of children (14.4 million) younger than five years of age were in some form of regular child care arrangement (Smith 1995). A national survey conducted in 1990 of 2,003 directors of licensed day care centers found that 99 percent of these facilities were in compliance with their state laws on smoking: 55 percent of the centers were smoke-free indoors and outdoors, 26 percent were smoke-free indoors only, and 18 percent allowed restricted indoor smoking. The best predictors of more stringent employee smoking policies were locations in the West or South, smaller size, and independent ownership (Nelson et al. 1993). This survey also found that of the 40 states that regulated employee smoking in day care facilities, only 3 states banned indoor smoking (Nelson et al. 1993). In a 2004 analysis by the ALA of state laws restricting smoking, researchers identified 44 states that regulated smoking in day care centers, of which 31 prohibited smoking, 5 allowed smoking only in enclosed and separately ventilated areas, and 8 had some other type of restriction (ALA 2004). These results only apply to licensed facilities and not necessarily to family day care or more informal arrangements, which may be less restrictive. A large proportion of children are in nonfederally funded settings; 50 percent of children in day care are cared for by a relative in an informal setting. The smoking rules in these settings have not been studied.

In 1994, the U.S. Congress passed the *Pro-Children Act of 1994*, which prohibits smoking in Head Start facilities and in kindergarten, elementary, and secondary schools that receive federal funding from the U.S. Department of Education, the U.S. Department of Agriculture, or the U.S. DHHS, with the exception of funding from Medicare or Medicaid. This legislation also applies to facilities that receive federal funding to provide children with routine health care, day care, or early childhood development services. This measure was reauthorized under the *No Child Left Behind Act of 2001*. No nationally representative survey of day care facilities has been conducted since the enactment of the *Pro-Children Act of 1994*.

Schools

During the past decade, schools have increasingly adopted smoke-free policies to minimize pro-smoking social norms, to reduce smoking initiation rates, and to protect children from secondhand smoke exposure in the school setting.

At the federal level, the *Pro-Children Act of 1994* prohibits smoking in facilities where federally funded educational, health, library, day care, or child development services are provided to children aged younger than 18 years (*Federal Register* 1994a). The *Pro-Children Act of 1994* was reauthorized under the *No Child Left Behind Act of 2001*.

Expanding upon the *Pro-Children Act of 1994*, the CDC Guidelines for School Health Programs to Prevent Tobacco Use and Addiction recommend a tobacco-free school policy that prohibits students, staff, and visitors from using tobacco products in school buildings, on school grounds, in school vehicles, and at school-sponsored events (including events held on and off school property) (CDC 1994). According to the guidelines, this policy should be in effect at all times, even when schools are out of session. The tobacco-free environment established by this policy protects children from secondhand smoke in school buildings and other areas that they frequent as part of their daily school experience and in particular eliminates exposure of children with asthma to secondhand smoke (CDC 2005c). These policies also reduce children's opportunities to use tobacco products and to witness others doing so, thus reinforcing the messages that children receive in school about the importance of healthy, tobacco-free lifestyles. Finally, tobacco-free school policies create young people who are prepared to—and in fact expect to—matriculate to smoke-free workplaces and communities (CDC 1994).

According to CDC's School Health Policies and Programs Study (SHPPS) 2000, 44.6 percent of schools reported tobacco-free school policies consistent with CDC recommendations, up from 36 percent in SHPPS 1994 (*Journal of School Health* 2001). The study also found that 45.5 percent of districts and 13 states reported such policies. Since 2000, the numbers of schools, districts, and states with tobacco-free school policies have continued to increase. Oregon is the

most recent state to adopt such a policy. A *Healthy People 2010* objective calls for establishing comprehensive tobacco-free policies in all junior high schools, middle schools, and senior high schools (USDHHS 2000a). While substantial progress has been made on this objective, the target is not likely to be met by 2010 unless activity increases.

Colleges

To date, legislation has focused on smoking policies in elementary and secondary schools. No federal legislation has targeted smoking policies at colleges, although there appears to be increasing attention to this issue at the college level. In 1996, ALA surveyed colleges and universities featured in the 1996 edition of the *Princeton Review Student Access Guide to the Best 309 Colleges* (Meltzer et al. 1995). Seventy-three percent of the colleges surveyed permitted smoking, including 62 percent of those calling themselves "smoke-free." Across all colleges, 62.4 percent allowed smoking in individual dorm rooms. A 1999 survey of 393 student health center directors from four-year colleges found that 85 percent of the respondents considered student smoking on their campuses to be either a problem or a major problem (Wechsler et al. 2001a). Restrictions on smoking were common; 81 percent of the colleges prohibited smoking in all public areas, but only 26 percent prohibited smoking in all indoor areas, including student residence halls and private offices. The most restrictive policies were found among private-sector institutions, religious-affiliated institutions, and those in the West. Although 55.7 percent of the health centers offered smoking cessation programs for students, the colleges reported little student demand. But the smoking cessation programs were not uniformly strong. Only 31 percent of the schools with cessation programs offered individualized counseling; 25 percent offered comprehensive programs with counseling, screening, and assessments by a physician or health professional; and 19 percent offered pharmacologic aids for smoking cessation. The impact of college smoking policies was studied by Wechsler and colleagues (2001b) using a survey administered at 128 colleges. Students who entered college as nonsmokers were about 40 percent less likely to be smoking at the time of the survey if they were living in smoke-free dorms. Wechsler and colleagues (2001b) also noted that current smokers who lived in smoke-free housing had lower cigarette consumption than those who lived in unrestricted housing.

In a study by Halperin and Rigotti (2003) that included interviews with key informants at the largest public university in each of the 50 states, 98 percent of the universities reported a smoking ban inside public buildings, 50 percent reported a ban outside building entrances, 54 percent reported a ban in student housing, and 30 percent reported a complete ban encompassing all three of these settings. In 2000, the American College Health Association recommended smoking bans in and around all campus buildings, including all campus housing and public areas (Fisher 2002). The impact of these recommendations has not yet been evaluated. In recent years, many colleges have expanded their smoking restrictions to include some outdoor areas, including, in some cases, making their entire campuses smoke-free.

Interstate Public Transportation

As noted earlier in this chapter (see "Historical Perspective"), the United States has prohibited smoking on all domestic airline flights of six hours or less since 1990. In addition, numerous airports in the United States have enacted smoke-free policies in the past several years. In 2002, researchers surveyed administrators about airport smoking policies at U.S. commercial service airports with more than 10,000 passenger boardings per year (CDC 2004d). Of the airports surveyed, 61.9 percent reported smoke-free policies in effect (defined as policies prohibiting smoking inside the airport by anyone, anywhere, and at any time). Larger airports, which account for the majority of passenger boardings, were less likely than smaller airports to have implemented such a policy. Smoke-free policies were reported by 41.9 percent of large-hub airports, 52.9 percent of medium-hub airports, 58.0 percent of small-hub airports, and 81.0 percent of no-hub airports. (The FAA assigns hub size designations based on the percentage of total U.S. passenger boardings that an airport accounted for during the previous calendar year.) These percentages of smoke-free policies, and in particular the figures for large-hub airports, have probably increased with the state clean indoor air laws that have been enacted since this survey was conducted. These laws typically apply to airports, and several of the states that have adopted comprehensive or relatively comprehensive laws are homes to major airports. ANR recently compiled a list of smoking policies at the nation's 10 busiest airports based on passenger traffic as of August 2001 (Baskas 2004). Five of these airports are entirely smoke-free indoors. The remaining five allow smoking in separate areas, but those smoking areas are not separately ventilated in most cases.

In 1971, the Interstate Commerce Commission (ICC) issued the first smoking regulations for interstate buses. The ICC mandated the creation of separate smoking sections in the rear of the buses. The ICC then ruled that as of January 6, 1972, the smoking area could not exceed 20 percent of the seats, but this order was not implemented. In 1976, the ICC amended the law to expand the smoking allotment to 30 percent. In 1990, the ICC banned smoking on interstate buses (*Federal Register* 1991).

Similar to buses, the initial 1971 ICC regulations for trains required that smoking on trains traveling on interstate routes be confined to designated areas (*U.S. Rail Passenger Service Act of 1970*). In 1976, ICC prohibited smoking in railroad food service cars and required separate coach cars for smoking and nonsmoking passengers. In 1987, congressional legislation that threatened to withhold federal funds influenced the decision of the State of New York Metropolitan Transportation Authority (MTA) to ban smoking on the MTA Long Island Railroad (USDHHS 1989). In 1994, Amtrak banned smoking on all short and medium distance train travel.

Hotels

Recently, a number of hotels have implemented voluntary smoke-free policies that apply to common areas such as lobbies and to all guest rooms. Many other hotels have increased the proportion of their guest rooms that are designated nonsmoking. According to a *USA Today* article from November 2003, a PricewaterhouseCoopers study conducted in 2003 found that 84 percent of hotel rooms in eight major markets were designated nonsmoking, an increase from the 80 percent reported in 1998 (Yancey 2003). According to the American Hotel & Lodging Association, a trade organization in Washington, D.C., 65 percent of the rooms in nearly 8,000 properties surveyed in 2001 were designated nonsmoking—an increase from the 61.1 percent reported in 1998 (Yancey 2003).

Interviews with hotel executives suggest that these moves are in response to public demand, although important benefits include reduced cleaning costs and benefits to employees (Hospitality Net 2001). Some hotel proprietors report that even smokers are increasingly requesting smoke-free rooms (Yancey 2003). On the other hand, some proprietors also report that requests for smoking rooms increase in the short run when smoke-free laws are implemented, perhaps because smokers are no longer allowed to smoke in many other settings (Yancey 2003).

Multiunit Housing

As evidence regarding the health effects of secondhand smoke has accumulated, there has been growing concern about the impact of secondhand smoke exposure in multiunit housing settings. These settings include commercially owned apartments, condominiums, and public housing facilities, such as housing authorities and subsidized housing. Together with the workplace, the home is a major source of secondhand smoke exposure, especially for nonsmokers who live with a smoker (Klepeis 1999; Cal/EPA 2005). Secondhand smoke from one unit in a multiunit housing complex can seep into an adjoining unit through shared air spaces or shared ventilation systems.

The main approach for addressing this issue has been education of landlords and property managers with the goal of having them implement voluntary no-smoking policies. In some cases, tenants have also taken legal action to achieve this outcome (Sweda 2004). These policies may apply to common spaces within the housing complex (such as lobbies, corridors, stairwells, elevators, laundry rooms, community rooms, and recreational areas), housing units rented to new tenants, or housing units rented to both new and existing tenants.

Until recently, landlords and property managers have been reluctant to restrict smoking in multiunit housing because of concerns about the legality of doing so and because of the perception that regulating tenants' smoking may constitute an intrusion on their privacy. However, tenants who live in multiunit housing have certain legal obligations and rights. These obligations and rights in many cases make it possible for landlords and property managers to restrict or eliminate smoking in apartments and for nonsmoking tenants to obtain relief from secondhand smoke seepage from adjoining units. In addition to protecting tenants from secondhand smoke exposure and avoiding legal action by nonsmokers who experience secondhand smoke seepage from neighboring units, landlords and property managers are in some cases motivated by additional factors, such as reductions in maintenance, cleaning costs, burns, fire danger, and property insurance premiums. Several organizations are providing information and technical assistance to landlords to encourage them to implement smoking restrictions in apartments and condominiums and are working with landlords to publicize smoke-free rentals through Web site listings (e.g., <http://www.smokefreeapartments.org>; <http://www.tcsg.org/sfelp/apartment.htm>; <http://www.mismokefreeapartment.org>).

A recent review of legal rulings in this area found that landlords, condominium associations, and other multiunit property holders may prohibit smoking for new, and in many cases existing, occupants (Schoenmarklin 2004). Courts do not recognize a legal right to smoke in such dwellings, whether the dwelling is publicly or privately owned. In addition, residents of multiunit dwellings have access to common law remedies for stopping secondhand smoke infiltration, including local safety and health codes. If a resident of a multiunit dwelling can demonstrate that secondhand smoke exposure limits a major life activity, the federal *Fair Housing Act of 1992* can be used to end the secondhand smoke incursion. Landlords and building owners can prohibit smoking in apartments and condominiums, protecting them from lawsuits related to secondhand smoke infiltration (Schoenmarklin 2004).

Similarly, a review of potential legal remedies for tenants affected by secondhand smoke seepage concluded that state regulations, such as sanitary codes, provide general language for protecting the health of residents in multiunit buildings (Kline 2000). Tenants can also use traditional claims of nuisance, warranties of habitability, and the right of quiet enjoyment.

The general health protection language of state regulations, along with evidence of the harmful effects of exposure to secondhand smoke, gives state agencies authority to regulate secondhand smoke infiltration between apartments in multiunit dwellings. In states where regulations do not exist, other legal remedies may be available, many premised on the existence of a harm to the nonsmoking resident (Kline 2000). In addition, residents who can prove that they have a disability, including multiple chemical sensitivity disorder or environmental illness, which is affected by exposure to secondhand smoke, have recourse under the *Fair Housing Act of 1992* (Schoenmarklin 2004).

In 2005, a housing court jury in Boston, Massachusetts, ruled that a couple could be evicted from a rented apartment based on other tenants' complaints that the secondhand smoke they generated was seeping into adjoining apartments (Ranalli and Saltzman 2005). The jury found that the couple's heavy smoking violated a clause that prohibited "any nuisance; any offensive noise, odor or fumes; or any hazard to health." They made this ruling even though the landlord had not included a specific nonsmoking clause in the lease.

Some government bodies have considered or enacted policies that restrict smoking in public housing. For example, a housing authority in Springfield, Illinois, adopted a policy phasing out smoking in common areas of public housing complexes (Bolinski 2003). Another housing authority in Auburn, Maine, adopted a policy that bans smoking in all units except those currently occupied by smokers, with these units gradually coming under the smoke-free policy as current tenants are replaced (Healthy Androscoggin 2004). The policy also prohibits smoking in housing authority buildings and within 25 feet of buildings, including common areas. Finally, a city council in Thousand Oaks, California, considered prohibiting smoking in its publicly subsidized apartments, including many or all residential units (Keating 2003; Lee 2003).

Other government bodies have gone further and taken steps to regulate smoking in private multiunit housing settings. For example, several cities in Alameda County, California, have local ordinances in place requiring that common areas in multiunit housing be smoke-free (Chen 2005). A Utah law stipulates that residential unit rental and purchase agreements may prohibit generation of tobacco smoke (Utah Condominium Ownership Act 2005). Finally, in 2003, legislation was introduced in the California legislature that would have regulated smoking in apartments and condominiums (LePage 2003b; Vogel 2003). Specifically, the legislation would have made indoor and outdoor common areas in these settings smoke-free, would have allowed landlords and homeowner associations to penalize residents whose secondhand smoke repeatedly seeps into neighbors' units, would have allowed tenants to bring legal actions against neighbors, and would have required all apartment and condominium units to be smoke-free by January 1, 2006, unless designated by their owners as smoking units. The sponsor ultimately withdrew the legislation, citing concerns that had been raised about it (LePage 2003a).

Outdoor Settings

In California, a state law banning tobacco use on all playgrounds and in "tot lot" sandbox areas took effect on January 1, 2002 (Hill 2002). The city of Los Angeles had already implemented a similar municipal law prohibiting smoking in all 375 city parks and recreation centers. Several other cities in California have also enacted smoke-free park measures (County of Los Angeles Department of Health Services 2001). These recent policy initiatives in California reflect a growing movement toward banning smoking in outdoor public places. The ANR reported that as of January 2005, a total of 577 jurisdictions had passed ordinances covering outdoor areas, including restrictions on smoking in outdoor areas near an enclosed building where smoking is prohibited and in sports

or entertainment venues, as well as in places where the public congregates, such as parks, beaches, and plazas (ANR 2005b). These policies are presented as measures not only to protect children, youth, and nonsmoking adults from secondhand smoke, but also to set a healthy example for youth, reduce litter, and prevent infants from ingesting discarded cigarettes.

A recent trend in this area has been the adoption of local policies banning smoking on public beaches. A number of California communities have adopted such policies, as have some communities in other states (Evans 2003; Fuchs 2004). In 2004, the California legislature considered, but ultimately rejected, legislation that would have prohibited smoking at all California state beaches (Fuchs 2004). In addition to protecting nonsmokers from secondhand smoke, these measures are typically intended to remove a leading source of beach litter.

Finally, as noted above, many hospitals and schools, as well as a number of colleges and other workplaces, have implemented campus-wide policies that prohibit smoking on outdoor grounds in addition to indoor facilities in recent years. In addition to protecting nonsmokers from secondhand smoke, these policies are also intended to project a positive institutional image, convey a consistent pro-health message, undercut the perception that smoking is socially acceptable, discourage tobacco use initiation among students, and encourage and support tobacco use cessation among students, patients, and employees.

Legal Approaches

Nonsmokers have used the U.S. legal system to gain protection from the harm caused by secondhand smoke. The first successful case occurred in 1976 (*Shimp v. New Jersey Bell Telephone Co.*, 368 A.2d 408, 145 N.J. Super. 516 [1976]) where a New Jersey Superior Court ruled in favor of a nonsmoking office worker who sought relief from exposure to secondhand smoke in her worksite (USDHHS 2000c). Sweda (2004) reviewed 420 cases of exposure to secondhand smoke between 1976 and 2003. Cases were categorized by type: negligence, workers' compensation and disability benefits, discrimination based on disabilities, smoke seepage in a multiunit building, child custody disputes, prisoners' rights, assault and battery, and cases against tobacco companies. Sweda (2004) concluded that successful cases are instrumental in convincing businesses and others to adopt smoke-free policies. For example, in *Staron et al. v. McDonald's Corp.*, 51 F.3d 353 (2d Cir. 1995), plaintiffs sued McDonald's based on the *Americans with Disabilities Act of 1990* (ADA 1990), which prohibits discrimination based on disabilities. The plaintiffs claimed that McDonald's restaurants were public accommodations that became inaccessible to customers with adverse reactions to tobacco smoke. A year after the suit was filed, McDonald's announced that all of its corporately owned restaurants would become smoke-free (Hilts 1994). This action paved the way for similar policies in other fast-food outlets. In 1995, the court ruled that a ban on smoking would be a reasonable modification.

Parmet and colleagues (1996) outlined the remedies available to persons with respiratory, cardiovascular, or other health conditions that are exacerbated by secondhand smoke exposure and that might qualify as disabilities under the terms of the ADA and the role that their physicians could play in helping them pursue these remedies. The commentary explained that such persons might be able to seek redress under the workplace and public accommodation discrimination provisions if policies allowing smoking in effect denied them the ability to work in or patronize these settings. The commentary draws a parallel between a restaurant allowing smoking and failing to provide a wheelchair ramp—both can in practice deny access to persons with specific disabilities and can thus be seen as constituting discrimination under the ADA. The commentary notes that physicians can play an important role by documenting that patients have serious health conditions that restrict their major life activities (e.g., breathing) and that are exacerbated by secondhand smoke. For example, physicians can provide patients with a letter to this effect that they can use in pursuing remedies with employers and managers of places of public accommodation. The commentary further suggests that, by educating such decision-makers and the general public that secondhand smoke is a serious health hazard, physicians can help resolve these situations through voluntary compliance and, ultimately, prevent them from occurring in the first place (Parmet et al. 1996).

In another novel approach, seven nonsmoking flight attendants sued the six major cigarette companies for illnesses resulting from exposure to tobacco smoke. *Broin v. Philip Morris Cos.*, No. 92-1405 (Fla., Dade Cty. Mar. 15, 1994), *cited in* 9.1 TPLR 2.1 (1994), was tried as a class action lawsuit on behalf of all flight attendants exposed to secondhand smoke and was settled in 1997. The settlement established and funded the Flight Attendants Medical Research Institute and provided a precedent that enabled individual flight attendants to sue tobacco companies for damages.

Although Sweda (2004) found a limited number of successful secondhand smoke cases, he observed, "the judicial branch has begun to recognize the need to protect the public—especially some of the most vulnerable members of our society—from the serious threat to their health that is exposure to SHS [secondhand smoke]" (p. i61).

Technical Approaches

Although policy approaches appear to be effective at reducing exposure, there are also technical strategies that have been used. This section reviews these strategies and evidence for their effectiveness.

Controlling Secondhand Smoke Exposure Indoors

Overview

Chapter 3 of this report (Assessment of Exposure to Secondhand Smoke) explained the foundation for engineering and policy options intended to reduce, restrict, or eliminate secondhand smoke exposure indoors. This chapter revisits the basic concepts of ventilation and air cleaning to provide an understanding of the various strategies proposed in building codes, ventilation designs, building operating procedures, and other practices to reduce or attempt to eliminate exposure of nonsmokers to tobacco smoke within a built environment. The discussion covers the evidence on the efficacy and effectiveness of these strategies. The literature review covers the relevant peer-reviewed evidence, but does not attempt to systematically capture the substantial non–peer-review or "gray" literature. This section first provides a simplified (time-averaged, steady-state form) mass balance equation for predicting indoor concentrations of a contaminant. This equation provides a foundation for considering the potential effectiveness of control strategies (Klepeis 1999; Ott 1999).

Mass Balance–Steady-State Equation

The mass balance model describes how the concentration of an indoor contaminant varies with the strength of the pollution source and the factors acting to reduce its concentration. Equation A expresses the physical factors governing concentrations of indoor airborne contaminants, including secondhand smoke:

$$\text{Equation A} \qquad C_{in} = \frac{PaC_{out} + Q_s/V}{a + k}$$

This form of the equation is simplified by the assumption that the air of the indoor environment is well mixed and that steady-state conditions exist. It is possible to computationally consider the temporal variation of each parameter in Equation A, as well as the multiple compartments within a space or building. With an expansion to multiple compartments (i.e., rooms or spaces), Equation A would include terms for describing air transfer between adjacent rooms or between areas (e.g., from a smoking section of a restaurant, club, or airplane to a nonsmoking area).

In Equation A, the indoor concentration (C_{in}) is in mass per unit volume and C_{out} is the outdoor concentration in the same units. For secondhand smoke, this term might be specified as μg per m^3 for particles and for some gaseous species, and as ng/m^3 for metals and other constituents of secondhand smoke that are present in small quantities. P is the unitless penetration coefficient. In the context of a building with a mechanical air handling unit (AHU), P would represent the fraction of a constituent in the incoming supply air that passes through filters and other system components such as cooling coils and ducts that would remove some of the constituents from the flowing air. For homes without air conditioning, P is the fraction of an airborne contaminant in the outdoor air that comes indoors through windows, doors, and cracks or down chimneys, driven by pressure differences across the exterior boundary of the structure. Penetration can be very high (approaching 100 percent) for particles of certain sizes, particularly small particles, and for inert (nonreactive) gases.

Penetration might, on the other hand, actually be zero if, for example, air-cleaning devices completely capture the contaminant.

The air exchange rate (a) describes the effective rate at which indoor air is replaced by outdoor air. The air exchange rate is expressed as inverse time, indicating the fraction of indoor volume that is exchanged in an hour. Most buildings do not have a "once through system" or complete mixing, where only air coming from the outdoors is used to replace all indoor air. Typically, an air exchange rate of one per hour might only be 65 percent effective in flushing out the indoor air. As discussed in Chapter 3 (see "Building Designs and Operations"), heating, ventilating, and air conditioning (HVAC) systems in buildings (and in airplanes) usually mix a portion of the outside air with a portion of the previously circulated indoor air to create the supply air that conditions indoor spaces. So the term PaC_{out} can be decomposed to include both components of the supply air: the ventilation component derived from outdoor air and the return (recirculated) air component.

The Q_s term represents the mass flux generation rate (mass/time) for internal sources of contaminants. For cigarettes, this term reflects the rate at which particles or specific gases are released and is thus an index of the strength of smoking as a source of indoor pollution. Data are available on emission rates of cigarettes (IARC 2000). Dividing Q_s by the volume (V) of a room, house, atrium, or other space yields a concentration flux term with units similar to the other terms in the numerator. In the context of secondhand smoke generation, smoking is a time-varying event. Detailed computational fluid dynamic models can estimate time-resolved concentrations associated with the smoking of a single cigarette. Steady-state models average source generation rates over hours to days. Estimating the volume term can be as straightforward as the simple calculation of the physical dimensions of a building, house, or room. In this case, volume refers to the space where air is "well mixed." Thus, there is an important distinction between estimated concentrations from a lit cigarette in still air versus the concentrations in a restaurant or a nightclub with substantial air movement and smokers dispersed throughout.

Equation A also shows that the flux terms in the numerator are divided by the air exchange rate (a) and a decay or removal rate (k). This k term represents the loss rate per unit of time through chemical or physical means, such as deposition on surfaces, air cleaning, or change of state or condition. For example, vapors might decay by condensing or adsorbing onto particles or through chemical transformations. The number of particles in particular size ranges might change because of agglomeration. Rates of loss of particles from the air reflect primarily diffusion to surfaces, sedimentation, coagulation, and evaporation. Vapors and gases do not settle out of the air, but they diffuse to surfaces, with possible re-emission, and can react with gaseous and particulate constituents of the air as well. The rate of loss to surfaces is enhanced by turbulence in the air, such as mixing by fans. The temperature of the surface also affects loss rates. By a mechanism called thermophoresis, particles and gases can be preferentially driven from warm surfaces such as radiators and light fixtures to cold surfaces. In addition, experiments reveal that concentrations of particle-bound polycyclic aromatic hydrocarbons decay twice as fast as respirable particle concentrations (Repace 2004b).

Policies for Controlling Secondhand Smoke

Although Equation A is a simple expression of a mass balance equation, it indicates all of the options for mitigating concentrations of secondhand smoke in indoor air. These options include source control, ventilation, and filtration. Among indoor air pollutants, secondhand smoke is unique in the possibility for full control. By eliminating sources indoors and preventing outdoor tobacco smoke from entering by distancing it from air intakes, the numerator of the equation becomes zero, and there is no secondhand smoke.

Equation B is derived from Equation A by considering tobacco smoke constituents only and by assuming that outdoor air contains no secondhand smoke components (i.e., $C_{out} = 0$). With these assumptions, Equation B implies that control options relate to increasing air exchange rates for ventilation or enhancing removal rates with air cleaning devices.

$$\text{Equation B} \qquad C_{in} = \frac{Q_s/V}{a + k} = \frac{Q_s}{V(a+k)}$$

Additional strategies include physically modifying the volume or area where smoking is allowed. Smokers might be separated from nonsmokers with controlled airflow that directs secondhand smoke to exhaust fans independently and separately exhausted from the HVAC system. This strategy is often used in restaurants or hotels that designate smoking and nonsmoking rooms or floors. Smoking lounges can be effective theoretically if the room is physically separated by walls and doors from surrounding spaces,

internal pressure is negative to surrounding areas, and air from the room is not mixed back into the supply air for the building.

Field studies provide some indication of the potential for various strategies implied by the mass balance equation to affect secondhand smoke concentrations. Liu and colleagues (2001) assessed the effectiveness of control measures for secondhand smoke in a study of 118 smoking areas in 111 county and city buildings. The data were collected in California from 1991 to 1994, before the current statewide indoor smoking ban, but the findings are relevant to current building scenarios. Inspection of the smoking areas showed a range of operational and design problems, including the incomplete separation of smoking and nonsmoking areas, a failure to vent the smoking area to the outside, and the recirculation of secondhand smoke-contaminated air. Only 7 percent of the areas had the requisite features for the most complete control: exhausting smoke-contaminated air outside, no recirculation from the smoking area, and full walls from floor to ceiling. Measurement data showed that this control strategy could reduce concentrations in surrounding nonsmoking areas.

In some situations where smoking can be intense, such as gaming establishments, a combination of strategies and technological enhancements may be needed to reduce secondhand smoke concentrations in the absence of a smoking ban. Supplemental air cleaners recirculate room air that has passed through filters or electrostatic air cleaners. Some establishments use devices to generate charged ions that attach to smoke particles to increase their removal rates by electrostatic attraction to any surface in the room. A combination of turbulent mixing, as with fans, and an added electric charge may significantly increase particle removal. In yet another approach, appliance manufacturers claim that adding ozone (O_3) to the indoor air will accelerate oxidative reactions of some secondhand smoke constituents and decrease odor and secondhand smoke concentrations.

These mass balance considerations imply a range of policy options related to source control and ventilation, including elimination of the source term (Q_s), leading to no secondhand smoke indoors, and increasing the effectiveness of air exchange (a) to achieve targeted concentration values (C_{in}). These options have been widely debated; the advocacy and public health communities argue that smoking bans are necessary, and the tobacco industry has proposed that secondhand smoke concentrations can be controlled at acceptable levels through strategies of mutual accommodation between smokers and nonsmokers, ventilation, and air cleaning (Bialous and Glantz 2002). The tobacco industry has attempted to assure that ventilation will be maintained as a strategy for achieving acceptable indoor air quality, even with smoking allowed.

The principles of public health protection underlying this discussion need to be considered. There is universal acceptance of the concept that outdoor air is a "public good," and for this reason, outdoor air quality is monitored in the United States to meet public health goals under the federal *Clean Air Act of 1990* (USEPA 2004). It is the obligation of government to protect the users (the general public) and maintain the quality of that public good (outdoor air), so users will not be harmed by contaminants released into the air by those who would pollute it. Indoor spaces are private as well as public. Consequently, the principles that have been applied to outdoor air may not apply directly to all indoor air, particularly in private places. In public places, where indoor air can be more readily construed as a public good, segregating smokers and banning smoking have become enforced approaches that are well accepted, and bans have become mandatory in many environments, including hospitals, schools, and childcare facilities.

In a limited way, the government has assumed an obligation to ensure that "workplace" air is free of specific airborne contaminants that can cause harm to the worker, as discussed earlier in this chapter. OSHA has standard-setting and enforcement responsibilities that are applied to the workplace. The FAA also has rule-making responsibilities affecting air quality for flight crews. In 1994, OSHA published a "Notice of Proposed Rulemaking on Indoor Air Quality" (*Federal Register* 1994b). The proposed rules included the requirement that employers either establish a designated smoking area with ventilation control or ban smoking. These rules would have eliminated secondhand smoke exposure to nonsmokers in the workplace by prohibiting work-related activities in the designated smoking area. Although lengthy hearings were held, these draft rules were never promulgated and have now been withdrawn (*Federal Register* 2001).

The WHO European Center established guiding principles for indoor air rights in its report *The Right to Healthy Indoor Air*, which provided a basis for excluding known hazardous substances from indoor air (Møhave and Krzyzanowski 2000, 2003). As discussed earlier in this chapter (see "Local Ordinances" and "State Laws and Regulations"), an increasing number of municipalities and states in the United

States, including California and New York City, have now completely banned smoking in workplaces and in public indoor environments. Yet the tobacco industry and some in the hospitality and gaming industries argue that with improved ventilation technologies, both smokers and nonsmokers can be accommodated (<http://www.philipmorrisusa.com/en/policies_practices/smoking_restrictions.asp>). Repace (2000a) counters that even with the optimistic assumption of a 90 percent reduction in secondhand smoke in bars and casinos by using the most advanced ventilation technologies, cancer and heart disease risks from secondhand smoke would not be reduced below the EPA limits for hazardous air pollutants in outdoor air. Although Repace's risk model is well documented, no regulatory entity or federal agency has relied upon Section 112 of the *Clean Air Act of 1990* as a framework for establishing indoor air quality goals for secondhand smoke at some de minimis risk level, and the tobacco industry places the emphasis on accommodation without specifying indoor air levels of secondhand smoke that would be acceptable (<http://www.philipmorrisusa.com/en/policies_practices/smoking_restrictions.asp>).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is the professional organization for the ventilation industries, and its membership includes thousands of practicing ventilation engineers in the United States. The ASHRAE Standing Standards Project Committee provides guidance on indoor space ventilation for achieving acceptable indoor air quality (American National Standards Institute/ASHRAE Standard 62-2001, *Ventilation for Acceptable Indoor Air Quality*) (ASHRAE 2001). The ASHRAE Standard 62-2001 provides the basis for municipal building codes and design specifications for HVAC equipment. The first version of Standard 62 was approved in 1973 with revisions in 1981 and 1989, and a process of revision is constantly ongoing (Bialous and Glantz 2002).

The 1989 revision of Standard 62 had implications for controlling secondhand smoke concentrations; the standard proposed that "acceptable indoor air quality," as defined by ASHRAE, could be achieved in the presence of "moderate" amounts of smoking by meeting ventilation requirements (ASHRAE 1989; Bialous and Glantz 2002). Bialous and Glantz (2002) provide a detailed account of Standard 62 and the involvement of the tobacco industry in deliberations around the standard. ASHRAE accepts the engagement of all affected parties in its activities.

Standard 62-2001 is the most recent version and is undergoing a process of continuous revision. It is important to point out that with the 1999 and 2001 revisions, there is no longer a footnote to the table providing ventilation recommendations that allow a moderate amount of smoking. The ASHRAE Board has acknowledged that allowing smoking indoors is incompatible with the stated goal of the standard, which is to "minimize the potential for adverse health effects" (Persily 2002, p. 329).

In 2005, ASHRAE published a position document on secondhand smoke that had the purpose of providing information on secondhand smoke to its members and of considering the implications of this information for building design and operation (ASHRAE 2005). The document, approved by ASHRAE's Board of Directors, recognized the consensus view that secondhand smoke exposure poses a risk to health. Among the conclusions were the following:

> There is a consensus amongst medical cognizant authorities that secondhand smoke is a health risk, causing lung cancer and heart disease in adults, and causing adverse effects on the respiratory health of children, including exacerbating asthma and increasing risk for lower respiratory infection. At present, the only means of eliminating health risks associated with indoor exposure is to ban all smoking activity. Although complete separation and isolation of smoking rooms can control secondhand smoke exposure in non-smoking spaces in the same building, adverse health effects for the occupants of the smoking room cannot be controlled by ventilation. No other engineering approaches, including current and advanced dilution ventilation, "air curtains" or air cleaning technologies, have been demonstrated or should be relied upon to control health risks from secondhand smoke exposure in spaces where smoking occurs, though some approaches may reduce that exposure and address odor and some forms of irritation. An increasing number of local and national governments, as well as many private building owners, are adopting and implementing bans on indoor smoking. At a minimum, ASHRAE members must abide by local regulations and building codes and stay aware of changes in areas where they practice, and should educate and inform their clients

> of the substantial limitations and the available benefits of engineering controls. Because of ASHRAE's mission to act for the benefit of the public, it encourages elimination of smoking in the indoor environment as the optimal way to minimize secondhand smoke exposure (ASHRAE 2005).

Because indoor exposure to secondhand smoke in the United States continues, and because in many countries outside the United States there are limited or no restrictions on smoking, it is useful to review the various strategies to lessen the impact of smoking indoors and assess their efficacy. These approaches incorporate segregation of smokers from nonsmokers and include controlled and enhanced ventilation and air cleaning.

Technological Strategies for Controlling Secondhand Smoke

Some state and local ordinances require designated nonsmoking and smoking areas in public access facilities such as restaurants. Typically, these ordinances provide little guidance on how to achieve this separation or how effective it has to be in controlling concentrations in the nonsmoking areas. Also, studies have not addressed all of the factors that are potentially relevant to this determination (e.g., smoking rates, dilution measures, containment measurements, and biomarkers of exposure) across the broad spectrum of possible designs. Therefore, only general guidance is available based on engineering principles, and there is a limited literature.

In integrated spaces—spaces with no walls that accommodate multiple occupants or uses such as restaurants, casinos, and similar venues—pressure-driven airflow is the only method capable of directing secondhand smoke away from nonsmokers. With separate rooms and physical barriers, air supply and exhaust routes can be designed to more effectively isolate impacts. However, employees may not have the same options as patrons to avoid exposure, particularly if their work activities require them to enter designated smoking areas.

A second general strategy involves controlled ventilation. Possible methods include ashtrays to capture cigarette emissions, hoods placed over gaming tables or bars to remove secondhand smoke from the area proximate to smokers, and displacement ventilation. Displacement ventilation can orient air supply and air exhaust in a configuration that directs secondhand smoke away from nonsmoking patrons and employees such as bartenders. Thus, displacement ventilation can be considered a design option for the separation strategy. Design criteria include a low-velocity air supply near the floor with the exhaust at the ceiling. Turbulence has to be reduced to limit the general mixing of secondhand smoke before it is exhausted. The location and balance of supply and exhaust air are as critical as the interior design is because barriers and heat sources such as lights and appliances can affect airflow. The movement of people stirs the air and actually causes bulk transport of air from smoking to nonsmoking areas, which reduces the effectiveness of separation strategies.

With efficient heat recovery devices for the exhaust air, it is becoming less costly to increase outdoor air supply rates. Because most office buildings have conventional HVAC systems that force conditioned supply air to mix with room air to achieve comfort conditions, the strategy to accommodate nonsmoking employees or visitors would simply be based on dilution. However, if complemented with improved filtration of the return air, it is possible to achieve greater reductions of some secondhand smoke constituents beyond what dilution alone can accomplish (ASHRAE 1999).

The concept is straightforward: process a portion of the air locally and remove secondhand smoke constituents with commonly used devices mounted on ceilings. The devices use the principle of electrostatic precipitation to remove particles or a series of filters to remove particles and odors. New devices have become available recently and include ultraviolet-activated photo catalytic systems that oxidize vapor phase organic compounds. With the addition of filters to this configuration, these devices could also remove particles. However, widespread application of these systems to effectively control secondhand smoke exposure in buildings has not yet been demonstrated.

Table 10.17 presents six technologies used in air cleaning systems (Daniels 2002). The devices that are effective for particles as well as for the vapor phase organic constituents of secondhand smoke might be more efficacious for controlling secondhand smoke. The effectiveness of these devices will be determined by the product of the volume of air processed and the removal efficiency of various constituents in comparison with the dilution rate achieved by the overall ventilation of the air delivered to the conditioned space. If the decay rate by supplemental air cleaning is comparable to or exceeds the dilution rate by air exchange, then a cleaning system may measurably reduce concentrations of secondhand smoke. If smokers are

Table 10.17 Comparison of air-cleaning systems

Characteristic	Technology					
	Electrostatic precipitation	**Solid media filtration**	**Gas-phase filtration**	**Ozone (O_3) generation**	**Catalytic oxidation**	**Bipolar air ionization**
Function	Electronic	Physical	Physico-chemical	Electronic	Physico-chemical	Electronic
Principle	High-voltage wire and plate	Flat, pleated, or high efficiency particulate air media	Sorption and reaction	Sparking discharge	Solid catalysts with or without ultraviolet	Dielectric barrier discharge
Process	Charging of particulate matter	Collection on porous media	Sorption and reaction	O_3 generation	Catalytic oxidation	Positive and negative ion generation
Active species	Charged particles	High surface area	Sorption and reaction sites	O_3	Reactive oxygen species	Reactive oxygen and charged species
By-products	O_3 if not cleaned regularly	Spent filters; contaminants	Spent media with contaminants	Significant O_3, atmospheric reactants	Exhausted or fouled catalysts, some VOCs*	Some O_3
VOCs	Sorption of VOCs on $PM^{\dagger}_x$	NA‡	Adsorption/ absorption	Chemical oxidation	Chemical oxidation	Chemical oxidation
PM_x	Collection on plates	Impact, settling, and diffusion	Collection on media	NA	NA	Agglomeration

*VOCs = Volatile organic compounds.
†PM = Particulate matter.
‡NA = Not applicable.
Source: Adapted from Daniels 2002.

clustered within a space and supplemental air cleaners can be appropriately placed to effectively capture secondhand smoke near the source, then the overall efficiency of an air-cleaning strategy can be further enhanced.

Effectiveness

Field and laboratory investigations have evaluated the secondhand smoke control strategies discussed above. Three extensive literature searches were conducted to identify articles related to the control of tobacco smoke in nonresidential settings. The searches included PubMed, Medline, Kompass, JICST-Eplus, BIOSIS Previews, Vizon SciTec, Dissertation Abstracts, Inside Conferences, ELSEVIER BIOBASE, PASCAL, National Institute for Occupational Safety and Health (NIOSH), ABI/INFORM, BioBusiness, Wilson Business Abstracts, ToxFile, EMBASE Excerpta Medica Database, and Current Contents Search.

The search was restricted to published articles, abstracts, conference abstracts, proceedings, and dissertations relevant to the following key words: environmental tobacco smoke OR ETS AND (control OR controlling OR controls) AND (separation OR filtration OR removal OR local source capture OR isolation OR elimination OR reducing exposure OR controlled exposure OR mechanical OR ventilation OR HVAC OR air condition). The third search included all listings appearing through August 29, 2003.

The searches yielded 50, 55, and 83 abstracts, respectively, which were then reviewed and categorized. Full articles were obtained for those deemed

relevant to the evaluation of smoking controls in nonresidential settings based on bans, separation, and mechanical systems. Further culling retained only articles that reported environmental measurements of particles, nicotine, or other indicators of secondhand smoke concentrations and the few studies that conducted laboratory evaluations of equipment and smoking chambers (rooms). The studies reported here have evaluated strategies that fall into one of three categories: bans, separation with existing conventional HVAC systems, or separation with designed control systems (e.g., ventilation or air cleaning).

There are many studies of concentrations of secondhand smoke in office buildings, hospitals, restaurants, bars (which are called public houses [pubs] in the United Kingdom), airplanes, and homes, among other locations (Chapter 4, Prevalence of Exposure to Secondhand Smoke). Comparisons of these studies are complicated by the different methodologies and environmental measurements used to characterize various components of secondhand smoke and the differences in sampling protocols (Chapter 3, Assessment of Exposure to Secondhand Smoke). Nicotine has been most widely used as an indicator of secondhand smoke, but other components of tobacco smoke have been used as well, including the particle mass, particle number density, and light scattering. Oldaker and colleagues (1990) made short-term measurements (one hour) of nicotine, respirable suspended particles (RSP), and ultraviolet-absorbing particulate matter (UVPM) in more than 125 offices and four cities. Turner and colleagues (1992) documented secondhand smoke markers for office areas with samples from nearly 500 locations. Hedge and colleagues (1993) measured various secondhand smoke constituents in 27 office buildings classified by ventilation systems. Baek and colleagues (1997) reported on nicotine and volatile organic compound levels in 12 office buildings in Korea; 4 of these buildings had recently instituted nonsmoking policies. Jenkins and colleagues (2001) examined the day-to-day variability of secondhand smoke components in a single large office building that permitted unrestricted smoking. In addition to repeated measurements at 29 locations in the building, there were personal samples collected from 24 nonsmoking participants. Sterling and colleagues (1996) studied personal and fixed locations of exposures in two U.S. office buildings that did not restrict smoking. A number of studies during the past 10 years assessed nicotine and respirable particle levels in workplaces, homes, and penal institutions (Hammond 2002; Hammond and Emmons 2005). Many of these studies were designed to assess the effectiveness of smoking bans and smoking restrictions such as separate designated areas or a designated smoking area either alone or in combination with mechanical systems.

The following sections summarize the articles that were reviewed and then categorized according to the information they provided on smoking bans, designated nonsmoking areas, and separate rooms with or without dedicated air handling systems. This discussion also includes studies that purported to demonstrate that with general building ventilation alone, the impact of secondhand smoke is not substantial.

Banning Smoking

Building on the earlier work of Becker and colleagues (1989) and Stillman and colleagues (1990), many studies have demonstrated the effectiveness of using markers to monitor for secondhand smoke, as well as the effectiveness of complete smoking bans to reduce the number of cigarettes smoked. Becker and colleagues (1989) measured and averaged seven-day nicotine concentrations one month before and six months after a smoking ban was instituted at Johns Hopkins Children's Center. Substantial and significant decreases of nicotine were noted in some areas, such as elevator lobby lounges, where levels dropped from 13 to 0.45 $\mu g/m^3$. However, levels of nicotine changed little in restrooms (7.33 versus 6.68 $\mu g/m^3$) and in outpatient clinics (0.28 versus 0.36 $\mu g/m^3$) where levels were already low.

Stillman and colleagues (1990) pursued a similar strategy to evaluate the effectiveness of a campaign to eliminate smoking from all areas of Johns Hopkins University medical institutions. The investigators monitored seven-day nicotine concentrations with passive samplers placed in randomly selected locations eight months before and again one month before the campaign. Median nicotine concentrations ($\mu g/m^3$) dropped significantly in cafeterias (7.06 versus 0.22 $\mu g/m^3$), waiting areas (3.88 versus 0.28 $\mu g/m^3$), offices (2.05 versus 0.12 $\mu g/m^3$), staff lounges (2.43 versus 0.12 $\mu g/m^3$), and corridors (2.28 versus 0.20 $\mu g/m^3$). Similar to the observations of Becker and colleagues (1989), restroom levels did not show a significant decline (17.71 versus 10.0 $\mu g/m^3$). Ott and colleagues (1996) also reported evidence that smoking bans can effectively reduce or eliminate secondhand smoke exposure in taverns.

As a result of California's smoking policies in public places, these investigators documented a 77 percent reduction in respirable particulate concentrations. Miesner and colleagues (1989) found concentrations of particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) of less than 30 $\mu g/m^3$ in offices without smoking and 30 to 140 $\mu g/m^3$ in restaurants and bars that permitted smoking. Brauer and Mannetje (1998) similarly showed that $PM_{2.5}$ in restaurants that prohibited smoking averaged 38 $\mu g/m^3$ (7–65 $\mu g/m^3$ range), while unrestricted smoking in restaurants raised the mean to 190 $\mu g/m^3$ (47–253 $\mu g/m^3$ range). Cadmium (Cd) concentrations also showed a consistent decrease in restaurants with smoking bans (0.65–1.7 $\mu g/m^3$) compared with restaurants that permitted smoking (2.2–10 $\mu g/m^3$ for smoking).

Heloma and colleagues (2001) reported on an evaluation of workplace nicotine exposure from secondhand smoke and the effect of national smoke-free workplace legislation in Finland. In March 1995, the *Tobacco Control Act* was reformed to move from voluntary compliance to prohibition of smoking on all premises for both workers and customers in workplaces. The authors pointed out that employers could comply by either imposing a total smoking ban or establishing designated smoking areas. Two rounds of surveys and measurements were conducted: one before the stricter law went into effect and one shortly afterward. The investigators surveyed 12 medium and large workplaces from both industrial and service sectors. Approximately 1,000 employees participated in each survey. Reported exposure to secondhand smoke, as well as the amount of smoking, decreased significantly between the two surveys. Median nicotine levels, which were 1.2 $\mu g/m^3$ in industrial workplaces, 1.5 $\mu g/m^3$ in the service sector, and 0.4 $\mu g/m^3$ in offices, all showed substantial decreases for the year following the enactment of stricter antismoking rules: 0.05 $\mu g/m^3$, 0.2 $\mu g/m^3$, and 0.1 $\mu g/m^3$, respectively.

The study conducted by Heloma and colleagues (2001) represents the most substantial evaluation of smoking restrictions in the workplace. Although nicotine levels were reduced significantly in all three sectors that were surveyed, the investigators still detected measurable levels in the follow-up survey. The authors did not distinguish between workplaces that banned smoking entirely and those that provided a designated smoking area. Unfortunately, distributional information on nicotine concentrations was not provided. The smallest reduction in nicotine was for office settings (75 percent), followed by the service sector (87 percent). The data do not indicate whether persistent exposure resulted from noncompliance, drifting smoke, or recirculated air from the designated smoking area.

In Japan, more than half of all adult men smoke, and the typical office environment is a large open (nonpartitioned) area (Mochizuki-Kobayashi et al. 2004). Thus, the exposure of nonsmoking workers to secondhand smoke in the Japanese workplace is extensive. In 1996, the Japanese government required employers to establish workplace smoking policies and procedures. Mizoue and colleagues (2000) from the University of Occupational and Environmental Health in Japan collaborated with Finnish and Swedish researchers to assess the effectiveness of various strategies to comply with the law. Approximately three-fourths of all nonsmokers reported some workplace exposure; 50 percent reported exposure to secondhand smoke of more than four hours per day. Unfortunately, markers for secondhand smoke were not collected in this survey of 3,224 municipal employees from a city in northern Kyushu, Japan. This survey was conducted six months after the national policy was implemented. Banning smoking reduced secondhand smoke exposure of nonsmokers, yet 25 percent still reported some workplace exposure, and 15.6 percent said the exposure occurred for four or more hours per day. The authors concluded that any policy less restrictive than eliminating (isolating) smoking from the work area was insufficient. This finding encouraged the government to pursue stricter rules in Japan's workplaces.

These studies clearly demonstrate that secondhand smoke exposure can be eliminated with a smoking ban, as predicted by the mass balance equation. However, the findings also indicate the need for full compliance with such bans because incomplete compliance will lead to continued exposure.

Separation Strategies

Carrington and colleagues (2003) conducted a study of secondhand smoke exposure in 60 randomly selected bars in Greater Manchester, United Kingdom. Separating smokers from nonsmokers reduced the concentrations of various secondhand smoke markers such as RSP, UVPM, and nicotine by about 50 percent in comparisons of smoking and nonsmoking sections (Table 10.18). However, the levels of secondhand smoke in the smoking and nonsmoking sections were unaffected by the various ventilation systems in place, which included electrostatic precipitators and extractor fans. The investigators also noted substantial variations in secondhand smoke

Table 10.18 Untransformed secondhand smoke marker concentrations ($\mu g/m^3$) for smoking and nonsmoking areas in United Kingdom public houses

Secondhand smoke markers (location)	N	Minimum	Maximum	Median	Percentiles	
					75	25
RSPM* (smoking)	138	14.6	356.3	98.3	153.1	50.0
RSPM (nonsmoking)	23	20.8	164.6	68.8	108.3	41.7
UVPM† (smoking)	137	0.5	269.7	58.5	108.3	25.7
UVPM (nonsmoking)	22	5.7	132.1	32.9	69.2	15.5
FPM‡ (smoking)	137	<0.1	298.3	73.2	127.0	28.4
FPM (nonsmoking)	22	8.5	152.3	37.7	74.9	18.6
SolPM§ (smoking)	137	1.6	514.4	63.8	148.6	21.7
SolPM (nonsmoking)	22	6.8	158.9	29.7	76.6	12.8
Nicotine (smoking)	134	0.5	516.9	63.0	132.8	23.5
Nicotine (nonsmoking)	23	0.5	77.8	21.1	42.7	10.6

Note: N is the total number of sample locations for 60 pubs.
*RSPM = Respirable suspended particulate matter.
†UVPM = Ultraviolet light-absorbing particulate matter.
‡FPM = Fluorescent particulate matter.
§SolPM = Solanesol particulate matter.
Source: Adapted from Carrington et al. 2003.

concentrations across the bars in the study, but only provided an overall statistical analysis. The authors concluded that the Public Places Charter, which was initiated by the hospitality industry and the government of the United Kingdom to increase the number of nonsmoking facilities and provide better ventilation, was having only limited success in abating secondhand smoke exposure. The investigators suggested that better ventilation designs, which the bars in the study did not have, might significantly reduce secondhand smoke exposure (Carrington et al. 2003).

There were attempts to control secondhand smoke exposure in a university cafeteria by implementing both strategies: separating smokers from nonsmokers and increasing the ventilation (Hammond 2002). Nicotine levels in the smoking section averaged 31 $\mu g/m^3$; in the nonsmoking section within 25 feet of the smoking section, concentrations were one-tenth of those levels; and nonsmoking sections that were farther away averaged levels of 0.7 $\mu g/m^3$. Results from tests conducted over a four-day period documented higher levels in some measurements than in the reported average values. This finding indicated that secondhand smoke had intruded into the nonsmoking areas.

In a study of 75 restaurants in 26 cities, Hammond (2002) reported a mean nicotine level of 3.7 $\mu g/m^3$ and a 1,000-fold range in concentrations. Similar to the United Kingdom bar study, separating smokers reduced exposure to secondhand smoke, but there was no evidence that an increase in ventilation had any effect. The data suggest that in spatially separated strategies where half or more of the seating area was nonsmoking, secondhand smoke levels in the nonsmoking sections were reduced, but levels remained high (Hammond 2002).

Lockhart Risk Management Ltd. (1995) attempted to characterize smoking density in studies of pubs in Vancouver, British Columbia (Canada); Repace (2000b) reported the results. In 10 pubs where smokers were

separated from nonsmokers, the Lockhart studies measured nicotine levels in both areas, counted the number of lit cigarettes, and from these numbers derived a density of active smokers per 100 cubic meters. Figure 10.8 shows a slight difference in nicotine levels between smoking and nonsmoking sections when the density of active smokers is taken into account. Nonetheless, the results demonstrated that some bars had either well-mixed air or poorly controlled airflow—nicotine levels in nonsmoking sections were only slightly reduced from those in the smoking sections.

Brauer and Mannetje (1998) also studied secondhand smoke exposure in restaurants and bars in Vancouver, British Columbia (Canada). The investigators collected six-hour integrated samples of PM less than 10 micrometers in diameter (PM_{10}) and $PM_{2.5}$ for mass concentrations and then extracted and analyzed the samples for Cd as a marker for cigarette smoke. Of the 20 restaurants sampled, 5 were classified as nonsmoking, 11 as restricted smoking with measurements from the nonsmoking area, and 4 as unrestricted smoking. The authors found that the three types of establishments differed in their mean PM_{10}, $PM_{2.5}$, and Cd concentrations, but did have some overlapping values from other possible sources. Nevertheless, the investigators noted a clear distinction among restaurant groups in the Cd levels. The mean and standard deviation for Cd in $\mu g/m^3$ were 0.97 (0.44) for nonsmoking restaurants, 1.3 (1.3) for restricted places, and 6.5 (3.4) for unrestricted places. The authors concluded that partial smoking restrictions substantially reduce but do not eliminate secondhand smoke exposure of nonsmokers, and nonsmokers and smokers alike might experience substantial particulate exposures from cooking emissions.

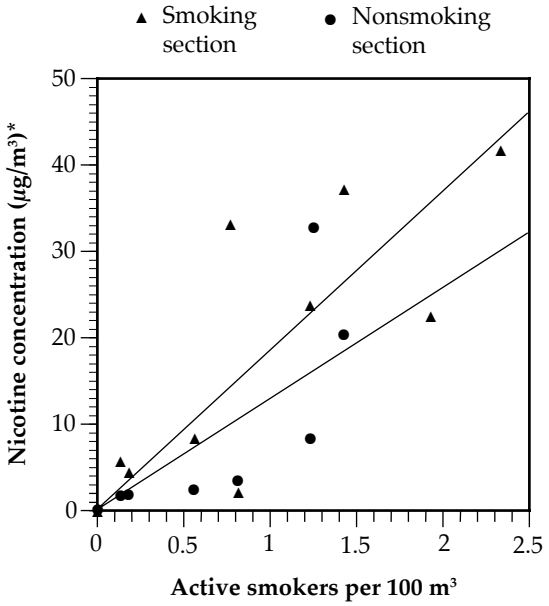
Separating smokers from nonsmokers does not alter the source strength in the mass balance model, but only moves nonsmokers away from the smoking area. Studies show that levels are lower on average in nonsmoking compared with smoking sections, but secondhand smoke is readily found in nonsmoking sections.

Designated Smoking Areas

Several researchers have investigated the use of designated smoking areas to control secondhand smoke (Vaughan and Hammond 1990; Pierce et al. 1996; Hammond 2002), and Wagner and colleagues (2002) have evaluated air leakage from a simulated smoking room. Vaughan and Hammond (1990) collected nicotine measurements in a modern office building before and after smoking was restricted to a snack bar on one floor. Measurements were made in areas and floors that were adjacent to and that shared the same AHU as the designated smoking area. Measurements were also collected from other locations (floors) in this building. Nicotine levels indicated that the policy successfully reduced exposure to secondhand smoke by 90 to 95 percent. However, a "spillover" effect into areas adjacent to the designated smoking area was apparent from nicotine levels that were four times higher than those in areas not sharing the same AHU with the smoking area. Smokers using the designated area were themselves subject to levels that were 1,800 times higher than the typical office nicotine levels before the new smoking policy took effect.

Hoping to achieve a better understanding of the effects that various design and operating parameters have on performance, Wagner and colleagues (2002) built a physical model of a smoking lounge at the Lawrence Berkeley National Laboratory. They found it essential to maintain the smoking room at a negative

Figure 10.8 Nicotine levels measured in 10 Vancouver, British Columbia, pubs for the Heart and Stroke Foundation of British Columbia and Yukon, 1995



*$\mu g/m^3$ = Micrograms per cubic meter.
Source: Lockhart Risk Management Ltd. 1995. Reprinted with permission from Robert W. Lockhart.

pressure with respect to adjacent areas to ensure that the tobacco smoke did not move out of the room into the surrounding air. To achieve this negative pressure, they established a separate exhaust for the room that exceeded supply and leakage. They also reported that the "pumping" action of a hinge-mounted door caused secondhand smoke to spill into adjacent areas. A sliding door is thus preferable to a standard swing-type door to reduce secondhand smoke leakage.

The spillage of secondhand smoke from a designated smoking lounge was evident in the study of an office building floor reported by Yamato and colleagues (1996). The smoking room (4 m × 4 m) at one end of a floor (45.5 m × 34 m) was equipped with three air cleaners with an effective air cleaning rate of once per minute. The ceiling exhaust provided two air changes per hour (ACH). Smoking was substantial, and average 24-hour suspended particulate concentrations in the smoking room during each of the two consecutive days studied ranged from 520 to 1,310 $\mu g/m^3$. Particle concentrations in the nonsmoking office area 25 m farther down the corridor were 30 and 50 $\mu g/m^3$ for each of the two days studied. However, the corridor, the hall leading to the stairs, and the kitchen located near the smoking room experienced concentrations three to seven times higher than in the nonsmoking office area. This case study indicated that with just four persons simultaneously smoking, air cleaners (even at one air change per minute) and exhaust ventilation were insufficient to maintain particle concentrations below the Japanese standard of 150 $\mu g/m^3$ for office buildings.

Pierce and colleagues (1996) conducted a set of experiments in an office suite of 3,100 square feet in a three-story building that totaled 45,000 ft^2. The building had a single roof-mounted AHU that supplied conditioned ducted air to ceiling diffusers and a ceiling plenum return (unducted). Ceiling-mounted fan coil units provided additional conditioning to the six exterior offices in the test suite. The conference room was 8 percent of the suite area (14 ft × 20 ft) and was the designated smoking lounge. Four air-cleaning devices were tested for effectiveness in reducing RSP, nicotine, CO, and other markers. The investigators made eight-hour measurements inside and outside the lounge as fixed and personal samples. Cigarettes were counted, and the entrance door to the lounge was kept closed except for entering and exiting. They studied six sets of conditions and reported that a baseline without smoking and one with smoking, but without auxiliary air cleaners operating, clearly demonstrated the impact of smoking. For example, nicotine levels went from below the level of detection to about 50 $\mu g/m^3$ inside the lounge, and RSP ranged up to 500 $\mu g/m^3$ for the smoking situation. The first device tested, Device 1, was a recirculating air cleaner (1,050 cubic feet [ft^3] per minute) with a 95 percent high efficiency particulate air (HEPA) filter and a bed of carbon, permanganate, and zeolite media. The authors did not report the volume of the lounge or the ventilation rate of the base building AHU. With the assumption that the room was 14 ft by 20 ft by 8 ft, Device 1 was capable of cleaning the entire volume of the lounge every two minutes, or 30 effective ACH. Even at this substantial volume flow, the concentration of nicotine, the secondhand smoke marker, only dropped to about one-half of the smoking/no device baseline, and the RSP levels were one-third to one-fifth of the smoking baseline levels. The CO levels were not affected, and the other secondhand smoke markers showed a 90 percent reduction.

Device 2 had a prefilter of unspecified efficiency and drew air at an unspecified rate past an O_3 generator. However, Pierce and colleagues (1996) did not report the generation rate or room O_3 concentrations. Apparently, this device did not lower any of the secondhand smoke markers.

Device 3 had an electrostatic prefilter, a V-bag filter that contained numerous V-shaped pockets to increase its surface area of unspecified efficiency, followed by a charcoal bed. The device was ceiling mounted and moved 650 ft^3 per minute. This system was capable of processing the room air every three to four minutes (if a very high removal efficiency could be achieved, the device would be equivalent to 15 to 20 ACH). Nicotine levels were slightly less than one-half of the baseline smoking condition. Particles and the other secondhand smoke markers did not appear to be reduced to any notable extent below the baseline smoking case. Nicotine levels in the lounge were 22.5 $\mu g/m^3$ and 19.8 $\mu g/m^3$ compared with 48 $\mu g/m^3$ and 54.2 $\mu g/m^3$ at baseline; RSP levels in the lounge were 380 $\mu g/m^3$ and 380 $\mu g/m^3$ compared with 155 $\mu g/m^3$ and 500 $\mu g/m^3$ at baseline (Pierce et al. 1996).

Device 4 drew in air at 750 ft^3 per minute past an electrostatic prefilter and a highly efficient (reported to be 99.999 percent) HEPA filter. It also had a carbon-adsorbing bed. Nicotine levels were again about one-half of the baseline smoking condition. The RSP and other secondhand smoke markers were reduced by 80 percent. This device, as with the others, did not reduce CO levels (Pierce et al. 1996).

The fixed location and personal monitoring collected outside the lounge provided some evidence that secondhand smoke might have spilled from

the lounge and was then recirculated by the ceiling-mounted fan coil units or was present in the supply air from the AHU operating in the building. The investigators did not describe the smoking policy for the building nor did they adequately describe the ventilation system, but the nicotine measurements were informative. Because RSP comes from many sources, small differences in air concentrations cannot readily be interpreted. However, the UVPM and the fluorescent particulate matter analyses are more specific to secondhand smoke compared with RSP analyses (Nelson et al. 1992). The baseline case for these two markers without smoking indicated that secondhand smoke from other smokers in the building was not a concern. Measurements during the runs with the different air cleaning devices provided evidence of some incidental secondhand smoke exposure. Given the laboratory findings of Wagner and colleagues (2002), some spillage of secondhand smoke occurs with conventional swing doors if strict negative pressures are not maintained.

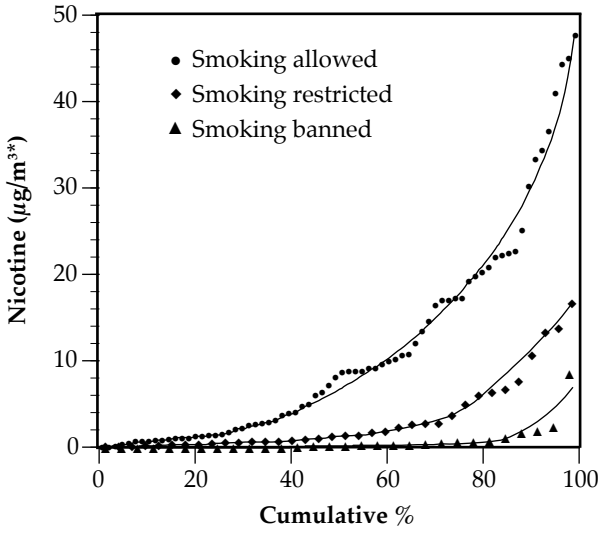
Pierce and colleagues (1996) generalized beyond the evidence documented in their study when they concluded that "auxiliary air cleaning devices operating concurrently with dilution ventilation can be effective in reducing the levels of nicotine and RSP in a designated smoking area" (Pierce et al. 1996, p. 57). Their study does not apply to all devices nor would it apply to all designated smoking areas within a building. These limited studies show that designated smoking areas also do not prevent exposure of persons outside of these areas to secondhand smoke. The strategy may require complicated engineering and a careful assessment of relevant building characteristics. Designated smoking areas may also adversely affect the health of smokers by exposing them to highly concentrated levels of secondhand smoke and would also subject any staff who enter to high concentrations (Siegel et al. 1995).

Smoking Bans Versus Unrestricted Smoking

Prohibiting smoking effectively reduces and can eliminate exposure to secondhand smoke in the workplace (Hammond et al. 1995). Using nicotine as a marker for cigarette smoking, Hammond and colleagues (1995) demonstrated that secondhand smoke could be reduced in offices and shops more effectively with a complete ban compared with partially restricted and unrestricted smoking policies. Figure 10.9 displays the frequency distribution for nicotine levels measured at the desks of nonsmokers under the three different conditions. The median nicotine concentrations dropped from 8.6 to 1.3 $\mu g/m^3$ when smoking was restricted and to 0.3 $\mu g/m^3$ when smoking was prohibited. Similar shifts in the distribution of nicotine concentrations were seen in measurements from nonoffice workplace settings (Figure 10.10).

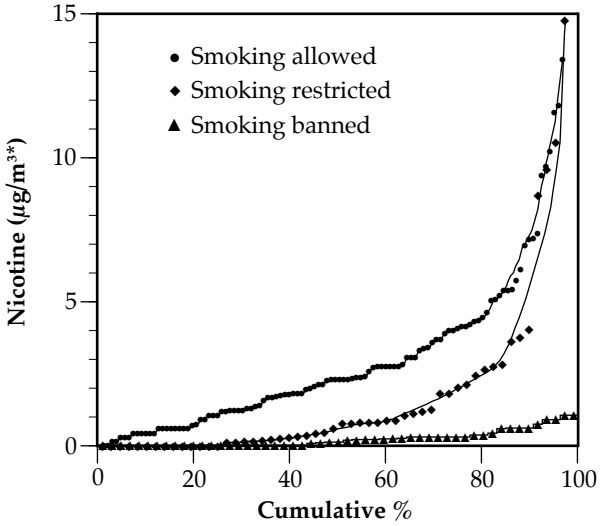
Jenkins and colleagues (2001) documented personal exposure measurements in a large, four-story office building with prevalent and unrestricted smoking. The air exchange rate was between 0.6 and 0.7 ACH. Of the 300 employees, 16 percent smoked regularly at work. Samples were analyzed for several secondhand smoke markers including nicotine. The nicotine levels in the nonsmoking offices and cubicles, as well as in the common areas, were in the range that Hammond and colleagues (1995) had measured in workplaces that restricted smoking. The article by Jenkins and colleagues (2001) pointed out that the secondhand smoke levels were lower than the levels OSHA had recorded in buildings with unrestricted smoking. A more appropriate analysis would include normalizing the results by occupant density, smoking prevalence, and effective ventilation rate. The building studied had a low occupancy density

Figure 10.9 Cumulative frequency distributions of weekly average nicotine concentrations at the desks of nonsmoking workers in open offices



*$\mu g/m^3$ = Micrograms per cubic meter.
Source: Hammond et al. 1995.

Figure 10.10 Cumulative frequency distributions of weekly average nicotine concentrations in nonsmokers' work areas in shops and other nonoffice settings



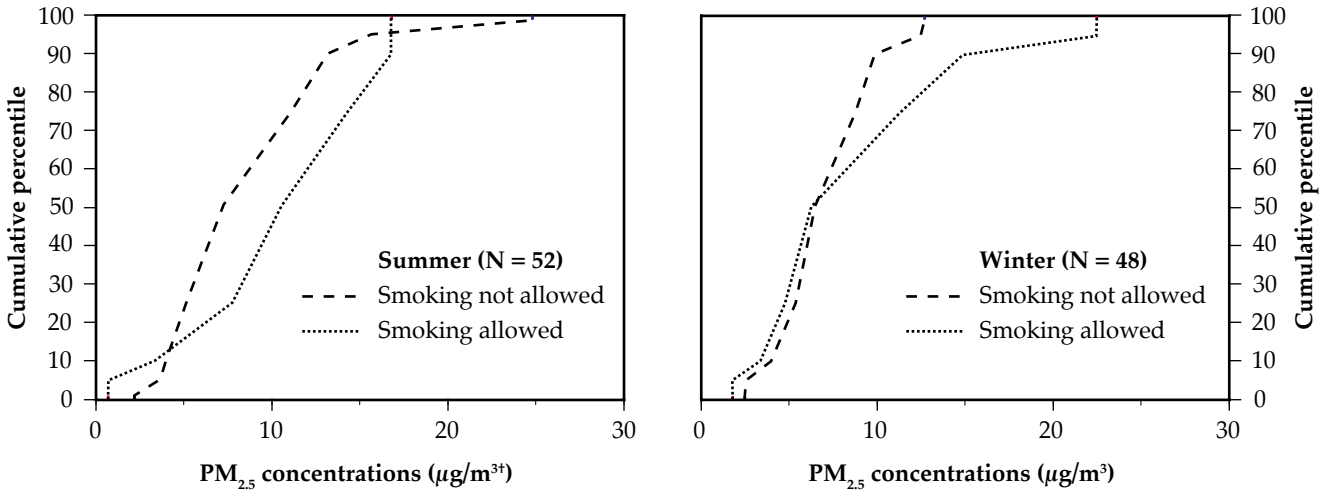
*$\mu g/m^3$ = Micrograms per cubic meter.
Source: Hammond et al. 1995.

of four persons per 1,000 ft^2; six to eight persons per 1,000 ft^2 is more typical for office buildings. The building that Jenkins and colleagues (2001) studied was well ventilated with carbon dioxide levels of only 125 to 175 parts per million above outdoor values. The effect of dilution can also be seen when comparing these results with those of Hammond and colleagues (1995). Forty percent of the nicotine values that Hammond and colleagues (1995) had documented in a building with unrestricted smoking exceeded the upper values that Jenkins and colleagues (2001) obtained in cubicles and offices with smokers.

Sterling and colleagues (1996) also studied secondhand smoke exposure in two office buildings with unrestricted smoking. The authors collected eight-hour personal and fixed location samples of respirable particle mass and other markers for secondhand smoke. Secondhand smoke markers and respirable particulates provided similar results whether measured in fixed locations or by direct personal (nonsmoker) assessments in one building, but less so in the second building. The lack of correspondence found in the second building was pronounced for particle phase measures but not for vapor phase components. This finding suggests that nicotine and 3-ethenylpyridine vapor phase markers measured in fixed locations within a building might represent a personal exposure to secondhand smoke. Building 1 was a two-floor sealed office building (approximately 20,000 ft^2) without operable windows and with 29.1 percent ventilation air; the HVAC was delivering an average of 18 ft^3 per minute per person with an assumed 60 percent ventilation effectiveness. Rates were somewhat higher at the fixed-site locations. Building 2 was also a sealed building without operable windows; it was three times the size of Building 1 and contained two AHUs. Assuming an 80 percent mixing efficiency for the ventilation air, AHU 1 served 231 people and supplied outside ventilation air between 21.0 and 35.6 ft^3 per minute per person. AHU 2 provided ventilation for 147 people who occupied the upper floor. AHU 1 ventilation air rates were between 20 and 36 ft^3 per minute per person. AHU 2 had a somewhat lower range—between 11 and 32 ft^3 per minute per person. This study documented the ventilation component, but not the actual amount or prevalence of smoking during the two days of monitoring. The occupancy density of Building 2 was less than typical, and both buildings had ventilation rates that exceeded ASHRAE standards in place at that time for office buildings. Therefore, the authors overstated their findings when they claimed, "the results demonstrate that with ventilation in accordance with current ASHRAE standards, dilution can be an effective means of controlling ETS-related constituents to low concentrations" (Sterling et al. 1996, p. 112).

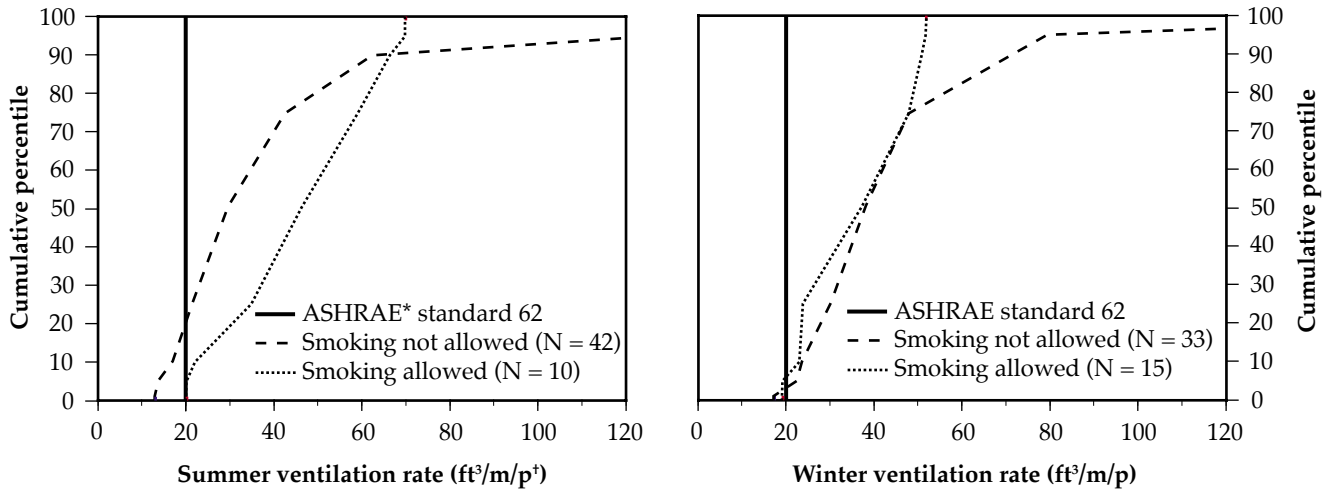
Indoor particle concentrations for $PM_{2.5}$ were measured in the comprehensive EPA study of 100 office buildings in the United States (Womble et al. 1995, 1996). Smoking was permitted in 29 of these buildings. Although there are no apparent differences in the outdoor particle concentrations ($PM_{2.5}$) measured at air intakes, the $PM_{2.5}$ concentrations inside buildings that did not permit smoking appear to be higher than inside buildings where smoking was permitted, particularly during the summer (Figure 10.11). When the investigators compared the ventilation rates for smoking and nonsmoking buildings, the buildings where smoking was permitted had similar ventilation rates for the buildings studied in the winter but higher ventilation rates for the buildings studied in summer (Figure 10.12). Most buildings exceed the minimum ventilation rates recommended in the most recent ASHRAE standard. Of the buildings with smokers, the median ventilation rates were about twice the recommended ASHRAE standard (ASHRAE 1989).

Figure 10.11 Cumulative distribution of indoor $PM_{2.5}$* concentrations in 100 United States office buildings by smoking policy



*$PM_{2.5}$ = Particulate matter less than 2.5 micrometers in diameter.
†$\mu g/m^3$ = Micrograms per cubic meter.
Source: Brightman 2005.

Figure 10.12 Cumulative distribution of ventilation rates in 100 United States office buildings by smoking policy



*ASHRAE = American Society of Heating, Refrigerating and Air-Conditioning Engineers.
†$ft^3/m/p$ = Cubic feet per meter per person.
Source: Brightman 2005.

The $PM_{2.5}$ data from the EPA Building Assessment, Survey and Evaluation Study underscore the importance of including details on ventilation conditions, smoking rates, and occupant density, among other parameters, in drawing conclusions about the efficacy of dilution or even of partial restrictions to mitigate the impacts of secondhand smoke exposure (Womble et al. 1995, 1996).

Conclusions

1. Workplace smoking restrictions are effective in reducing secondhand smoke exposure.
2. Workplace smoking restrictions lead to less smoking among covered workers.
3. Establishing smoke-free workplaces is the only effective way to ensure that secondhand smoke exposure does not occur in the workplace.
4. The majority of workers in the United States are now covered by smoke-free policies.
5. The extent to which workplaces are covered by smoke-free policies varies among worker groups, across states, and by sociodemographic factors. Workplaces related to the entertainment and hospitality industries have notably high potential for secondhand smoke exposure.
6. Evidence from peer-reviewed studies shows that smoke-free policies and regulations do not have an adverse economic impact on the hospitality industry.
7. Evidence suggests that exposure to secondhand smoke varies by ethnicity and gender.
8. In the United States, the home is now becoming the predominant location for exposure of children and adults to secondhand smoke.
9. Total bans on indoor smoking in hospitals, restaurants, bars, and offices substantially reduce secondhand smoke exposure, up to several orders of magnitude with incomplete compliance, and with full compliance, exposures are eliminated.
10. Exposures of nonsmokers to secondhand smoke cannot be controlled by air cleaning or mechanical air exchange.

Overall Implications

Total bans on indoor smoking in hospitals, restaurants, bars, and offices will substantially reduce secondhand smoke exposure, up to several orders of magnitude with incomplete compliance, and, with full compliance, exposures will be eliminated. Absent a ban, attempts to control secondhand smoke exposure of nonsmoking occupants or patrons have mixed results. Uncontrolled air currents, mixed return air and ventilation air, and the lack of complete physical barriers lead to persistence of some secondhand smoke exposure with partial restriction strategies. The few studies that claim unrestricted smoking in offices meets ASHRAE standards do not provide convincing evidence that exposures of nonsmokers to secondhand smoke were adequately reduced (ASHRAE 1999). Specially designed smoking areas inside a building can effectively isolate secondhand smoke, but effectiveness depends on engineering

design and on high volume exhaust separated from the main AHU to maintain a negative pressure within the physically isolated area. Mechanical air cleaning has not been sufficiently effective to permit exhaust air, transported or leaked air from a designated smoking area, or air from a physically separated smoking room or lounge to be remixed with ventilation air.

Ventilation rates substantially higher than the minimums recommended by ASHRAE (1999) might dilute some secondhand smoke constituents in some indoor settings to levels indistinguishable (statistically) from levels in buildings that restrict smoking. Perhaps, under such circumstances, indoor air quality might be perceived as acceptable at the 80 percent threshold criterion set by ASHRAE for persons voluntarily electing to be indoors in the presence of active smokers. However, this threshold criterion does not adequately account for possible health effects associated with exposure to secondhand smoke constituents even at low levels. Absent being able to specify acceptable levels of airborne contaminants and risks associated with secondhand smoke, concentration-based guidelines for secondhand smoke cannot be developed. Thus, exposure to secondhand smoke components cannot be controlled sufficiently through dilution ventilation or by typical air cleaning strategies if the goal is to achieve no risk or a negligible risk. The only effective controls that eliminate exposures of nonsmokers are the complete physical isolation of smoking areas with separate air exhausts or a total smoking ban within the structure. This conclusion echoes prior conclusions of federal agencies (USDHHS 1986; USEPA 1992; NIOSH 1991).

Despite wider adoption of smoking restrictions, exposures to secondhand smoke persist. Among adults, data from the 1991 NHIS Health Promotion and Disease Prevention Supplement indicate that 20.2 percent of lifetime nonsmokers and 23.1 percent of former smokers reported any exposure to secondhand smoke at home or at work (Mannino et al. 1997). Self-reported data from NHANES III (1988–1991) suggest that 37 percent of lifetime nonsmokers were exposed to secondhand smoke, and men (46 percent) were more likely than women (32 percent) to experience exposure (Steenland et al. 1998). Most nonsmokers were exposed in the workplace (20 percent) compared with those exposed at home (11 percent) or at both work and home (6 percent). However, Pirkle and colleagues (1996) used high-performance liquid chromatography atomospheric-pressure chemical ionization tandem mass spectrometry to analyze serum cotinine levels and found that 87 percent of nonsmokers had detectable levels. These investigators also noted that children, non-Hispanic Blacks, and males had higher levels than the rest of the populations that were studied (Pirkle et al. 1996).

Some evidence suggests that exposure among certain ethnic and gender groups may be higher. For example, Pletsch (1994) examined self-reported secondhand smoke exposure data from 4,256 Hispanic females aged 12 through 49 years who participated in the Hispanic Health and Nutrition Examination Survey (NCHS 1985). Pletsch (1994) found that 62 percent of Mexican American women, 59 percent of Puerto Rican women, and 52 percent of Cuban American women were regularly exposed to secondhand smoke at home, and 35 percent of Mexican American women, 28 percent of Puerto Rican women, and 49 percent of Cuban American women were regularly exposed at work.

According to NHIS data, most of the U.S. working population (76.5 percent) does not smoke (NCHS, public use data tape, 2002). In 2002, there were an estimated 100.3 million nonsmoking workers in the United States. In a study that compared exposure levels with OSHA's significant risk standards, more than 95 percent of the office workers exposed to secondhand smoke in the United States exceeded OSHA's significant risk level for heart disease mortality, and 60 percent exceeded the significant risk level for lung cancer mortality (Repace et al. 1998). Repace and colleagues (1998) estimated excesses of 4,000 heart disease deaths and 400 lung cancer deaths were attributable to workplace exposure.

On the basis of this review, it is clear that banning smoking from the workplace is the only effective way to ensure that exposures are not occurring. Despite reductions in workplace smoking, significant worker safety issues remain that only smoking bans can address. The home remains the most serious venue for secondhand smoke exposure.

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