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Copyright Information

Secondhand Smoke in the Workplace

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Author Note

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Abstracto

El humo de segunda mano (secondhand smoke o SHS) se inhala involuntariamente por los no fumadores y a veces se le llama humo de tabaco en el ambiente (Environmental Tobacco Smoke o ETS). Este tipo de humo es una mezcla de humo indirecto (lateral) y humo de la corriente principal o directa. El SHS causa enfermedades cardiovasculares y respiratorias en adultos y niños no fumadores, que afectan la salud y pueden causar la muerte. El propósito de este artículo es enfatizar los varios efectos adversos causados por la exposición al humo de segunda mano, enfocándose en técnicas para medir el SHS ambiental y los patrones de exposición al SHS a través del tiempo. Se realizó una búsqueda en PubMed usando los siguientes términos clave: "humo de tabaco", "humo de segunda mano", "efectos en la salud" y "leyes sobre el tabaquismo". Se usaron 25 artículos relacionados al humo de segunda mano y se compararon respecto a los conocimientos actuales y las recomendaciones sobre las medidas sobre tabaquismo en los centros laborales. Los resultados de la búsqueda revelaron que los efectos que perjudican significativamente la salud están directamente relacionados a la exposición al humo de segunda mano, y afectan a todas las razas, etnias y grupos ocupacionales. Si bien hay varias leyes en vigor, la mayoría se proponen separar a los fumadores de los no fumadores. Los resultados requieren que las leyes se cumplan para que la prohibición de fumar se aplique de manera uniforme en los centros laborales y se desincentive el incumplimiento. Se debe proporcionar a todos los trabajadores información sobre los efectos adversos del tabaquismo y sobre clases para dejar de fumar. Las leyes deben requerir la designación de zonas restringidas a fumadores mientras las leyes avanzan hacia la prohibición total. La ventilación de la zona para

fumadores debe cumplir con los estándares generales y la presión del aire debe ser ligeramente negativa para asegurar el flujo de aire dentro de la zona para fumadores.

Abstract

Secondhand smoke (SHS) is defined as the smoke inhaled involuntarily by nonsmokers, often also referred to as Environmental Tobacco Smoke (ETS). SHS is a mixture of side-stream (side stream smoke) smoke and mainstream (main stream smoke) smoke. SHS exposure causes cardiovascular and respiratory diseases in nonsmoking adults and children, resulting in significant morbidity and mortality. The purpose of this article is to emphasize the various adverse health effects of second hand smoke exposure, focusing on environmental SHS measurement techniques and patterns of SHS exposure through time. A PubMed search was performed using the following keywords: "tobacco smoke", "second hand smoking," health effects," and "smoking laws." Twenty Five articles were used pertaining to secondhand smoking were compared against current knowledge and recommendations for workplace smoking policies. Results from the search revealed that significant adverse health conditions are directly related to second hand smoke exposure, and prevail across different races, ethnicities, and occupational groups. Whereas numerous legislations are currently in place, most aim to separate smokers and nonsmokers. These findings require that Legislation be enacted to uniformly ban smoking from workplaces and provide disincentives for non-compliance. Information about the harmful effects of smoking and smoking-cessation classes should be offered to all workers. Legislation could require designated restricted smoking areas for workplaces as they move towards a complete ban. Ventilation of the smoking area should meet general standards, and the smoking area should have a slight negative pressure to ensure airflow into the area.

Keywords: Secondhand smoke, workplace, smoke-free laws

Introduction

Cigarette smoking and exposure to secondhand smoke (SHS) became highly prevalent in most developed countries during the 20th century. The United States (US) Surgeon General reports provided an expansive amount of evidence and authoritative synthesis that led to definitive conclusions concerning smoking as a cause of disease. Despite growing evidence of the association of tobacco smoke with disease, a lot of work still remains to be done to protect vulnerable population against the harmful effects of cigarettes. Since evidence surfaced relating tobacco use to direct adverse health effects, extensive research has ensued exploring all possible routes of exposure. Current emphasis revolves around the effects of tobacco smoking on those that are indirectly exposed by being in the vicinity of active smokers. As more and more evidence has surfaced about possible adverse effects from indirect exposure, smoke free laws in public places and worksites has become a priority among advocacy groups.

What Is Secondhand Smoke Exposure?

The term "secondhand smoke" refers to cigarette smoke that others are exposed to involuntarily by sharing the same environmental airspace. There are two components to SHS: 1) main stream smoke, which is the exhaled tobacco smoke of active smokers, and 2) side stream (side stream smoke) smoke, that comes off of the burning cigarette. Both main stream smoke

and side stream smoke have components that are harmful to the health of exposed persons, although there might be quantitative differences. This has led to research being directed into the health effects of side stream smoke just as intensely as main stream smoke. Side stream smoke is generated under lower temperature conditions, but may have significant amounts of toxic compounds, sometimes in higher concentrations, than main stream smoke. Main stream smoke usually gets quickly diluted as it disperses into the ambient environment, but still contains significant amounts of potential carcinogens (Mannino, 2012)

The t morbidity and mortality related to SHS exposure can be attributed to cardiovascular and respiratory illnesses. A report from the Surgeon General in 2010 estimated that approximately 46,000 cardiovascular deaths and 3,400 respiratory deaths occur among the non-smoking population in the US each year (Morbidity and Mortality Weekly Report [MMWR], 2011; U.S. Department of Health and Human Services [DHHS], 2010). The primary locations where exposure to SHS is likely to occur are in homes of active smokers, public places such as restaurants/bars, and workplaces that do not have smoking policies. Cars and other vehicles in which active smoking takes place are a source of SHS exposure, as well (DHHS, 2014).

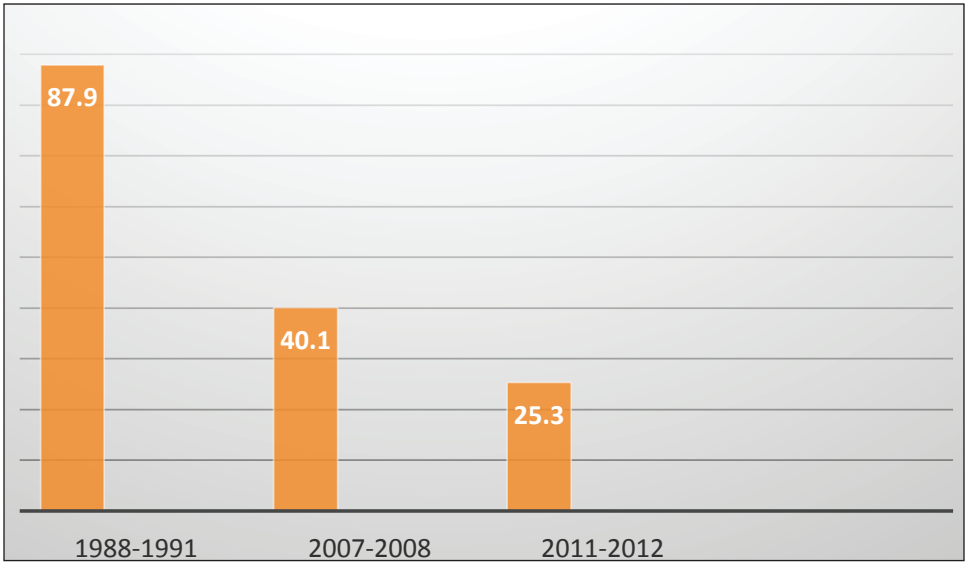
Measurement of Secondhand Smoke Exposure in the Environment

Components of tobacco smoke can be measured in the environment while an individual is actively engaging in smoking, as well as after the event. Tobacco smoke contains various measurable components like carbon monoxide, nicotine, and benzene. These components are present in concentrations that depend on various factors, such as the area of the space that smoking occurs, the duration of active smoking, the numbers of smokers in the vicinity, as well as the ventilation system of the airspace, including the type and efficiency of air cleaning mechanism in place.

The principal metabolite of nicotine (cotinine) is the most studied and followed biomarker for qualitative and quantitative measurement of tobacco smoke. There are various ways to measure tobacco smoke components in smokers, as well as non-smokers. Measurements include analyzing samples from blood, urine, saliva, and hair to assess the body burden of tobacco smoke. Study of tobacco smoke components have clearly shown that they are absorbed by non-smokers, further justifying the health hazard that SHS poses for this subset of the population (National Institute of Occupational Safety and Health (NIOSH). As per the National Research Council (NRC), the estimated average urine cotinine level in a smoker is about 1825 ng/ml, while a non-smoker averages about 25 ng/ml. Nicotine is almost exclusively attributed to tobacco smoke and has been shown to be prevalent in the ambient atmosphere where tobacco is smoked, as well as in non-smokers.

Trends In Secondhand Smoke Exposure

Another way second hand smoke can be assessed is by the urinary metabolite of nicotine, cotinine. Tobacco smoke exposure can be quantified by evaluating the urine cotinine levels. A study conducted by the CDC showed that in a select population from 1988-1991 nearly 90 of 100 (87.9%) nonsmokers had a measurable level of cotinine. This was followed in later years (2007-2008) by a decrease in measurable cotinine to about 40 of every 100 people (40.1%). The most current period studied was from 2011-2012, where about 25 of every 100 (25.3%) nonsmokers had a measurable level of cotinine, refer to figure 1.



A study put out by the CDC showed that in a select population from 1988-1991 that nearly 90 of 100 (87.9%) nonsmokers had a measurable level of cotinine. This was followed be a decrease in 2007-2008 to about 40 of every 100 people (40.1%) had a measurable level of cotinine. The next measured years was 2011-2012, where about 25 of every 100 (25.3%) of nonsmokers had a measurable level (DHHS, 2006).

Figure 1. Trends of Cotinine levels found over the years.

Growing regulations and more strict laws about smoking in public and at work have contributed to the decline in cotinine levels described above. Additionally, current societal norms view smoking less and less as an acceptable practice, in addition to increased awareness of the harms of passive tobacco smoke exposure. These changes have led to a conscious effort to avoid passive and active tobacco smoke exposure (DHHS, 2006).

Demographic Differences in Second Hand Smoke Exposure

Overall, there was a general reduction in cotinine levels across all racial and ethnic groups, higher cotinine concentrations were found in specific groups Non-Hispanic Black Americans had a higher level of cotinine when compared to non-Hispanic White Americans and Mexican Americans. Data from 2011-2012 suggest that SHS exposure among Black nonsmokers was 46.8% compared to non-Hispanic White nonsmokers (21.8%) and Mexican American nonsmokers (23.9%) (MMWR,2015).

A difference in cotinine levels was also found with varying levels of socioeconomic status. Greater than two out of every five nonsmokers exposed to secondhand smoke were living below the poverty level over the 2011-2012 time period. Additionally, various occupational profiles (i.e. white collar, blue collar, and construction workers) were found to have significantly higher exposures to secondhand smoke. Specifically, blue collar workers and construction workers were exposed to secondhand smoke in greater quantities than white collar employees (MMWR, 2015).

Third Hand Smoke: Another Aspect of Passive Smoke Exposure

Third hand smoke (THS) refers to tobacco smoke particles that stay behind on indoor surfaces, even after majority of it has dispersed out of the environmental airspace (Matt et. al., 2010). THS is sometimes defined using three R's; how it *remains*, how it *re-emits* toxicants, and how it *reacts* with air pollutants. THS includes not only smoke particles on hard surfaces, but also smoke particles that adhere to clothes, the body, and hair of smokers allowing it to re-enter the ambient air and expose non-smokers to SHS (Matt *et. al.*, 2011).This process is referred to as stale smoke and is a growing public health concern. As THS can be a potential health hazard for non-suspecting persons from the inadvertent exposure to tobacco smoke, the public health threat is even greater (Sleiman *et. al.*, 2010). Efforts may be made to ventilate the environment that has been exposed to THS, but harmful components have a potential to persist, despite major efforts at elimination (Matt *et. al.*, 2011).

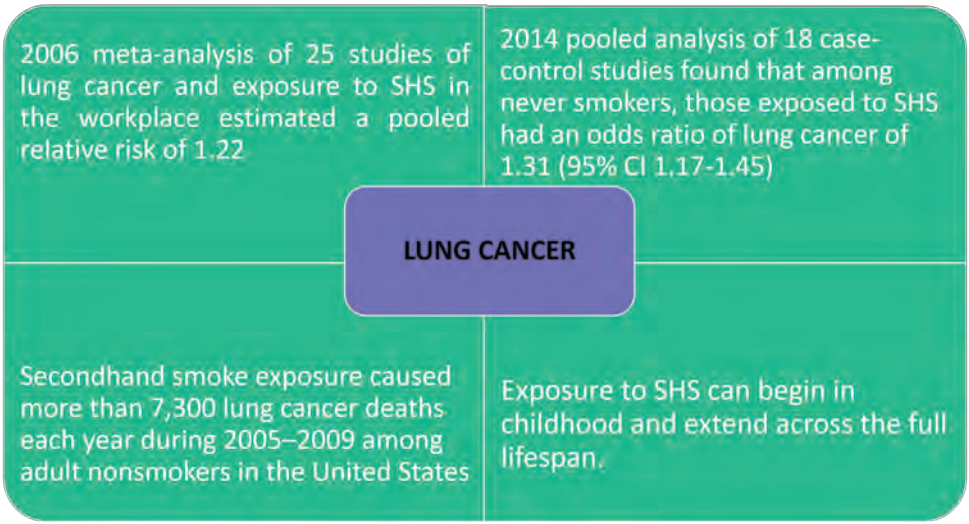
Environmental Tobacco Smoke (ETS) and Mainstream Smoke (main stream smoke): A Chemical Comparison

Secondhand smoke (SHS) is defined as the smoke inhaled involuntarily by nonsmokers, often also referred to as Environmental Tobacco Smoke (ETS). SHS is a mixture of side-stream (side stream smoke) smoke and mainstream (main stream smoke) smoke. ETS has been found to contain many of the same toxic and carcinogenic agents as are found in main stream smoke, but in lower concentrations (DHHS, 2016). The major differences in the contents of side stream smoke versus main stream smoke come from the fact that main stream smoke is generated at higher combustion temperatures, which produces stronger reducing agents in the backdrop of oxygen deficiency due to the cigarette cone burning (DHHS, 2016). Burning cigarette has a peak combustion temperature of 900°C during puffing, but only 600°C in between puffs. ETS gets diluted in the air whereas exposure to main stream smoke entails direct exposure to the concentrated form of the tobacco smoke. However, exposure to ETS is a prolonged exposure as compared to main stream smoke which is limited in time (DHHS, 2016).

Health Consequences of Environmental Tobacco Smoke (ETS) Exposure.

Lung cancer

Second hand smoke exposure is a recognized risk factor for development of lung cancer (DHHS, 2006). There is a very small, but established, dose-dependent association between SHS carcinogens with lung cancer. This association is important, as ETS exposure can span the entire life from childhood to adulthood (DHHS, 2006). A meta-analysis in 2006 of 25 studies found a pooled relative risk of 1.22 (95% CI 1.13-1.33) for lung cancer in a study population of non-smokers exposed to SHS (DHHS, 2006). Another meta-analysis of 18 case-control studies showed increased overall odds for lung cancer in non-smokers exposed to SHS of 1.31 (95% CI 1.17-1.45)(Kim, *et. al.*, 2006). In understanding these risks, there were 7,300 lung cancer deaths that can be attributed to secondhand smoke exposure among adult nonsmokers in the United States from 2005 - 2009 (DHHS, 2014). Figure 2 illustrates the multipronged effect of secondhand smoke exposure on the development of respiratory pathologies.



An overview in the top row of various studies followed by the bottom row of known risks associated with SHS exposure and lung disease. Included after the Lung disease section as highlight.

Figure 2. Highlights from Health Consequences in Lung Disease

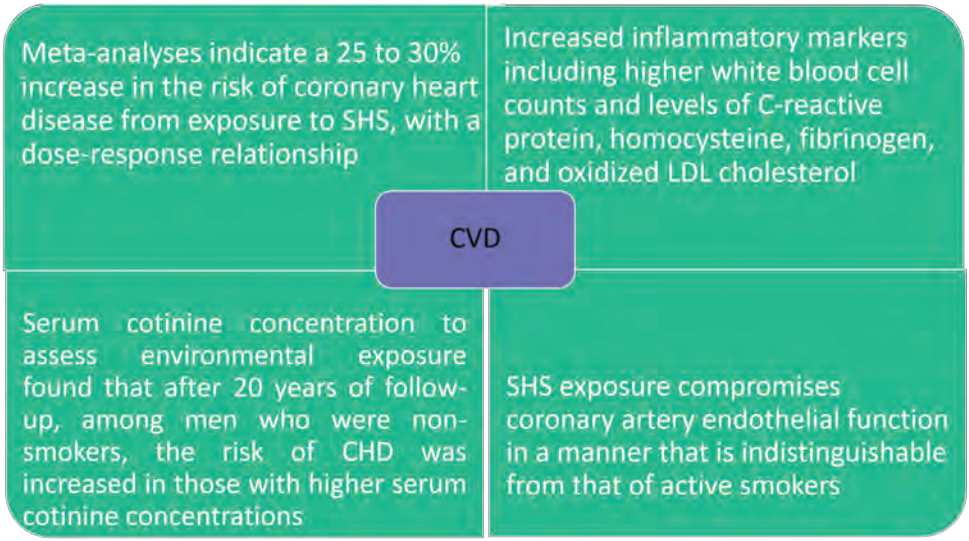
Cardiovascular disease

SHS exposure also increases the risk of cardiovascular disease in non-smokers. Pooled relative risks from meta-analyses indicate a dose-response relationship from SHS exposure, with a 25 to 30 percent increased risk of coronary heart disease (He *et. al.*, 1999; Law, Morris, & Wald, 1997). Various mechanisms by which SHS has been shown to cause cardiovascular morbidity include endothelial dysfunction and increase of inflammatory markers (He *et. al.*, 1999).

In a study including healthy young volunteers, exposure to SHS was found to compromise coronary artery endothelial function in the same way as in active smokers (Panagiotakos *et. al.*, 2004). SHS is also associated with increased inflammatory markers, like increased white blood cell counts and increased levels of C-reactive protein, homocysteine, fibrinogen, and oxidized LDL cholesterol (Panagiotakos *et. al.*, 2004). Some studies looking at serum cotinine concentration to assess SHS exposure found that in a 20 year follow-up of non-smoking men, coronary heart disease (CHD) risk was directly proportional to serum cotinine concentrations. Compared with men in the lowest quartile of serum cotinine concentration, the risks in the second, third, and fourth quartiles were 1.45, 1.49, and 1.57, respectively (Whincup, *et. al.*, 2004). Figure 3 illustrates the commonest pathologies and clinical conditions of the cardiovascular system that stem from exposure to secondhand smoke exposure.

Other respiratory tract illness

Asthma and chronic obstructive pulmonary disease (COPD) are associated with SHS exposure (Menzies, *et. al.*, 2006). Several studies have shown improvement in the status of people with asthma after the implementation of workplace bans on smoking (Menzies, *et. al.*, 2006).



An overview in the top row of various studies followed by the bottom row of known risks associated with SHS exposure and CVD. Included after the cardiovascular disease section as highlight.

Figure 3. Highlights from Health Consequences associated with CVD

Advocacy and Policy

Banning smoking in the workplace is the only way to eliminate smoke exposure to non-smoking workers Physical segregation of smokers and non-smokers, however, will not completely eliminate smoke exposure as they share the same airspace. Depending on the extent of the exposure, SHS exposure of the non-smoking population may be comparable to that of a person sharing a house with a smoker.

Tobacco smoke exposure and cardiac disease risk association was studied in Scotland where the outcome suggested a reduction in risk for developing heart disease (Pell, *et. al.*, 2008). This reduction was most likely attributable to the nationwide ban on smoking at work and in public spaces. Part of the study collected data about the number of admissions secondary to acute coronary syndrome 10 months before and 10 months after the passage of the smoking ban in work and public places. A 17% (95% confidence interval [CI], 16%-18%) decrease was found in the number of admissions over the time period studied. A reduction was also seen in the hospitalization numbers for smokers, former smokers and non-smokers by 14%, 19% and 21% respectively (CI given for these %?). A decrease in serum cotinine levels was found in the group reporting decreased exposure to SHS in non-smokers, from 0.68 to 0.56 ng/ ml ($P<0.001$)(19).

In another study by Hammond et al, airborne nicotine concentrations were found to be less than 1 mcg/m^3 in both restaurants and offices with a smoking ban, as compared to 2-6 mcg/m^3 in offices that allowed smoking, and 3-8 mcg/m3 in restaurants that allowed smoking. These findings are comparable to mean nicotine concentrations of 1- 3 mcg/m^3 that have been measured in the homes of smokers (Hammond, 1999).

An increasing trend in adopting non-smoking policies in workplaces has been observed. A model workplace is one that completely bans smoking with consideration also given to policies that outline designated areas for smoking. It is important to not only implement non-smoking policies, but also help smokers to quit. This should include opportunities to participate in smoking cessation programs to promote long-term cessation efforts (Hammond, 1999).

Smoke Free Workplace Laws: The Current Trends in the United States

Since the turn of the century, there has been a drive to limit the general public's exposure to SHS. The Department of Health and Human Services (DHS) included objective 27-13 in *Healthy People 2010* which called for laws to eliminate smoking in public places and worksites in all 50 states plus the District of Columbia (DC), but we as a nation were unable to reach our goal in 2010 (Healthy People 2020). Healthy People 2020, objective TU-13 no aims to complete the task of its predecessor. Too meet this objective, the CDC reported changes that have been made to state laws in a Morbidity and Mortality Weekly Report (MMWR). This report discussed 26 states (including DC) which enacted laws banning smoking in indoor areas, including worksites, restaurants, and bars by 2010 (MMWR, 2011). The first law was enacted in Delaware in 2002, which included a comprehensive smoking ban throughout the state. The report also noted regional discrepancies; for example, southern states are slow to adopt the prohibition of smoking in public places.

In 2007, Tennessee enacted the Non-Smokers Protection Act, which made smoking in enclosed public spaces illegal, with a few exceptions; most notably private companies and worksites (TN State Legislation SENATE BILL NO. 1325, 2007). Since *Healthy People 2020* seeks a smoke-free policy adoption nationally, and the CDC considers a state smoke free law to be in place only when comprehensive, it has served as an inspiration for this advocacy effort to promote the facts related to the harms of environmental smoke and exposure (Healthy People, 2010) The CDC considers a state smoke free law comprehensive to be in effect when it protects three sectors from ETS; private sector worksites, bars, and restaurants. In Tennessee, the laws do not completely prohibit smoking in private-sector worksites or bars; therefore, these laws do not fully protect a non-smoker and may not be considered comprehensive under the CDC rules. As time passes, some states have expanded their laws to create coverage of these sectors specified by the CDC strengthening the protection for non-smokers to ETS.

Recommendations for Companies in a State/City Without a Smoke Free Policy

The best overall method for eliminating tobacco smoke in the work place is a complete ban on smoking and implementation of smoking cessation programs to assist with workers' cessation needs. Ideally, workers should not be forced to breathe in tobacco smoke just because they work in occupations that support their essential life needs.

A publication released by NIOSH outlined steps by which a workplace can eliminate tobacco use in the workplace. The publication noted that employers have to work with all parties in implementing non-smoking policies from the labor force to the management. All stakeholders should be brought into the decision making process. The article further discussed

how strategies developed by schools of public health could be tailored to suit each workplace. Four steps were outlined; 1) Offer incentives to stop smoking, 2) Offer cessation classes or counseling to the workers, 3) Distribute information among workers about the harms of smoking, and 4) Implement disincentives for those who continue to smoke after non-smoking policies have been implemented.

When there is physical separation of smokers and non-smokers, a false sense of security prevails (DHHS, 2016). If the same airspace is shared, it is not possible to completely eliminate passive exposure of smoke for the non-smoking population of workers. Any area within the building where smoking is permitted, the smoke will have a tendency to spread through the shared airspace. In order to ensure complete separation, the designated smoking area should be outside of the building and operate under a separate ventilation system that does not allow the smoke to flow back into the common workspace or public walking areas. This consideration was reiterated in the 1986 Surgeon General's report on involuntary smoking, which concluded that by simply separating smoker and non-smokers complete protection from SHS is not possible for non-smokers. Implementing this mechanism can reduce the exposure to ETS, but due to the ability of smoke particles to spread through the common airspace exposure to all workers is very likely (DHHS, 2016).

The only satisfactorily proven method of ETS elimination is completely prohibiting smoking in the workplace (DHHS, 2016). However, the current industrial culture dictates a lack of ability to implement such laws in the workplace. Until then, the most effective way to keep non-smoking working class from being exposed to ETS is to ensure smoking areas are completely separate from the general workplace and operate under its own ventilation system. In addition, it is necessary to ensure that the exhaust system does not intermix with the general circulation, As additional precautionary measures, workplaces should put up warning signs to indicate that designated areas are in place for smoking and smoking on premises are allowed only in such areas. Such signs should be put up in English, as well as Spanish, or any other predominant non-English language that is used by a majority of the working population.

Benefits of Comprehensive Smoking Bans

There have been studies made to look at the impact of a comprehensive smoking ban on the healthcare utilization and admission rates. One such study focused on the state of Arizona following the comprehensive ban enacted in May 2007. They evaluated the rate of admissions for asthma, stroke, chest pain, and acute myocardial infarction from January 2004 until May 2008. They matched corresponding months before and after the smoking ban to find a statistically significant decrease in admissions for these diagnoses (Herman & Walsh, 2011). There have also been studies evaluating the effect of a comprehensive smoking ban by counties following implementation of a ban for 12 months, one study showed both a 20% percent reduction in hospital admission rates for heart attacks and 11% reduction for COPD (Barr *et. al.*, 2012).

Conclusion

This country has a long history steeped in the use of tobacco, being one of our first cash crops and cornerstone in the forming of the republic. The Tobacco Industry also has a long history of bullying and manipulation that still casts a shadow on public health. A history not easily forgotten, the formation and implementation of tobacco control laws is not easy, and neither is quitting. By bringing growing fields of evidence we can offset the influence of big business forcing law makers to seek better controls for the general public. Given the growing number of states to ban the use of tobacco products comprehensively there is pressure on many state legislators to protect the general population from the effects of ETS exposure. Since, there is clear evidence of the negative effects of smoking on the health of the public, we should analyze the financial benefits to enact laws to better protect our citizens. Since it has been shown to reduce hospital admissions and exacerbating a number of chronic condition we can therefore see a reduction in health care spending. We should promote the programs to reduce tobacco use in new consumers and provide resources to help old consumers cut out the habit. It's not easy to quit tobacco use and it requires strong reinforcement to keep from returning to tobacco use. It is the right of any mature adult to enjoy tobacco products- if they desire to do so, but it also the right of everyone to be protected from carcinogenic compounds.

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