

Health Consequences of Secondhand Smoke: Policy Implications

Active smoking increases medical morbidity and mortality from a variety of cancers, cardiovascular disease, respiratory disease, and illness; has negative reproductive consequences; and has ill effects on numerous other aspects of health and well-being.¹ In the United States, tobacco use represents a leading cause of preventable disease and death. Cessation of active smoking has been linked to significant improvements in tobacco-related disease morbidity and mortality, particularly in cases associated with respiratory and cardiovascular disease.² Public health initiatives, smoking policies, and improved healthcare research and education have all benefited our nation's health by reducing tobacco use.^{3,4} Despite these declines in active smoking, however, we continue to struggle with the issue of involuntary exposure to secondhand smoke and its associated health consequences.

This report will review the health effects of secondhand smoke exposure and the health impact of smoke-free air policies on reducing secondhand smoke exposure.

Composition of secondhand smoke

Secondhand smoke encompasses both sidestream smoke and mainstream smoke. Sidestream smoke, emitted from the ends of burning cigarettes, pipes, or cigars, represents the majority of secondhand smoke. Mainstream smoke is exhaled by people who are actively smoking. Both components of secondhand smoke are considered to be detrimental to health.

Over 4000 chemical compounds are present in secondhand smoke, including respiratory irritants such as ammonia, formaldehyde, sulfur dioxide, and acrolein.⁵ Secondhand smoke has been classified as a Group A carcinogen, a substance known to cause cancer, by the United States Environmental Protection Agency,⁶ the National Toxicology Program, and the International Agency for Research on Cancer. The National Institute for Occupational Safety and Health has also designated it an occupational carcinogen.

Over 60 compounds in secondhand smoke are known or suspected carcinogens, linked to a variety of cancers, including those of the lung, bladder, liver, and breast. These carcinogens include arsenic, benzene, and vinyl chloride, all of which are already regulated by the United States as hazardous air pollutants. Two secondhand smoke compounds linked to bladder cancer, 2-naphthylamine and 4-aminobiphenyl, were banned from dye manufacturing⁷ and other industrial uses in the US and abroad.

Secondhand smoke is also considered a biological aerosol,

which can be a source of biologic toxins. Tobacco is an agricultural product containing a variety of bacterial and fungal species,⁸ including the gram-negative bacterial species *Pantoea agglomerans* that has strong endotoxic and allergic properties.⁹ Certain gram-negative bacteria produce endotoxins, including lipopolysaccharide (LPS). These endotoxins have been found in tobacco smoke^{10,11,12} and are known to cause respiratory disease when inhaled.¹³ In addition to endotoxins, a variety of other bacterial and fungal constituents are concentrated highly in tobacco smoke and are linked to various respiratory disorders.⁸

Health consequences of secondhand smoke

The health consequences of secondhand smoke exposure have been well-documented.¹⁴ From the unborn to the aged, secondhand smoke exposure leads to premature death and disease. There is no safe level of exposure to secondhand smoke,¹⁴ and all nonsmokers exposed to secondhand smoke may be susceptible to a wide variety of adverse health effects.

In 2006 the US Department of Health and Human Services reviewed previously published research on the health impact of secondhand smoke exposure. Based on the available evidence at that time, the ensuing Surgeon General's report evaluated the role of secondhand smoke in relation to a variety of illnesses. Secondhand smoke was either determined to be a cause, suggestive to be a cause, or not yet established as a cause/not a cause of these illnesses. A summary of many of these findings is presented in Table I. Since the publication of the Surgeon General's report in 2006, our knowledge of the health consequences of secondhand smoke exposure has expanded greatly through medical research, further implicating secondhand smoke as a cause of or risk factor for different illnesses.

Many current and previous studies have demonstrated the impact of secondhand smoke on cardiovascular function and disease. Secondhand smoke exposure is linked to a 25 to 30 percent risk increase for coronary heart disease¹⁴ and is strongly associated with acute coronary syndromes.^{15,16} It has also been established as a risk factor for peripheral artery disease and ischemic stroke.¹⁷ Even short exposures to environmental tobacco smoke can adversely influence atherogenesis,¹⁸ or plaque buildup in arteries, and could increase the risk of heart attack through decreased reserves for blood flow through the heart vessels and less heart rate variability.¹⁴ Two hours of exposure reduces heart



rate variability, which increases risk of myocardial infarction by approximately 10 percent.¹⁹

A cancer-causing agent in multiple organs, secondhand smoke has been firmly established as a cause of lung cancer,^{14,20,21} regardless of the environment in which the exposure occurred (home, workplace,^{22,23} etc.). Higher risk is present in all who are exposed to secondhand smoke, and may be even more magnified if that exposure began before age 25.²⁴ Nonsmokers who live with a smoker have a 20 to 30 percent increase in their risk of lung cancer from secondhand smoke.¹⁴

Airway diseases, including impaired lung function, asthma, and chronic obstructive pulmonary disease (COPD),²¹ are also solidly linked to secondhand smoke exposure. Odor annoyance and nasal irritation are caused by secondhand smoke, and respiratory symptoms such as coughing, wheezing, and shortness of breath are linked to secondhand smoke exposure in both healthy adults and those with asthma. Secondhand smoke is a risk factor for adult-onset asthma, worsening of asthma, and COPD.

Perhaps most alarming is the impact of secondhand smoke, particularly parental smoking, on children. Secondhand smoke exposure is a known cause of Sudden Infant Death Syndrome (SIDS), lower respiratory illnesses including those associated with wheezing, and middle ear diseases such as acute and

recurrent ear infections in children.¹⁴ More and more research indicates that secondhand smoke exposure is also a likely cause of childhood asthma^{25,26} and cancers. Maternal exposure to secondhand smoke during pregnancy is a cause of reduced infant birth weight and is a risk factor for preterm delivery.

Mounting evidence links secondhand smoke to cognitive impairment. Children exposed to parental smoking may have impaired cognitive development.²⁷ As discussed previously, secondhand smoke is a risk factor for heart disease²⁸ and stroke;²⁹ these conditions are related to cognitive decline in adults.³⁰ Most recently, research suggests that exposure to secondhand smoke may be directly linked to the risk of cognitive impairment in adults.³¹

While we have much to discover about the health consequences of secondhand smoke, research continues to establish it as a cause or potent risk factor for a wide variety of diseases. These adverse health effects, particularly those experienced involuntarily by nonsmokers, have driven efforts in both the medical and public communities to minimize exposure to secondhand smoke. Some countries (such as France, England, Ireland, and Scotland) have banned smoking from public places nationwide, including workplaces, restaurants, bars, and clubs. Here in the US, some states and local jurisdictions have also implemented clean indoor air acts or other legislative efforts to

minimize secondhand smoke exposure. Smoke-free air policies have also been instituted in airplanes, federal buildings, and hospitals. These efforts have varied in their degree by area or state: Some states have implemented complete bans in 100 percent of restaurants, bars, and workplaces; others have partial bans excluding certain establishments from these bans; still others have no statewide legislation at all. A summary of states/areas with complete, partial, or no statewide legislation is presented in Table II.

**After implementation of smoke-free air policy
Air quality improvement**

After enactment of laws prohibiting smoking in indoor workplaces and public places, levels of airborne particulate

Table I: Summary of 2006 Surgeon General Report: Health Consequences of Involuntary Exposure to Tobacco Smoke¹⁴

	Causally Related to SHS	Suggested Causal Relationship to SHS	Insufficient evidence as of 2006
Cardiovascular System	-Coronary heart disease	-Stroke -Atherosclerosis	
Cancers	-Lung	-Breast -Nasal Sinus	-Nasopharyngeal -Cervical
Respiratory system effects: Adults	-Odor annoyance -Nasal irritation	-Increased nasal irritation in those with history of nasal allergies and respiratory illness -Acute respiratory symptoms in people with asthma -Acute respiratory symptoms in healthy people -Chronic respiratory symptoms -Adult-onset asthma -Worsening of asthma control -COPD	-COPD morbidity
Respiratory system and other effects: Children	-Sudden Infant Death Syndrome (SIDS) -Lower respiratory illnesses -Middle ear diseases (including acute and recurrent ear infections) -Respiratory symptoms -Asthma in school-aged children -Wheeze illnesses -Reduced lung function if exposure after birth	-Onset of childhood asthma -Childhood cancer	-IgE mediated allergy -Cognitive effects -Behavioral problems -Height/growth
Impact of maternal smoking during pregnancy	-Persistent adverse effects on lung function throughout childhood	-Childhood cancer	
Maternal exposure to secondhand smoke during pregnancy	-Reduced birth weight of infant	-Preterm delivery	-Spontaneous abortion -Female fertility -Neonatal mortality -Congenital malformations

Table II: State and commonwealth smoke-free air policies in the United States^{32,33}

Complete — 100% of restaurants, work-places, bars	Partial — 100% of restaurants OR workplaces OR bars	No statewide or commonwealth policy for 100% of restaurants OR workplaces OR bars	Statewide or commonwealth smoke-free air policy for gaming facilities
Arizona	California	Arkansas	Arizona
Delaware	Colorado	Alabama	California
District of Columbia	Connecticut	Alaska	Colorado
Hawaii	Florida	Georgia	Delaware
Illinois	Idaho	Indiana	Florida
Iowa	Louisiana	Kansas	Illinois
Maryland	Maine	Kentucky	Maryland
Massachusetts	Nevada	Michigan	Massachusetts
Minnesota	New Hampshire	Mississippi	Minnesota
Montana - effective 10/09	New Mexico	Missouri	New Jersey - except casinos
Nebraska	North Carolina - effective 1/10	Oklahoma	New York
New Jersey	North Dakota	South Carolina	Ohio
New York	Pennsylvania	Tennessee	Oregon
Ohio	Vermont	Texas	Puerto Rico
Oregon		Virginia	Washington
Puerto Rico		West Virginia	
Rhode Island		Wyoming	
South Dakota - effective 7/09			
Utah			
Washington			
Wisconsin — effective 7/10			

matter in restaurants, bars, and employee workplaces decline rapidly and significantly. This is verified by multiple air monitoring studies, such as those in Bloomington, IN; Fort Wayne, IN; West Lafayette, IN; and Lexington, KY. The Bloomington study indicated that the level of indoor air pollution declined by more than 90 percent after the city implemented a smoking ban that included bars and restaurants. Similarly, after adopting policies prohibiting smoking in all indoor workplaces including bars and clubs in the city, both Fort Wayne and West Lafayette demonstrated a 94 percent drop in fine particle air pollution in places where smoking was occurring before the law's enactment. Lexington demonstrated a 91 percent drop in indoor air pollution.³⁴

Health impact: Decreasing exposure to secondhand smoke

In order to assess nonsmokers' changing exposure to secondhand smoke, many studies measure urinary, salivary, or serum

cotinine levels in their subject populations. Cotinine, a breakdown of nicotine, is a highly sensitive and specific marker of active and passive exposure to tobacco.³⁵ Monitoring cotinine levels in response to varying degrees of smoking bans helps determine the bans' efficacy in minimizing non-smokers' exposure to secondhand smoke. Using data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES), Pickett et al analyzed serum cotinine levels from adult populations in different counties throughout the United States³⁶ in order to estimate nonsmokers' exposure to tobacco. Table III illustrates the results.

The New York State Department of Health assessed exposure to secondhand smoke among nonsmokers before and after implementation of a comprehensive statewide smoke-free air policy in 2003. Prior to the statewide policy, some areas of New York had local ordinances; these varied in the degree to which they restricted smoking. Nonsmoker participants in the study³⁷ reported on exposure to indoor smoking and submitted saliva samples for cotinine measurement. Results indicated sharp declines in both reported exposure to indoor smoking and objective saliva cotinine levels after the statewide smoking ban was implemented. This study demonstrated the effectiveness of statewide smoking legislation, as well as the potential impact of comprehensive statewide legislation, even in areas with

previously existing local smoking bans. Additional studies evaluating the statewide smoke-free air policy have indicated a significant decline in secondhand smoke exposure among non-smoking hospitality workers.^{38,39}

Countries which have implemented nationwide smoke-free air policy have also witnessed reductions in secondhand smoke exposure. Scotland, in particular, has demonstrated a significant decline in smoke exposure among different nonsmoker populations: adults living in nonsmoking households, children living in

Table III: Nonsmoking Adults' Exposure to Tobacco in Counties with Varying Laws³⁵

Counties	Percent of nonsmoking adults exposed to tobacco
Without smoke-free laws	45.9 percent
With comprehensive smoke-free laws	12.5 percent
With limited smoke-free laws	35.1 percent



nonsmoking households,⁴⁰ and children living in households with a father who smokes.⁴¹

Health Impact: Improving respiratory symptoms

Many studies have investigated the impact of smoke-free air policies on respiratory symptoms of occupational workers most regularly exposed to secondhand smoke, such as those employed in bars, casinos, and hospitality venues which had previously allowed smoking. A study in Lexington, KY, analyzed bar and restaurant workers' exposure to secondhand smoke and respiratory symptoms before and after implementation of a smoke-free air policy.⁴² Results demonstrated a significant reduction in respiratory symptoms among these hospitality workers, regardless of their smoking status. The greatest benefit was seen among bar workers, the most vulnerable to occupational secondhand smoke exposure.

A study in the state of California specifically addressed the respiratory health of bartenders before and after statewide legislation prohibiting smoking in bars and taverns.⁴³ Measurements included spirometric assessment to evaluate lung function; respiratory symptoms; and secondhand smoke exposure. After implementation of the smoke-free air policy, bar employees reported sharp declines in workplace secondhand smoke exposure. There was also a significant reduction in respiratory symptoms (such as coughing, wheezing, and shortness of breath) which had affected the majority of bar workers prior to the smoke-free policy. Objective spirometric measurements of lung function demonstrated improved lung function in both smoker and nonsmoker bar employees after the smoke-free air policy.

In countries that have implemented policies nationally, the effectiveness of smoke-free air policies in reducing secondhand smoke exposure and respiratory symptoms among bar workers has also been demonstrated nationwide.⁴⁴

Health Impact: Decreasing admissions for myocardial infarction

When smoke-free legislation is introduced in public places and indoor workplaces, affected areas have also experienced significant and rapid declines in hospitalizations for acute myocardial infarctions. A recent analysis by the Pueblo Heart Study evaluating the health impact of a smoke-free policy enacted in 2003 in the city of Pueblo, CO, indicates that this decline is sustained and advanced for years after implementation of the ban.⁴⁵

One of the earliest studies in the United States evaluated the impact of a smoke-free air policy on hospitalizations for acute myocardial infarctions in the geographically isolated town of Helena, MT.⁴⁶ A local smoke-free air policy in public places and workplaces was in effect for six months before a court chal-

lenge lifted the policy. During the six months of the policy, there was a 40 percent decline in local hospital admissions for myocardial infarctions; other localities near Helena that did not have such a smoking policy demonstrated continually increasing rates of myocardial infarction admissions. Once the smoking policy in Helena was removed, rates of admissions for myocardial infarction rose.

While both the Pueblo and Helena studies demonstrated significant reductions in admissions for myocardial infarctions related to local smoke-free air policies, the findings did not differentiate between admissions of smokers versus nonsmokers. A 2007 study by Seo and Torabi⁴⁷ specifically investigated the impact of a countywide smoke-free air policy on admissions for myocardial infarctions among nonsmokers. The county of Monroe, IN, had implemented a workplace and restaurant smoking ban in 2003; the ban was expanded in 2005 to include bars and clubs. Admissions for myocardial infarctions in Monroe

County nonsmokers were compared to a demographically-matched control county which had not instituted smoke-free air policy. Prior to the Monroe County ban, admission rates were similar in both counties. There was a significant decline in admissions in Monroe County after implementation of the smoking policy compared to the control county. Also, during the five months after expansion of the policy to include bars and clubs, there were no Monroe County nonsmoker admissions for myocardial infarctions.

The Pueblo, Helena, and Monroe County studies illustrate the potential impact of local smoke-free air policies on hospital myocardial admission rates. Similar findings have been demonstrated at the state level, particularly in New York, where a statewide comprehensive smoke-free air policy was implemented in 2003. This policy prohibited smoking in all workplaces, including restaurants and bars. The statewide policy was associated with a decrease in population exposure to environmental tobacco smoke, demonstrated through measurement of salivary cotinine levels in a representative sample.³⁷ Prior to the statewide policy, many local ordinances had already implemented varying degrees of smoking bans. Juster et al⁴⁸ sought to compare hospital admission rates for acute myocardial infarction before and after the comprehensive statewide ban. Their study demonstrated a significant decline in these admissions from the prior period of local smoking policy to the period of a statewide comprehensive smoke-free air policy.

A 2008 study in Scotland revealed a significant decline in admissions for acute coronary syndrome among both smokers and nonsmokers after enactment of a nationwide smoke-free air policy in public places.⁴⁹ Italy also experienced declines in admissions for myocardial infarction after a national legislative ban on smoking.⁵⁰

Cotinine, a breakdown of nicotine, is a highly sensitive and specific marker of active and passive exposure to tobacco.⁴³ Monitoring cotinine levels in response to varying degrees of smoking bans helps determine the bans' efficacy in minimizing nonsmokers' exposure to secondhand smoke.

Health Impact: Decreasing active smoking

In addition to their beneficial impact on the health of nonsmokers, smoke-free air policies may also benefit the health of smokers. Indeed, many studies demonstrate reduction in tobacco use by active smokers when smoking policies are implemented.^{51,52,53,54} A meta-analysis of 26 studies demonstrated that totally smoke-free workplaces were associated with reductions in smoking prevalence of nearly 4 percent among employees. The same meta-analysis found that active smokers reduced the number of cigarettes they consumed by about 3.1 cigarettes per day when their workplaces were smoke-free.⁵⁵

Smoking restrictions also encourage active smokers to stop smoking or to seek help for smoking cessation.⁵⁶ This may lead to decreased or elimination of smoking at home;^{57,58} this in turn could significantly relieve the health burden assumed by children who live with parents who smoke. Smoking policies, particularly when they are statewide and comprehensive, are also associated with decreased youth smoking rates.^{59,60}

Policy Implications

Secondhand smoke is a known carcinogen and contains a variety of chemical and biologic toxins. A comprehensive body of research validates concerns about the adverse health consequences of exposure to secondhand smoke. These adverse health effects are seen in many different populations, including smokers and nonsmokers, children and adults, and those with secondhand smoke exposure at their workplaces, including restaurants, bars, clubs, and casinos. Some of the greatest occupational exposure is among bar employees.

Policies to restrict smoking in public and indoor places are primarily motivated by the tremendous public health burden associated with secondhand smoke exposure. This burden not only translates into disease morbidity and premature mortality, but also exerts profound stress on healthcare resources and systems already struggling to address the related burden of active smoking. For several years, media anti-smoking campaigns, healthcare professionals, and legislatures have attempted to discourage smoking. These efforts have been vital in addressing the health consequences of active smoking. However, the documented impact of local and statewide smoke-free air policies verifies the need for public policy to reduce exposure to secondhand smoke.

The policies already in place at local, state, and national levels offer varying degrees of coverage. All have had some effect on degree of secondhand smoke exposure. However, we now know that there is a significantly greater reduction in workplace secondhand smoke exposure when comprehensive smoking policies are in place, compared to partial smoking restrictions.^{51,56,61,62} This is true for statewide policies, as well: The more extensive a state's clean indoor air laws, the higher percentage of workers reporting a smoke-free environment.⁶³ This may also lead to a greater impact on youth smoking and smoking in the homes of children.

Smoking policies are very effective. They are associated with improved air quality, reduced exposure to secondhand smoke (verified through objective analyses), and beneficial health implications. Areas with smoke-free air policies demonstrate reduced hospital admissions for acute myocardial infarction. Respiratory symptoms decrease among those typically exposed to secondhand smoke in the workplace, particularly employees of bars and taverns. Additionally, these policies may encourage active smokers to quit smoking, which would be expected to decrease both health consequences of active smoking and exposure of children to parental smoking.

We offer the following evidence-based recommendations to policymakers as suggestions for constructing effective smoking policy:

- **Comprehensive policy over partial policy.** Policy should ensure protection of hospitality workers in a variety of venues, including bars, restaurants, and clubs. Bar workers in particular have high occupational exposure and may benefit from smoke-free air policies that include bars and taverns. In the absence of such policy, the decisions of businesses to allow smoking have profound implications on the public's health and well-being. The impact of these decisions extends well beyond individual health, representing a greater public health problem.
- **Strong statewide policy.** Comprehensive statewide policy ensures equal protection of all citizens. In states with varying degrees of local smoking policy, the support of a strong, comprehensive statewide policy offers increased protection. In the absence of comprehensive state policy, local jurisdictions can mitigate the health consequences of smoking through comprehensive local policy.
- **Continued smoking cessation efforts.** Smoking policies may encourage active smokers to quit smoking; thus, smoking cessation education and programs should continue to receive support. These programs may also decrease household smoking and the vulnerability of children exposed to secondhand smoke at home.

In these times of escalating healthcare costs, policymakers must step forth to help relieve the health and economic burdens associated with secondhand smoke exposure. The health benefits of smoking policies are clear and expansive, encompassing many different populations, including smokers and youth. Occupational exposure to secondhand smoke continues to represent a significant health hazard to many employees. Their continuing exposure substantiates the need for comprehensive policy that would protect these workers, including those in bars, restaurants, and clubs. Such comprehensive policy would represent a great step forward for this nation's public health.



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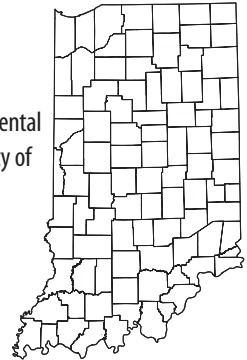
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