Estimating the Economic Impact of Secondhand Smoke Exposure in Indiana in 2018

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Cynthia K . Lewis & Associates, LLC
Cynthia K Lewis, MPH
Terrell W Zollinger, DrPH

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ABSTRACT

Introduction: This study updates the 2014 estimate of the health-related costs of secondhand smoke (SHS) exposure for the residents of 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 secondhand smoke exposure both for adults and children. Estimated costs included hospital inpatient costs, hospital outpatient costs, hospital emergency department costs, physician office visit costs, medication costs, and loss of life costs where available, based on the most currently available patient data, vital statistics, census data and other published research. Attributable risk values were applied to the number of Indiana deaths, hospital discharges, physician office and outpatient hospital visits, emergency department visits and medication costs to estimate the number of individuals impacted by SHS exposure in Indiana in 2018. Cost estimates not already in 2018 dollars were adjusted to 2018 values.

Results: The overall cost of healthcare and premature loss of life attributed to SHS for Indiana residents was estimated to be approximately $2.1 billion in 2018. $1.1 billion in healthcare costs and $917.3 million in loss of life for adults, and $76.6 million in healthcare costs and $98.9 million in loss of life for infants and children. The estimated population for Indiana in 2018 was 6,691,878 resulting in SHS related costs of approximately $328 per capita.

Conclusions: The results of this study provide data estimates needed to educate the public, community leaders, and state policymakers about the health effects and costs of SHS exposure in Indiana.

INTRODUCTION

Exposure to secondhand tobacco smoke (SHS), also known as environmental tobacco smoke, passive smoking, and involuntary smoking, is a significant contributor to adult and childhood morbidity and mortality in the United States.[1-5] 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 nonsmokers to SHS in adulthood 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, asthma, and diabetes.[2-7] 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, 10-27]

Exposure of children in utero and after birth to SHS has been linked to multiple conditions. In utero exposure to SHS is causally associated with low birth weight, spontaneous abortion, respiratory syncytial virus bronchiolitis, cleft palate and Legg-Perthes disease while childhood exposure is associated with asthma exacerbations, otitis media, chronic respiratory symptoms, cystic fibrosis exacerbation, Legg-Perthes disease, allergies, meningococcal disease, loss of hearing, and cognitive behavioral impairment. [2-

[5,8-9, 16-17, 19-20, 28-34] Also, many children and adults are injured from fires started by smoking.[5] The Centers for Disease Control and Prevention report that any level of exposure to SHS can be dangerous.[35]

While the prevalence of SHS exposure declined from 87.5% to 25.2% among U.S. nonsmokers from 1988-1991 to 2013-2014 [36], an estimated 58.0 million nonsmokers were still exposed to SHS. SHS exposure continues to be a major public health concern. First, as presented below, 16.1% of the adult U.S. population was currently smoking in 2018. For Indiana in 2018, 21.1% of the adults were smoking and most current smokers were male, most often between the ages of 25-64, and were American Indian/Alaskan Native. These statistics suggest that there are many opportunities for non-smoking adults and children in Indiana to be exposed to secondhand smoke.

Adult Smokers in Indiana and the United States, 2018*		
	Indiana	**United States**
Adults who are current smokers	21.1%	16.1%
Males who are current smokers	23.4%	17.6%
Females who are current smokers	19.0%	13.5%
18-24 years of age	18.4%	11.5%
25-44 years of age	24.9%	19.1%
45-64 years of age	25.0%	17.6%
65 year of age and older	10.6%	8.9%
White	21.8%	16.3%
Black	20.8%	17.4%
Hispanic	12.9%	12.3%
AN/AI	33.2%	29.1%
Asian	9.9%	7.7%
Multiple Race	N/A	23.5%

*CDC, Behavioral Risk Factor Surveillance 2018.[37]

The data also highlight the need to address exposure to SHS disparities. SHS exposure prevalence was highest among nonsmokers aged 3–11 years (37.9%), non-Hispanic blacks (50.3%), those who were living in poverty (47.9%), living in rental housing (38.6%), living with someone who smoked inside the home (73.0%), or among persons who had less than a high school education (30.7%). [36]

Much work has been done in Indiana to protect non-smokers from the deleterious effects of SHS. Indiana has a statewide law prohibiting smoking in non-hospitality workplaces and restaurants, which covers 100% of Indiana's population. [38] Approximately 31% of the Indiana population is protected by strong local laws that prohibit smoking in non-hospitality workplaces, restaurants, and bars.[38] 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. The most recent studies conducted at the state level include a study from Minnesota that used Blue Cross/Blue Shield claims to estimate the cost to be $44.58 per capita (2003 data).[39] It should be noted that the smoking rate for adults in Minnesota was substantially lower than the smoking rate for adults in Indiana (21.1% in Minnesota vs. 26.1% in Indiana) according to the 2003 BRFSS.[40] The purpose of this report is to update the 2014 estimate of the costs of healthcare and premature loss of life resulting from SHS exposure in the Indiana.[41]

METHODS

Costs of SHS related mortality and morbidity were estimated using national data sources including attributable risk values for diseases that are known to be causally

related to SHS exposure for adults and for children. Estimated costs included hospital inpatient costs, physician office visit costs, hospital outpatient visit costs, medication costs for individuals treated for care, loss of life costs and ambulatory care costs, where available, based on state and national data sources.

Data sources included the National Ambulatory Medical Care Survey, National Hospital Ambulatory Medical Care Survey, National Health Interview Survey, National Cancer Institute, Medical Expenditure Panel Survey, Kids Count Data Center, Indiana State Department of Health, and the U.S. Census. Attributable risk values were applied to the most recent data available to determine an estimate of individuals impacted by SHS in Indiana.

More specifically, this study used national research-based attributable risk values, community-based demographic data, disease incidence in the community (i.e. disease-specific hospitalizations in 2018, office visits in 2016, hospital outpatient visits in 2009-2010 (combined) and 2017, and emergency department visits in 2009-2010 (combined) and 2017, average charges in 2013, 2017, and 2018 for the selected diseases, mean age of death for SHS related diseases and an estimated statistical value of life as of 2018. Before applying the costs per case estimates to the number of events, the costs were adjusted to 2018 dollars using the medical care category of the consumer price indices established by the U.S. Department of Labor.[42]

The estimated attributable risk values were obtained from articles and reports identified in searches of major literature databases. The three primary sources used for this study include: the 2005 California EPA (CalEPA) Report,[2] the 2006 Surgeon General's Report,[3,4] and a study conducted by Aligne and Stoddard.[5]   More recent

studies are not available in the literature. 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. The CalEPA report summarized multiple research studies that presented values based on thorough reviews of meta-analyses, literature syntheses, and epidemiological studies in the U.S. and in other industrialized countries. CalEPA considered peer-review publications and frequency of article citations in selecting articles used as sources of the attributable risk values. When more than one value was presented in the CalEPA report, this study used the best estimate or median estimate if the studies were equivalent in design. Furthermore, the sources used in the CalEPA report considered sample sizes of the studies, the extent to which the studies accounted for confounding factors, selection bias when comparing groups, bias in ascertaining exposure, and generalizability to the U.S. population.

Questionnaire-based assessments of exposure to SHS are the most widely used method 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.[43, 44]

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 focused on the importance of using biomarkers to assess exposure.[4] Biomarkers are more specific, sensitive and objective which are necessary qualities for program evaluation and community surveillance. Evidence suggests that the 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 percent of nonsmoking adults.[45] 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 costlier 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.[45-50] Thus, while the use of biomarkers may be preferred, well-designed questionnaires are considered to produce valid results.

The attributable risk values used in the current study were based on research using current measures of exposure based on 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

Morbidity costs for diseases among adults caused by exposure to SHS included costs for hospitalizations, physician office visits, hospital outpatient care, emergency department care, and medications. The number of hospital discharges (2018) and charges (2018) for the specific diseases were obtained directly from annual hospital discharge summaries prepared by the Indiana Hospital Association and provided to the Indiana State Department of Health. Note that the formulas use "CH" to indicate the cost of care because the value provided is actually "charges" associated with the care, rather than

actual costs of providing the care. The text uses the term "costs" since this is a term that the general public associates with economic impact; however, it is the charges for the care that were provided.

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

Hospitalization Costs = H * AR * CH

Where:

H is the number of hospitalizations in Indiana for the specific disease;

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

CH is the average charge per hospitalization for the specific disease in 2018.

The method used for estimating the number of events and costs for physician office visits, hospital outpatient visits, emergency department visits and medications used data publicly available from the National Ambulatory Medical Care Survey (NAMCS), National Hospital Ambulatory Medical Care Survey (NHAMCS), National Health Interview Survey (NHIS), National Cancer Institute SEER Program (NCI), Medical Expenditure Panel Survey Household Component (MEPSHC) and the U.S. Census. The most recent year data were available were used.

To estimate the ambulatory care costs for each specific attributable disease in adults, the first step was to estimate the number of events for the study year in Indiana.

Indiana Physician Office Visits

To obtain the number of Indiana physician office visits for those with specific types of cancer, the following formula was used:

Physician office visits for specific cancers = TIO * PCV * CST

Where:

TIO = Total Indiana physician office visits from NAMCS,[51]

PCV = Percent of U.S. physician office visits with cancer as primary diagnosis from NAMCS,[51] and

CST = Cancer specific type – the proportion of all U.S. cancers that were a specific type from NCI.[52]

To determine the number of Indiana physician office visits for coronary heart disease, stroke, asthma, and diabetes, the following formula was used:

Indiana physician office visits for specific diseases = USDPV/USDN * INDN

Where:

USDPV = Number of U.S. physician office visits for the specific disease from NAMCS[53] (asthma, diabetes, heart disease, and stroke),

USDN = Number with the disease in U.S. population from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke) NHIS[56] (diabetes) prevalence rate and U.S. Census estimate of the U.S. population (2018), and

INDN = Number with the disease in Indiana from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke) NHIS[56] (diabetes) prevalence rate and U.S. Census estimate of the Indiana population (2018). [64]

Indiana Hospital Outpatient Office Visits

Hospital outpatient office visit data were not available for those with cancer; however, data were available regarding hospital outpatient visit data for asthma, coronary heart disease, diabetes and stroke cases. The following formula was used to estimate the number of hospital outpatient office visits for diseases caused by exposure to SHS:

Indiana hospital outpatient office visits for specific diseases = USDHV/USDN * INDN

> Where:

>> USDHV = Number of U.S. hospital outpatient visits from the product of the population increase from base year (year of publication) to 2017 and the number specific disease visits from NAMCS/NHAMCS[57] (asthma and stroke) and NHAMCS[58] (CHD and diabetes)

>> USDN = Number with the disease in U.S. population from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke) NHIS[56] (diabetes) prevalence rate and U.S. Census estimate of the U.S. population (2018), and

>> INDN = Number with the disease in Indiana from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke), and NHIS[56] (diabetes) prevalence rate and U.S. Census count of the Indiana population (2018).[64]

Indiana Hospital Emergency Department Visits

Hospital emergency department visit data were available for those with asthma, diabetes, coronary heart disease, and stroke. The following formula was used to estimate the number of hospital emergency department visits for each disease.

Indiana hospital emergency department visits for specific disease = USDEDV/USDN * INDN

> Where:

>> USDEDV = Number of U.S. hospital emergency department visits from NHAMCS[59] (asthma, stroke, and diabetes) and number of events from product of the population increase from base year (year of publication) to 2017 and the number of visits from NAMCS/NHAMCS[57] (CHD)

USDN = Number with the disease in U.S. population from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke) NHIS[56] (diabetes) prevalence rate and U.S. Census estimate of the U.S. population (2018), and

INDN = Number with the disease in Indiana from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke) NHIS[56] (diabetes) prevalence rate and U.S. Census estimate of the Indiana population (2018).[64]

Estimating costs of ambulatory care for SHS caused diseases

Once the number of ambulatory care events were determined, then the costs of that care for each specific attributable disease in adults could be estimated. The formulas used to calculate the costs for each of the diseases were:

Physician Office Visit Costs = EPO * AR * CH

Hospital Outpatient Visit Costs = EHO * AR * CH

ED Visit Costs = EED * AR * CH

Where:

EPO is the estimated number physician office visits in Indiana for the specific disease,

EHO is the estimated number of hospital outpatient visits in Indiana for the specific disease,

EED is the estimated number of emergency department visits in Indiana for the specific disease,

AR is the attributable risk of getting the disease if exposed to secondhand smoke and,

CH is the mean annual charge per visit for the specific disease generated from MEPSHC.[60]

The total annual prescribed medication costs per person for the specific conditions included in this report applied the annual cost of prescription medications for specific diseases to the estimated prevalence of each disease in Indiana. The formula used to calculate the mean annual medication costs for each specific attributable disease in adults was:

Medication Costs = INDN * AR * CH

Where:

INDN = Number with the disease in Indiana from the product of NHIS[54] (asthma) NHIS[55] (CHD and stroke) NHIS[56] (diabetes) NCI[52] (cancer types) prevalence rate and U.S. Census estimate of the Indiana population (2018) [64]

AR is the attributable risk of getting the disease if exposed to secondhand smoke, and

CH is the mean annual charges for medication per individual for the specific disease generated from MEPSHC.[60]

Limitations in Estimating SHS Adult Morbidity Costs

The major limitations that affect the validity of the estimated adult morbidity costs relate to data gaps and underlying assumptions. First, since the disease prevalence and the annual mean costs of physician visits, ambulatory care visits, and medication costs of many of the conditions for Indiana were not available, the estimates used in this study were based on disease-specific prevalence rates and costs for the U.S. If Indiana-

specific information were available and used, then there would be more confidence in the cost estimates. Second, the base number for hospital outpatient visits for stroke and asthma and emergency department visits for coronary heart disease were from 2010 and 2011 respectively. The number of visits for each were estimated for 2017 by applying the population increase for individuals 18 years of age or older in Indiana to the base year. This assumes the number of visits would increase at the same rate as the population. Third, MEPSCH converted from ICD-9 to ICD-10 in 2016. The mean cost per person for each specific disease in MEPSHC may include ICD-10 codes that are not included in the specific conditions in this study. For example, the mean cost per person for heart disease includes all ICD-10 codes for heart disease, not just coronary heart disease. Fourth, the costs of pain and suffering were <u>not</u> included in this model. Fifth, 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. Sixth, 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 Indiana. Given these limitations, the estimates are conservative and are believed to 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 secondhand smoke;

D is the number of deaths in Indiana in 2018 for the specific disease;

VL is the estimated value of a full life ($10,000,000 for 2018);

LE is the life expectancy of 78.7 years (2018) and,

AD is the average age of death in 2018 for the specific disease for those who died before their life expectancy.

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, the number of deaths for the specific diseases, an estimate of the value of life, life expectancy (78.7) years as reported by the National Center for Health Statistics[61] and the average age at death for the specific diseases in 2018 as reported by the Indiana Hospital Association to the Indiana State Department of Health. 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 Value of a Statistical Life (VSL) of $10 million in 2018 was estimated using the formula from the United States Department of Transportation.[62] This was an increase from the previous estimate of $9.2 million in 2014 used to generate the 2016 report.

The mean age at death for those who died before they reached life expectancy for causes attributed to SHS exposure was subtracted from the average U.S. life expectancy of 78.7 years for 2018 divided by this average life expectancy (78.7 years) to determine

the percent of years of life lost. This percent of years 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 study. Second, it was assumed that the attributable risk values found in the published literature apply to the Indiana 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 secondhand smoke; however, that age was unknown. Given these limitations, the estimates are conservative and believed to 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.[5] The first step was to estimate the number of events in children using a ratio of the values provided by Aligne and Stoddard to the U.S. population for the particular age group, using this 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 Indiana for the applicable disease;

P_{SC} is the number in the applicable sub-population of children in Indiana based on the U.S. Census estimates of children living in Indiana during 2018;

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 2018.

This calculation was used to determine an estimate of the initial number of events for the Indiana population. The attributable risk estimates, also reported by Aligne and Stoddard,[5] were then applied to the estimated number of events in Indiana. An estimate of the number of events among Indiana 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 Indiana 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 Indiana among both the exposed and non-exposed applicable sub-populations.

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 Indiana, using the formula:

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

Where:

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

C_E is the cost per event (office visit, hospitalization, etc.) for each disease adjusted to 2018 U.S. dollars; and,

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

The Aligne and Stoddard[5] data included the number of office visits for the SHS related pediatric illness. Their data were used because office visit data were not available for children in Indiana.

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[5] article. The findings in their study (attributable risk, utilization, and cost of care) may not be representative of Indiana although that assumption is made for this study. The data from the study are also several years old and may no longer be reliable, but a more recent study is not available. Also, the diseases included in their analysis may not be a complete list of diseases that can be attributed to SHS exposure. Thus, using only the diseases and conditions in their study would underestimate the actual costs of SHS exposure in Indiana. Also, the Aligne and Stoddard[5] study did not include all sources of healthcare, such as emergency room and medication 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, these were omitted from this model. Given these limitations, the estimates are conservative and underestimate the true cost of SHS

exposure.

RESULTS

The total economic impact of secondhand smoke exposure on the health of

Indiana residents was estimated to be $2,194,683,195 in 2018. Since the 2018 population

of Indiana was estimated to be 6,691,878[64], the total per capita cost of SHS in Indiana

was estimated to be $327.96 per person in 2018.

Total Healthcare and Loss of Life Costs for Selected Conditions Related to SHS Exposure in Indiana, 2018

Adults		
Total Health Care Costs	$1,101,690,446	
Total Loss of Life Costs	$917,344,164	
Total Costs for Adults		**$2,019,034,610**
Children		
Total Health Care Costs	$76,665,103	
Total Loss of Life Costs	$98,983,482	
Total Costs for Children		**$175,648,584**
Total Costs for Adults and Children		**$2,194,683,195**
Population of Indiana, 2018	6,691,878	
Total per Capita Costs		**$327.96**

SHS Adult Morbidity and Mortality Costs

The overall estimated cost of healthcare for adults in Indiana attributed to SHS

was estimated to be $1,101,690,446 in 2018. The loss of life costs for these same

conditions was estimated to be $917,344,164 in 2018. Combined, the SHS morbidity and

mortality costs for adults attributed to SHS totaled $2,019,034,610 in 2018. The total

estimated cost of healthcare and loss of life for each of the adult conditions included in

this study is presented in Graph 1.

Graph 1. Total Estimated Healthcare and Loss of Life Costs for Adult Conditions Related to SHS Exposure
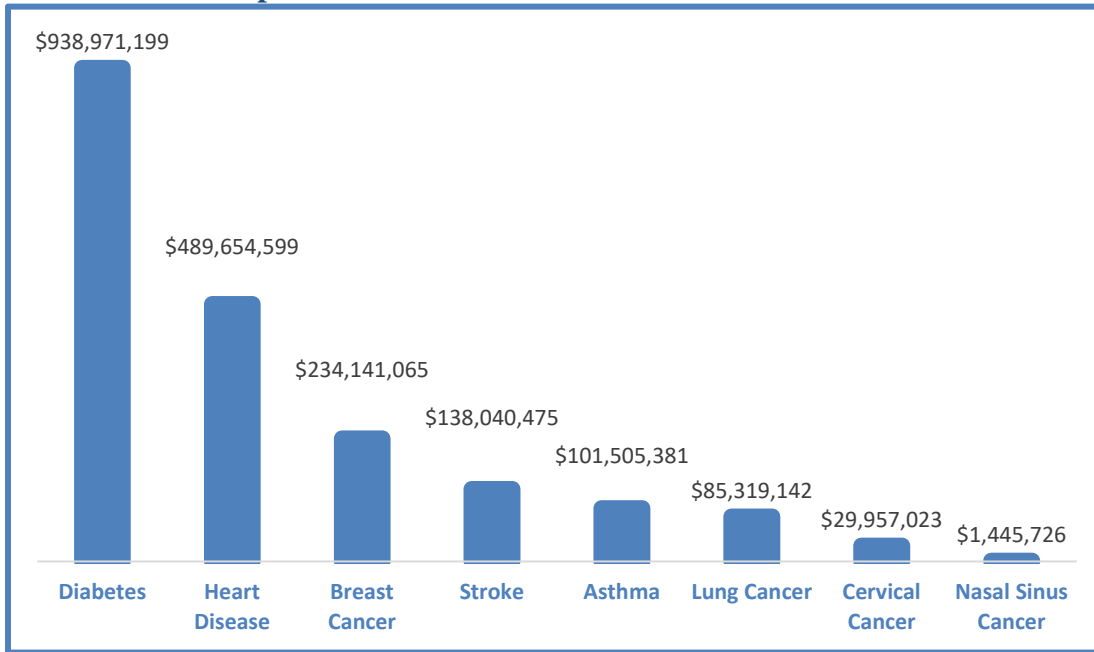
The estimated number of hospital discharges, physician office visits, emergency department visits, hospital outpatient visits and medications in 2018 for the eight conditions attributable to SHS for adults in Indiana are shown in Table 1 (cancer types) and Table 2 (asthma, coronary heart disease, diabetes and stroke) of the attachment. While morbid conditions result in many types of contacts with the health care system (home care, specialty care, pharmacy, etc.), only data on certain medical care were available for the adult population in in the U.S. The adult deaths for the causes attributable to SHS exposure in Indiana are also shown in Table 1 and Table 2 of the attachment. The mortality statistics were also used to determine the mean ages at death from these causes, which were needed to calculate the cost of loss of life.

SHS Child Morbidity and Mortality Costs

The overall costs of healthcare for infants (born and unborn) and children were estimated to be $76,665,103 in 2018. The estimated loss of life costs for these same

conditions were $$98,983,482 in 2018. Combined, the SHS attributable morbidity and

mortality costs for children were estimated to total $175,648,584 in 2018. The total

estimated costs of healthcare and loss of life for each infant and childhood condition is

presented in Graph 2.

Graph 2. Total Estimated Healthcare and Loss of Life Costs for Infant and Childhood Conditions Related to SHS Exposure
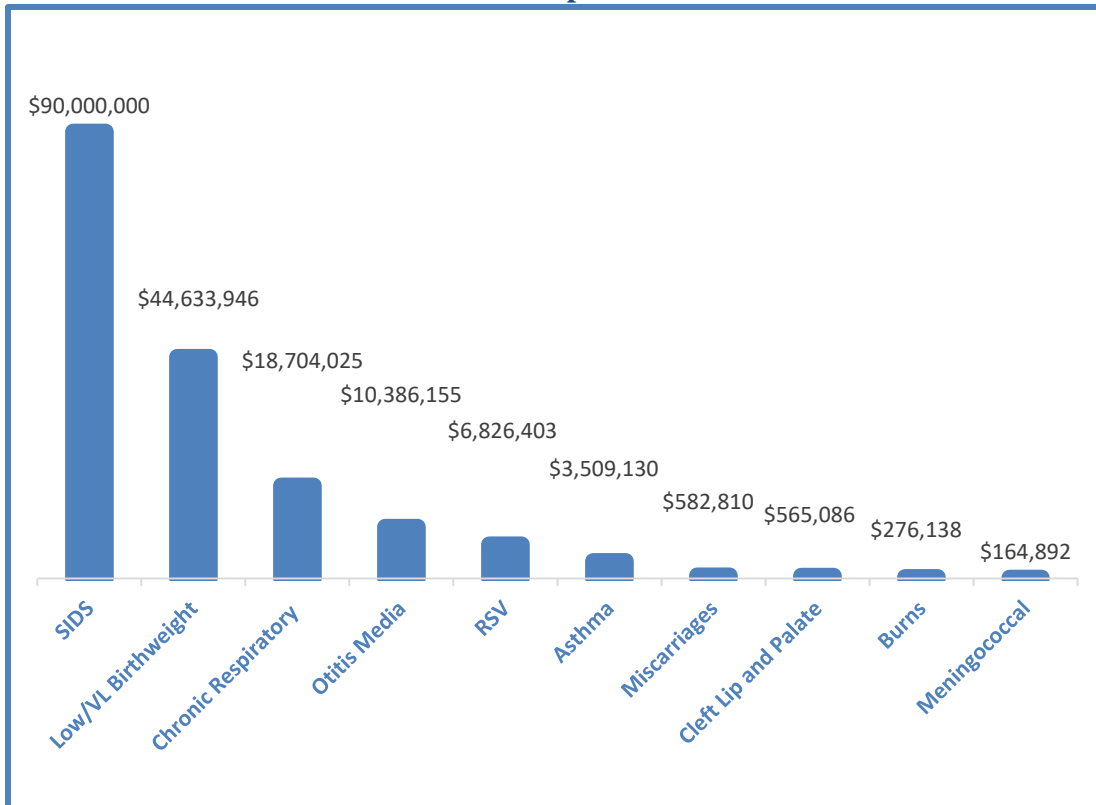

Table 3 of the attachment presents the estimated incidence of morbidity and

mortality for SHS attributable medical conditions among infants (born and unborn) and

children. The numbers of deaths by cause were provided by the Indiana State Department

of Health. The number of low birth weight and very low birth weight deliveries for

Indiana were obtained from the Kids Count Data Center.[63] The number of children

receiving health care through office visits was determined by applying the estimated

number of children in Indiana derived from the 2018 U.S. Census estimates to rates

calculated from numbers published in the Aligne and Stoddard article.[5] For example, the number of office visits for otitis media for children less than 15 years old, as reported by Aligne and Stoddard,[5] was divided by the total number of children less than age 15 in the United States (using 2018 census estimates) to get a national rate of office visits by children in this age group with otitis media. This rate was then multiplied by the total number of children less than 15 years of age in Indiana from the 2018 census to obtain the estimated number of office visits for otitis media in Indiana.

DISCUSSION

Exposure to SHS is not only a significant health concern, but a significant economic concern as well. It was estimated that in 2018, over $1.1 billion were spent in Indiana for the hospitalization and health care of patients with diseases attributed to SHS exposure. Additionally, in 2018 an estimated $917.3 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 Indiana was estimated to be $2.1 billion in 2018 or about $328 per person. These costs do not include the healthcare and loss of life costs of Indiana residents who are smoking themselves, but only those who are exposed to SHS. The cost to businesses due to loss of productivity, cleaning and additional health insurance premiums are also not included.

The total economic cost related to SHS exposure estimated for 2018 was approximately the same as reported for 2014. The total healthcare costs increased by approximately 56% from 2014; however, the loss of life cost decreased by approximately 41%. While there was a significant increase in medical care costs, the true increase may be underestimated. The mean cost per person increased for Indiana hospital discharges in

2018; however, the mean cost per person for some of the care settings and disease conditions retrieved from the 2017 MEPSHC database decreased from 2014. One possible reason for the decrease may be due to the MEPSHC conversion to ICD-10 from ICD-9 in 2016. Additionally, it is not possible to select specific ICD-10 codes for each condition within MEPSHC. Comparison of costs retrieved from MEPSHC cannot be made for data reported before and after the conversion in 2016.

The most reliable data used in this study were the Indiana hospital discharges provided by the Indiana Hospital Association to the Indiana State Department of Health. These data allow for selection of specific ICD-10 codes and are actual mean costs per person based on the total number of visits and total costs. It is for this reason that it is possible the MEPSHC costs per person underestimate the true mean cost per person for the disease conditions in this study.

There are three main reasons why the estimated loss of life decreased from 2014 even though the VSL increased. First, there were fewer deaths for lung cancer, nasal sinus cancer and stroke in 2018 than there were in 2014. Second, the mean age of death for stroke cases exceeded the average life expectancy, which resulted in zero years of life lost. Finally, the mean age of death increased notably between 2014 and 2018 for all disease conditions. Therefore, the number of years of life loss decreased.

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. The lowest level of the estimated value of a human life provided by federal agencies was also chosen.

Given these decisions, the total estimated economic impact of SHS exposure provided in this report is considered to be the minimum cost.

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 their spouse, children, family members, friends, co-workers and customers. The adult smoking rates in Indiana are notably higher than the nation as a whole. While the rate of smoking among adults in the U.S. was 16.1%, Indiana's adult smoking rate was 21.1% percent in 2018.[37] It has been estimated that almost 38% of children 3 to 11 years old are exposed to SHS in their homes.[36] Since the adult smoking rate in Indiana is higher than the national average, it is reasonable to infer that adults and children in Indiana are exposed to SHS at a higher rate than in the U.S. overall.

The healthcare-related costs arising from SHS exposure could be avoided or reduced in two ways. First, individuals should quit smoking. Second, those who continue to smoke tobacco should be discouraged from smoking in their home, their automobile, their workplace and other areas where non-smokers may be exposed to SHS, especially indoors. 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.[65] Strong smoke-free laws are needed to protect the health of individuals in all work place settings, including restaurants, bars and clubs, casinos, and multi-unit housing. 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 SHS policies in Indiana from 2002 to 2007, Zollinger et al. found a significant increase during this time period in the proportion of individuals who were aware that exposure to SHS causes cancer, heart disease and sudden infant death syndrome, and the proportion who are concerned about the health effects of exposure to secondhand smoke.[66] There was also a decrease in the proportion of workers who were exposed to cigarette smoke in their workplaces, and a decrease in the proportion of individuals who had been in a car where someone was smoking.[66] Results from the 2019 Indiana Adult Tobacco Survey (IATS) indicate residents continue to recognize the dangers of SHS and support limiting its exposure. The 2019 IATS reported almost 97% (96.7%) of adults considered breathing secondhand smoke to be either very harmful (65.7%) or somewhat harmful (31.0%).[67] The 2019 IATS also found that 80.1% of all Indiana homes were smoke-free. [68] Less than half (45.9%) of current smokers' homes were smoke-free while almost 90% (88.7%) of nonsmokers' homes were smoke-free. [67] Approximately 88% of adults thought smoking should not be allowed in indoor work areas.[67]

Given the high incidence of smoking and the lack of a strong statewide smoke-free air law that covers all workplaces including bars, clubs, and casinos, Indiana continues to be at high risk for incurring SHS related costs. More effective public policies related to SHS need to be developed in Indiana to achieve lower healthcare 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 higher health insurance premiums used to pay for the treatment required for people with preventable diseases attributed to SHS exposure. Employers additionally assume many of the indirect costs associated with tobacco use and SHS such as increased employee sick leave due to SHS exposure. 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 visit, and pharmaceutical costs resulting from exposure to SHS attributable diseases. Consumers also pay higher amounts for goods and services as businesses pass on their additional costs. Society assumes the cost burden for the uninsured population through large amounts of uncollected hospital revenues; taxpayers bear the cost of Medicaid benefits for low-income individuals and 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.

The rise in use of electronic cigarettes, vapes, and related devices (collectively referred to as e-cigarettes) deserves some mention in this study as the effects experienced by those exposed secondhand may also contribute to adverse health conditions that aren't currently well documented in the existing literature. Using an e-cigarette is often called "vaping." Vaping produces an aerosol that generally contains nicotine, flavorings, other chemicals, and sometimes marijuana extracts. Users inhale this aerosol as well as bystanders when the user exhales into the air. E-cigarettes were developed in the last decade but have increased dramatically in popularity and use in recent years. It was

estimated that in the U.S. 3.6 million middle and high school students, including 60,000

Indiana middle and high school students, used these devices in 2018. [68,69] In 2017, it was

estimated that 2.8% of the U.S. adult population used e-cigarettes and in 2018 6.7% of

Indiana adults used e-cigarettes.[69,70]

The main concerns for primary users and those exposed secondhand are the

adverse health effect of nicotine and the risk of cancer from volatile organic compounds

and cancer-causing chemicals. In addition to being highly addictive, nicotine has been

shown to be toxic to developing fetuses and inhibits the proper development of the lungs

of children, adolescents and young adults. In addition, ultrafine particulates are inhaled

deep into the lungs, some of the flavorings have been linked to serious lung diseases, and

the aerosols also contain heavy metals such as nickel, tin and lead.[71] A review of the

current research related to secondhand inhalation of e-cigarette aerosols concluded that

passive exposure has the potential to cause adverse health effects.[72] However, these

potential respiratory health risks resulting from secondhand e-cigarette aerosol exposure

have not been sufficiently evaluated to quantify the hazards.[73]

It is important to use these data to educate consumers, business owners,

legislators and policymakers to make them more aware of the huge economic

consequences of SHS at the state and community level. It is the role of policymakers 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 for

every man, woman and child who lives in Indiana.

RECOMMENDATIONS

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 Indiana;

- Encourage businesses and institutions that are not already 100 percent smoke-free to totally eliminate smoking at the workplaces and on their grounds, on their campuses including schools, colleges and universities, multi-unit housing, day care centers, restaurants, other food or beverage service establishments, and casinos;

- Strictly enforce no smoking restrictions in all public areas as well as in workplaces and on school campuses;

- Provide more support for smoking cessation programs by businesses, health departments and healthcare providers; and,

- Encourage smokers not to smoke in shared areas.

- Identify potential data sources and methods for reporting disparities that may exist among subpopulation groups

- Continue monitoring current literature on studies related to vaping/electronic cigarettes and effects of secondhand exposure.

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