Estimating the Economic Impact of Secondhand Smoke in Marion County, Indiana, 2010

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ABSTRACT

Introduction: This study updates the 2008 estimate of the health-related costs of secondhand smoke (SHS) exposure for Marion County, Indiana.

Methods: Costs of SHS related mortality and morbidity were estimated using national attributable risk values for diseases that are known to be causally related to SHS exposure both for adults and children. Estimated costs included hospital inpatient costs, loss of life costs and ambulatory care costs where available, based on hospital discharge data, vital statistics, census data, and other published research. Attributable risk values were applied to the number of Marion County deaths in 2010 and hospital discharges in 2008 to estimate the number of individuals impacted by SHS exposure. All cost estimates were adjusted to 2010 dollar values.

Results: The overall cost of health care and premature loss of life attributed to SHS for Marion County residents was estimated to be $195.3 million in 2010 -- $88.5 million in health care costs and $106.8 million in loss of life consisting of $79.2 million in health care costs and $95.3 million in loss of life for adults and $9.3 million in health care costs and $11.5 million in loss of life for children. The estimated population for Marion County in 2010 was 903,393 resulting in SHS related costs of $216.22 per capita.

Conclusions: The results of this study provide data estimates needed to educate the public, community leaders, and local policy makers about the health effects and costs of SHS exposure in Marion County.

INTRODUCTION

Exposure to secondhand tobacco smoke (SHS), also known as environmental tobacco smoke, passive smoking, or involuntary smoking is a significant contributor to adult and childhood morbidity and mortality in the United States.[1-4] SHS is a complex mixture of gases and particles comprised of smoke from burning cigarettes, cigars or pipe tobacco (side stream smoke), mainstream smoke that is not inhaled by the smoker, and exhaled tobacco smoke. Side stream smoke and mainstream smoke contain the same chemical constituents including at least 250 chemicals known to be toxic or carcinogenic.[1] Exposure of adult nonsmokers to SHS has been causally associated with many medical conditions, including lung cancer, nasal sinus cancer, breast cancer, cervical cancer, ischemic heart disease (myocardial infarction and arteriosclerosis), stroke, eye and nasal irritation, spontaneous abortions and asthma.[2-5] In addition, other studies have suggested that exposure to SHS may be causally associated with adult leukemia, angina pectoris, hearing loss, allergies, periodontal disease, dysmenorrhea, colds, pneumonia, meningococcal disease, macular degeneration, congestive heart failure and cardiac arrhythmia.[2, 6-23] Exposure of children to SHS has been linked to low birth weight, sudden infant death syndrome, respiratory syncytial virus bronchiolitis, asthma exacerbations, otitis media, chronic respiratory symptoms, cystic fibrosis exacerbation, Legg-Perthes disease, allergies, meningococcal disease, loss of hearing and cognitive behavioral impairment.[2-4, 12-13, 15-16, 24-30] Also, many children[4] and adults are injured from fires started by smoking. The Centers for Disease Control and Prevention report that any level of exposure to SHS can be dangerous.[31]

SHS exposure continues to be a major public health concern. First, as presented below, 17.3% of the adult U.S. population was currently smoking in 2010.[32, 33] More of the adult current smokers in the U.S. were male, most often between the ages of 25-34, and were Black. For Indiana in 2010, more of the current smokers were males and more were Black, however the highest smoking rates were in the 25 to 54 age range. CDC estimated that 23.6% of adults in Marion County were current smokers in 2010, which was higher than the smoking rate for Indiana or the U.S. These statistics suggest that there are many opportunities for non-smokers in Marion County to be exposed to SHS, given the lack of policies to protect others.

Adult Smokers in Marion County, Indiana and the United States, 2010

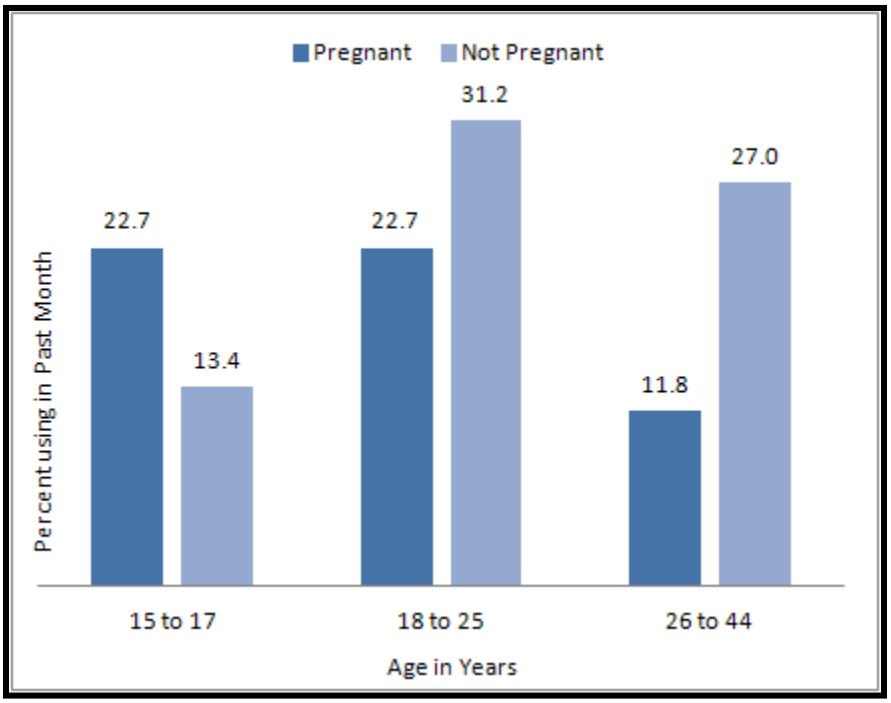
	Marion County*	Indiana**	United States**
Adults who are current smokers	23.6%	21.2%	17.3%
Males who are current smokers	26.4%	23.3%	18.5%
Females who are current smokers	21.0%	19.3%	15.8%
18-24 years of age	24.1%	21.2%	20.0%
25-34 years of age	26.6%	26.8%	23.4%
35-44 years of age	28.2%	25.2%	18.3%
45-54 years of age	22.6%	24.8%	19.5%
55-64 years of age	28.1%	19.8%	16.0%
65 year of age and older	10.2%	8.0%	8.4%
White	19.6%	20.6%	16.7%
Black	34.1%	30.1%	20.3%
Hispanic	22.4%	16.8%	14.9%

*CDC, Behavioral Risk Factor Surveillance Survey, SMART BRFSS City and County Data 2010.
**CDC, Behavioral Risk Factor Surveillance Survey, Prevalence and Trends Data 2010.

Second, many children are exposed to the effects of smoking before birth. The Department of Health and Human Services, Substance Abuse and Mental Health Services Administration reports that smoking rates among young women ages 15 to 17 were higher for those who were pregnant (22.7%) than among those not pregnant (13.4%).

Furthermore, the combined 2009 through 2010 data show that about 16.4% of all pregnant females reported "cigarette use during the past month."[34] In 2008, 18.5% of pregnant women in Indiana smoked compared with 15.7% in Marion County.[35]

Percent of Pregnant and Non-Pregnant Women Currently Smoking, 2009-2010, United States*



*2010 National Survey on Drug Use and Health: Summary of National Findings

Third, it has been estimated that over one-half (53.6%) of the children in the United States children were exposed to SHS in the home in 2007-2008.[31]

Much work has been done to protect the public's health from the deleterious effects of SHS with about 79.5% of the U.S. population and 36.0% of the Indiana population being protected by smoke-free laws as of June 2011[36] and numerous studies have reported the link between SHS exposure and morbidity and mortality among both adults and children. However, little is available in the scientific literature regarding the economic consequences of these adverse SHS related health effects. A study from

Minnesota[37] used Blue Cross/Blue Shield claims to estimate the cost at $44.58 per capita (2003 data) It should be noted that the smoking rate for adults in Minnesota was substantially lower than the smoking rates for adults in Indiana (21.1% in Minnesota vs. 26.1% in Indiana) according to the 2003 BRFSS.[38] The purpose of this report is to update previous estimates of the costs of health care and premature loss of life resulting from SHS exposure in Marion County, Indiana.[39, 40]

METHODS

Costs of SHS related mortality and morbidity were estimated using national attributable risk values for diseases that are known to be causally related to SHS exposure for both adults and children. Estimated costs included hospital inpatient costs, loss of life costs, and ambulatory care costs, where available, based on hospital discharge data, vital statistics and census data. Attributable risk values were applied to the most recent data available (number of deaths in 2010 and hospital discharges in 2008) to determine the number of individuals impacted by SHS exposure in Marion County.

This study used national research-based attributable risk values, community-based demographic data from the U.S. Census Bureau (2010), disease incidence in the community (i.e. disease-specific hospitalizations in 2008), average hospital charges in 2010 for the selected diseases, median age of death for SHS related diseases 2010, and an estimated economic value of life as of 2010. The estimated attributable risk values were obtained from articles and reports identified in searches of major literature databases. Of these, three were the primary sources used for this study: 1] the 2005 California Environmental Protection Agency (CalEPA) Report,[2] 2] the 2006 U.S. Surgeon General's

Report[3] and 3] a study conducted by Aligne and Stoddard.[4] The major data source was the CalEPA report which also provided the basis for many of the health effects cited in the 2006 Surgeon General's Report.[3] The CalEPA report summarized several research studies that presented attributable risk values based on thorough reviews of meta-analyses, literature syntheses, and epidemiological studies in both the U.S. and in other industrialized countries. CalEPA considered peer-reviewed publications and frequency of article citations in selecting the articles used as sources for the attributable risk values. When more than one value was presented in the CalEPA report, this study used the estimates from the strongest study design, or the median estimate if the studies were equivalent in design. Furthermore, the sources used in the CalEPA report considered the sample sizes of the studies, the extent to which the studies accounted for confounding factors, selection bias when comparing groups or bias in ascertaining exposure, and the generalizability to the U.S. population.

Questionnaire-based assessments of exposure to SHS were the most widely used methods to evaluate individuals' exposure to tobacco smoke. Questionnaires have important advantages: they are relatively inexpensive; they can be feasibly administered in a variety of ways, including mail surveys, telephone surveys, or in person; and, they are able to assess both current and past exposures. The disadvantages include difficulties in validation, particularly of a past exposure and the potential for misclassification.[41, 42] Measures of exposure in the studies included in the CalEPA report were often based on self-report questionnaire based assessments. However, the 2006 Surgeon General's Report[3] focused on the importance of using biomarkers to assess exposure. Biomarkers are more specific, sensitive, and objective, which are necessary qualities for program

evaluation and community surveillance. Evidence suggests that prevalence of tobacco smoke exposure is significantly underestimated when using questionnaires. Data from the Third National Health and Nutrition Examination Survey (NHANES III) showed a detectable level of cotinine in 88% of nonsmoking adults,[43] which is much higher than community questionnaire studies examining exposure to tobacco smoke.[44] A significant limitation of using biomarkers, however, is that biomarkers measure only current exposure, not lifetime exposure to tobacco smoke. In addition, obtaining access and cooperation of study participants to gather specimens for biomarker studies are more costly and the logistics are more difficult. Questionnaires can be used to measure historical exposure, although recall biases do exist. Finally, evidence shows that there is a strong correlation between both sources of exposure assessments.[43, 45-49] Thus, while use of biomarkers may be preferred, well-designed questionnaires can produce valid results.

The attributable risk values used in the current study were based on research using current measures of exposure from both questionnaires and biomarkers. While these decisions were dictated by available research, it is believed that the result yielded more conservative measures of attributable risk.

SHS Adult Morbidity Costs:

The formula used to calculate the hospitalization costs for each specific attributable disease in adults was:

Hospitalization Costs = AR * H *CH

Where:

AR is the attributable risk of getting the disease if exposed to SHS;

H is the number of hospitalizations in Marion County during 2008 for the specific disease; and,

CH is the average charge per hospitalization for the specific disease, adjusted to 2010 dollars.

Attributable risk values for specific diseases were specified in the CalEPA report.[2] When multiple attributable risks were reported, the attributable risk from the study with the strongest design, or the median when all designs were equivalent, was used. The number of hospital discharges (2008) and charges (2010) for the specific diseases were obtained from the annual hospital discharge summaries prepared by the Indiana Hospital Association and provided to the researchers by the Marion County Department of Public Health.

Limitations in Estimating SHS Adult Morbidity Costs: The major limitations that affected the validity of the estimated adult morbidity costs relate to data gaps and underlying assumptions. First, annual costs of outpatient care, emergency room care, and medications for the specific diseases were not available and were not included in the cost estimates. Second, costs of pain and suffering were not included in this model. Third, only those diseases with well-documented attributable risks for SHS exposure were included. There are most likely other diseases caused by SHS exposure for which attributable risk rates have not yet been determined. Fourth, this model assumed that the percent of costs attributed to treatment of the specific diseases caused by SHS exposure is the same as the percent of cases of disease that are attributed to secondhand exposure. Finally, it was assumed that the attributable risk values found in the published literature

apply to the population in Marion County. Given these limitations, the estimates are conservative and underestimate the true cost of SHS exposure.

SHS Adult Mortality Costs:

The mortality costs for each condition attributed to SHS were calculated using the following formula:

$$\text{Loss of Life Costs} = AR * D * VL * [(LE - AD)/LE]$$

Where:

AR is the attributable risk of getting the disease if exposed to SHS;

D is the number of deaths in Marion County in 2010 for the specific disease;

VL is the estimated value of a full life ($6,100,000 for 2010);

LE is the life expectancy of 78.2 years (2009); and,

AD is the average age of death in 2008 for the specific disease.

The term [(LE – AD)/LE] estimates the proportion of a person's life that is lost due to premature death.

The information needed to calculate these costs included: the disease-specific attributable risk for SHS exposure, the number of deaths for the specific diseases (based on Marion County death certificates for 2010 deaths), an estimate of the value of life, life expectancy (78.2 years as reported by the National Center for Health Statistics based on 2009 deaths[50] and the average age at death for the specific diseases. The same attributable risk values were used for the loss of life estimates as for the costs of hospitalization.

To determine the loss of life costs, the estimated monetary value of life was obtained from the United States Department of Transportation.[51] The value was estimated

at $6,100,000 for 2010. This was a substantial increase from the previous estimate of $3,000,000 in 2003.

The median age at death for causes attributed to SHS exposure was subtracted from the average U.S. life expectancy of 78.2 years for 2009 and divided by this average life expectancy (78.2 years) to determine the percent of life lost. This percent of life lost was multiplied by the value of life estimate and then multiplied by the number of SHS attributable deaths for each illness to obtain an estimated dollar value for the SHS attributable loss of life.

Limitations in Estimating SHS Adult Mortality Costs: There are several limitations related to estimating of the costs of adult mortality from SHS exposure. First, only those diseases with well-documented attributable risks for SHS exposure were included in our application. There are most likely other diseases caused by SHS exposure for which attributable risk rates have not yet been determined. Second, it was assumed that the attributable risk values found in the published literature apply to the Marion County population. A third concern is that there may not be agreement on the actual value of a full life, since this is a difficult and subjective variable to quantify. Fourth, this model used the life expectancy at birth, which provides a conservative estimate of the proportion of life lost. A more accurate measure would be to use life expectancy at the time the individual began being exposed to SHS; however, that age was unknown. Hospital discharge data for 2008 were used for this study. Although these data are several years old, it is expected that disease-specific hospitalization rates are fairly constant over a short period of time. Given these limitations, the estimates are conservative and underestimate the true cost of SHS exposure.

SHS Child Morbidity and Mortality Costs:

The model for estimating child morbidity and mortality was structured differently to take advantage of the data provided by Aligne and Stoddard.[4] The number of cause-specific deaths (2010) and hospitalizations (2008) of children in Marion County was provided by the Marion County Public Health Department. However, the cases of specific diseases or events for children were not known for Marion County; thus, the following estimation procedure was used. The first step was to estimate the number of events in children using a ratio of the values provided by Aligne and Stoddard[4] to the U.S. population for the particular age group, using the formula:

$$E_{SC} = P_{SC} * (E_{US} / P_{US})$$

Where:

E_{SC} is the estimated number of events in the sub-population of children in Marion County for the applicable disease;

P_{SC} is the number in the applicable sub-population of children in Marion County based on the U.S. Census estimates of children living in Marion County during 2010;

E_{US} is the number of events in the U.S. for the disease in the applicable sub-population; and,

P_{US} is the number in the applicable sub-population based on the U.S. Census reported estimates of children living in the U.S. during 2010.

This calculation was used to determine an estimate of the initial number of events for the Marion County population. The attributable risk estimates, also reported by Aligne and Stoddard,[4] were then applied to the estimated number of events in Marion County. An estimate of the number of events among Marion County youth that can be attributed to SHS exposure was then obtained using the formula:

$$E_{SHS} = AR * E_{SC}$$

Where:

E_{SHS} is the number of events in Marion County attributable to SHS;

AR is the SHS attributable risk of getting the disease if exposed to SHS; and,

E_{SC} is the estimated total number of events in Marion County among both the exposed and non-exposed applicable sub-populations.

Before applying the costs per case estimates reported by Aligne and Stoddard [4] to the number of events, the costs were adjusted to year 2010 dollars, using the medical care category of the consumer price indices established by the U.S. Department of Labor.[52] Finally, the cost estimates for the SHS attributable events were determined by multiplying the costs per event by the number of SHS attributable events in Marion County, using the formula:

$$C_{SHS} = C_E * E_{SHS}$$

Where:

C_{SHS} is the cost of disease attributable to SHS in Marion County;

C_E is the cost per event (office visit, hospitalization, etc.) for each disease adjusted to 2010 U.S. dollars; and,

E_{SHS} is the number of events related to each of the diseases in Marion County attributable to SHS.

The Aligne and Stoddard[4] study data included the number of office visits for the SHS-related pediatric illnesses. Their data were used because office visit data were not available for Marion County.

Limitations in Estimating SHS Costs in Children:

The method used to estimate the costs of exposure to SHS for children relies on the data presented in the Aligne and Stoddard[4] article. The findings in their study (attributable risk, utilization, and cost of care) may not be currently representative of Marion County, although that assumption is made for this study. Also, the diseases included in their analysis may not be a complete of diseases that are attributed to SHS exposure. Thus, using only the diseases and conditions in their study would underestimate the actual costs of SHS exposure. Also, the Aligne and Stoddard[4] study did not include all sources of health care, such as emergency room and pharmacy costs, which, if included, would have increased the cost of these diseases significantly. Finally, the cost of pain and suffering of the children and their parents were not included in their study thus, were omitted from this model. Given these limitations, the estimates are conservative and underestimate the true cost of SHS exposure.

RESULTS

The numbers of hospital discharges in 2008 for the seven conditions attributable to SHS for adults in Marion County are shown in Table 1. While morbid conditions result in many types of contacts with the health care system (office visits, hospitalizations,

pharmacy, etc.), only hospitalization data were available for the adult population in Marion County.

The deaths for the causes attributable to SHS exposure in Marion County are also shown in Table 1. The mortality statistics were also used to determine the median ages at death from these causes, which were needed to calculate the cost of loss of life.

Table 2 presents the estimated incidence of morbidity and mortality for SHS related medical conditions among children. The number of deaths and low birth weight deliveries were obtained from the birth and death records provided by the Marion County Department of Public Health. The number of children receiving health care though office visits was determined by applying the estimated number of children in Marion County derived from the 2010 U.S. Census estimates to rates calculated from numbers published in the Aligne and Stoddard article.[4] For example, the number of office visits for acute otitis media for children less than 15 years old, as reported by Aligne and Stoddard,[4] was divided by the total number of children less than age 15 in the United States (using 2010 census data) to get a national rate of office visits by children in this age group with acute otitis media. This rate was then multiplied by the total number of children less than 15 years of age in Marion County from the 2010 census to obtain the estimated number of office visits for acute otitis media in Marion County.

SHS Adult Morbidity and Mortality Costs:

Table 1 presents the estimated incidence, attributable risk, and costs of health care and loss of life of SHS related medical conditions for adults. The overall cost of hospitalizations for adults in Marion County attributed to SHS was estimated to be $79,213,117. The loss of life costs for these same conditions was estimated to be

$95,314,450. Combined, the SHS morbidity and mortality costs for adults attributed to SHS totaled $174,527,567 in Marion County.

SHS Child Morbidity and Mortality Costs:

Table 2 presents the estimated incidence, attributable risk, and costs of health care and loss of life for SHS related medical conditions for children in Marion County. The overall costs of health care for children were estimated to be $9,313,027. The estimated loss of life costs for these same conditions were $11,492,399. Combined, the SHS attributable morbidity and mortality costs for children were estimated to total $20,805,426.

Thus, the total economic impact on the health from SHS exposure on Marion County residents in 2010, as shown in Table 3, was estimated to be $195,332,995.The 2010 population of Marion County was estimated to be 903,393.[53] The total per capita health cost of secondhand smoke exposure in Marion County was estimated to be $216.22 per person in 2010.

DISCUSSION

Exposure to SHS is not only a significant health concern, but a significant economic concern as well. This study developed a model to estimate the health-related costs of SHS exposure on a county level using existing data. It was estimated that in 2010 $88.5 million was spent in Marion County for the hospitalization and health care of patients with diseases attributed to SHS exposure. Additionally, in 2010 an estimated $106.8 million was lost due to premature death that can be attributed to SHS exposure. The total cost (health care costs and the cost of premature loss of life) for diseases

attributed to SHS in Marion County was estimated to be $195.3 million in 2010 or about $216 per person. These costs do not include the health care and loss of life costs of Marion County residents who are smoking themselves, but only those who are exposed to SHS.

The economic costs of SHS exposure estimated for 2010 are substantially higher than reported for earlier years. There are several reasons why the costs increased. First there have been increases in the costs of medical care. Second, the ICD codes for coronary heart disease and stroke have been expanded to more completely include the disease conditions caused by SHS exposure. Finally, the value of life was estimated at $6,100,000 for 2010 by the U.S. Department of Transportation. This was a substantial increase from the previous estimate of $3,000,000 in 2003.

The cost estimates provided in this report are conservative. The list of conditions used in this study included only those conditions where substantial evidence exists in the literature that a portion of the cases can be attributed to SHS exposure. In addition, not all of the medical care costs could be captured from existing data sources. Finally, we chose the lowest level of the estimated value of a human life provided the federal agencies. Given these decisions, the total estimated economic impact of SHS exposure provided in this report is underestimated.

It is widely known that tobacco use contributes to the increased incidence of disease and premature loss of life in those who smoke; however, many do not recognize the impact of a person's smoking on his or her spouse, children, family members, friends, co-workers and customers. The adult smoking rates in Marion County are higher than the nation as a whole and slightly higher than in the State of Indiana. While the rate of

smoking among adults in the U.S. was 17.3%, the adult smoking rate in Marion County was 23.6% in 2010.[32,33] It has been estimated that over one half (53.8%) percent of the U.S. population is exposed to SHS in their homes.[31] Since the adult smoking rate in Indiana is higher than the national average, it is reasonable to infer that adults and children in Marion County are exposed to SHS at a higher rate.

The health-related costs arising from SHS exposure could be avoided or reduced in two ways. First and most obvious, individuals could quit smoking. Second, those who continue to smoke tobacco should be discouraged from smoking in their home, their automobile, their workplace and other places where non-smokers might be exposed to SHS. Banning smoking in public places has been shown to be an effective tool for reducing tobacco-related morbidity across a multiplicity of diseases in adults and children.[54] Comprehensive workplace smoke free laws are needed to protect the health of workers in all work place environments, including restaurants, bars and clubs. If they do not already fall under a community smoke free air law, business owners and managers could consider making their businesses smoke-free. However, such policies need to have the support of the public and business owners. This requires that people clearly understand the magnitude of the consequences of SHS both from an individual health perspective as well as from an economic perspective.

Examining the trend in attitudes about secondhand smoke policies in Indiana from 2002 to 2007, Zollinger et al. found a significant increase during this time period in the proportion of individuals who do not allow smoking in their homes, the proportion who are aware that exposure to secondhand smoke causes cancer, heart disease and sudden infant death syndrome, and the proportion who are concerned about the health effects of

exposure to secondhand smoke. There has been a decrease in the proportion of workers who are exposed to cigarette smoke in their work places, and a decrease in the proportion of individuals who have been in a car where someone was smoking.[55]

Given the high incidence of smoking and the relatively weak smoke free policies, Marion County continues to be at high risk for incurring high SHS related costs. More effective public policies related to SHS need to be developed in Marion County to achieve lower health care costs and improved overall health status.

The costs of SHS, in addition to its impact on health status, should be considered when developing policy recommendations to combat the effects of tobacco smoking on a population. The costs of morbidity and mortality associated with SHS are directly or indirectly borne by many. Employers bear additional costs for health insurance premiums used to pay for the treatment required for people with the SHS preventable diseases. Employers additionally assume many of the indirect costs associated with tobacco use and SHS such as increased employee sick leave due to SHS exposure or lost work time for smoke breaks. Consumers may assume the additional costs of SHS associated with their portion of insurance premiums and any additional coinsurance and/or co-payments associated with the hospitalization, physician and pharmaceutical costs resulting from exposure to SHS attributable diseases. Society assumes the cost burden for the uninsured population through the large amount of uncollected hospital revenues; taxpayers bear the cost of Medicaid benefits for indigents and for Medicare clients requiring treatment for SHS related diseases. Additionally, society as a whole endures the burden of premature loss of life. The lost productivity and opportunity cost of these losses have effects that carry on for many years.

It is important to use these data to educate consumers, business owners, legislators and policy makers to insure they are well aware of the huge economic consequences of SHS at the community level. It is the role of policy makers and government agencies to protect the health of its citizens and to promote the economic prosperity of the community – enacting comprehensive smoke-free legislation clearly fits within that role. Such legislation would reduce the economic burden of SHS exposure by at least $216 for every man, woman and child who lives in Marion County per year.

RECOMMENDATIONS

Policy recommendations resulting from this study include the following:

- Encourage the use of these findings to further educate the public, as well as community leaders and policy makers, about the health impacts and costs of SHS in Marion County;
- Encourage businesses and institutions that are not already 100 percent smoke-free to totally eliminate smoking at the workplaces and on their grounds including schools, colleges and universities, day care centers, restaurants and other food or beverage service establishments;
- Strictly enforce no smoking restrictions in all public areas, and in businesses and on school campuses;
- Provide more support for smoking cessation programs by businesses, health departments and health care providers; and,
- Encourage smokers not to smoke in shared areas.

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