The Economic Burden of Childhood Exposure to Secondhand Smoke in Maine

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Executive Summary

Secondhand smoke exposure in children has been proven to cause adverse health outcomes, putting children at increased risk of asthma, pneumonia, bronchitis, reduced lung function, common cold symptoms (cough, phlegm, wheeze, and breathlessness), ear infections, and sudden infant death syndrome (SIDS). Also, many other adverse effects have recently been associated with childhood exposure to secondhand smoke, including cancer, colic, vitamin C deficiency, learning and behavioral deficits, rhinitis, and tooth decay. As such, there is no acceptable risk-free level of secondhand smoke exposure to children. Recent efforts to educate smoking parents and to impose smoking bans in public places have had a positive effect on decreasing childhood exposures in Maine. However, one out of every five adults in Maine still smoke, and nearly half this group have children. The rate of exposure is highest for low income children, where nearly half of the adult population receiving government subsidized health insurance report being current smokers. It is therefore not surprising that these children are more likely to suffer from wheeze and asthma than other children in the state. The rate of secondhand smoke exposure to children also varies regionally, with lower levels observed in coastal and southern Maine.

In order to evaluate the effectiveness of imposing further smoking restrictions on adults in the state, this report seeks to quantify the healthcare costs associated with secondhand smoke exposure in Maine children. The impact of tobacco smoke exposure across different settings (home, car, etc.) can not be separately identified. However, exposure in vehicles is addressed in detail in this report given the current proposal to legislate a state-wide ban in this microenvironment. Estimates of the total healthcare costs associated with secondhand smoke exposure in children range from $8-$11.5 million dollars per year, and 6-12% of the childhood illnesses examined in this report can be attributed to SHS exposure. However, these estimates are restricted to certain respiratory conditions and ear infections, and for this reason are very likely to be an underestimate of the total economic burden of secondhand smoke exposure in Maine children. Not surprisingly, the results also suggest that a significant fraction of the total economic burden is paid by the state through the MaineCare program. Although this program insures less than a third of children in the state, it is responsible for 65% of the smoking-related healthcare costs.

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Introduction

In this report, the economic cost of childhood exposure to secondhand smoke (SHS) in Maine is examined. This work draws from the available literature on the causal relationship between various adverse health outcomes and SHS, as well as state-level statistics on the prevalence[1] of childhood illnesses and SHS exposure patterns in Maine. SHS exposure contributes to morbidity[2] in children, increasing both short and long-term healthcare costs from ear infections, respiratory illnesses and asthma, among others. Children with these conditions incur direct costs in the form of greater rates of healthcare utilization from physicians, larger amounts of prescription drugs, and higher hospitalization rates. These costs are largely preventable, since it is the direct result of the behaviors of adults (typically the primary caregivers or parents) who voluntarily expose infants and children to SHS.

The purpose of this study is to evaluate the impact of a potential smoking ban in vehicles. However, children are also exposed to SHS in other locations, including the home, and it is not feasible to separate out the individual effects of each exposure setting. For this reason, a more comprehensive approach is applied that incorporates the totality of SHS exposure and health effects in Maine children, although the importance of in-vehicle exposures to the overall health outcome is examined. For example, while smoking in cars represents a relatively low percentage of the time exposed to SHS, the nature of the vehicle exposure setting, i.e., small enclosed space and low rate of air exchange, can lead to dangerously high exposure levels similar to those observed in a smoke-filled adult pub. Decreasing SHS exposures in this high impact setting will improve child health outcomes in Maine, as well as yield direct cost savings to those that pay these healthcare expenses, including the state (MaineCare), private insurers, and individuals.

This healthcare cost assessment uses a prevalence-based approach to predict the annual level of resources used to combat SHS-related childhood illnesses in Maine. For these purposes, data was compiled on the level of risk and exposure to SHS, as well as the estimated direct and indirect healthcare costs in 2007 dollars. Direct costs include the payment for goods and services used to treat a smoking attributable illness, such as hospitalizations, physician and other professional services, prescription drugs and medical supplies. Indirect costs include unpaid caregiver expenses or time spent off work, missed school days, and higher rates of morbidity and mortality among exposed children.

The healthcare costs associated with SHS are examined for asthma, pneumonia, wheeze, and otitis media (OM) also known as middle ear disease. Unfortunately, the healthcare costs related to other acute respiratory symptoms and illnesses known to be related to SHS exposure, such as cough, phlegm, bronchitis, and breathlessness, are difficult to quantify, although they are certain to be significant (especially with regard to indirect costs). For the purposes of this report, these non-asthma respiratory symptoms and illnesses are grouped together under the wheeze category, since this is the only symptom for which prevalence data is available in Maine. Also, given the focus of the current debate to reduce SHS exposure in children already born, this report excludes a cost assessment of prenatal exposure, such as low birth weight and higher infant mortality

[1] Prevalence is defined as the percentage of exposure or disease burden in a given population.

[2] Morbidity is defined as a diseased condition or state.

rates. It is also limited to the health effects where the science is strongly indicative of a causal association, and to outcomes for which healthcare expenditure data is readily available. Therefore, the estimates provided in this report should be viewed as a conservative baseline estimate of the negative health impacts related to childhood exposure to SHS in Maine. A more detailed study should be conducted to estimate the total economic burden of SHS to the state.

Health Risks of SHS

Secondhand smoke (SHS), a known human carcinogen (US EPA 1992; IARC 2002; SG 2006; CA EPA 1997; NRC 1986; IM 2000; WHO 2002), represents a complex mixture of exposure to burning cigarettes from mainstream (exhaled by smoker) and sidestream (smoldering cigarette) smoke. SHS contains at least 250 chemicals that are known to be either toxic or carcinogenic, many at levels much greater than mainstream smoke alone (SG 2006). For this reason, the US Surgeon General has concluded that there is no risk-free level of SHS exposure to either non-smoking adults or children (SG 2006). Furthermore, children are anatomically more vulnerable than adults to the ill effects of SHS, due to smaller airways and higher breathing rates, as well as less developed immune systems.

The evidence of the negative health impact of SHS exposure in children is extensive. A recent US Surgeon General's review of the existing medical literature (SG 2006) found sufficient evidence to support a causal link between exposure to SHS and an array of illnesses in children, including asthma, pneumonia, bronchitis, reduced lung function, common cold symptoms (cough, phlegm, wheeze, and breathlessness), and otitis media (OM). This report also provided suggestive evidence linking childhood cancers with SHS exposure.

Table 1: Risk Estimates*	
Asthma	1.37 (1.15-1.64) [14]
Wheeze (<age 5)	1.55 (1.16-2.08) [5]
Wheeze (5 and older)	1.24 (1.17-1.31) [30]
Pneumonia (<age 5)	1.54 (1.31-1.80) [11]
OM (<age 5)	1.48 (1.08-2.04) [7]

*Odds ratios taken from Cook and Strachan 1999; 95% confidence intervals in parentheses; number of studies used to generate composite risk estimate in brackets

In order to take advantage of the full extent of the medical literature in this area, reported risks were derived from a comprehensive analysis of the existing literature on the topic (Cook and Strachan 1999). The authors used statistical meta-analyses techniques to aggregate risk estimates from available studies of SHS exposure in children (up to 1998). Overall, the literature presents a consistent picture of elevated risks in both younger and older children. Risk (as determined by the odds ratios[3]) was 20-60% higher for children with at least one smoking parent. These risks were generally higher for preschool age children, and for children exposed to maternal smoking. These estimates were further supported by more recent findings on the impact of SHS in children using data from the National Health and Nutrition Examination Survey

[3] The odds ratio is defined as the odds of disease among children exposed to SHS divided by the odds of disease among children not exposed to SHS.

(Mannino et al. 2001, 2002), which found that exposure to SHS was associated with greater risk of both wheezing and asthma in children.

For a listing of the risk estimates used to construct total attributable healthcare costs in this report, see Table 1. Where available, the risk estimates are separated by age group, since it has been shown that preschool age children are more susceptible to the negative effects of SHS. All risk estimates compare children in non-smoking households to those where either parent smokes. This is a more conservative view of risk than those comparing non-smoking households to either maternal or both parents smoking.[4]

Although not explicitly accounted for in this report, the literature illuminating other non-cancer health effects of SHS exposure in children is growing in importance (see Table 2). According to the Centers for Disease Control (SAMMEC 2007), approximately 18.5% of Sudden Infant Death Syndrome (SIDS) cases and 12.8% of low birth weight births in Maine are attributable to in utero exposure. Incorporating these expenditures on other illnesses associated with SHS would significantly increase the derived healthcare cost estimates attributable to SHS exposure in children.

Table 2: Other potential health effects of SHS in children

Adverse outcome	Description	Citations
Vitamin C Deficiency	Reduced plasma ascorbate (serum absorbic acid) from SHS exposure inhibits Vitamin C intake	Preston et al. 2003 Strauss 2001
Rhinitis	Allergic reaction similar to hay fever that promotes the release of histamines	Biagini et al. 2006
Colic	Increased plasma and intestinal motilin levels from SHS exposure	Shenassa and Brown 2004
Sudden Infant Death Syndrome (SIDS)	Higher concentrations of nicotine in lungs of children exposed to SHS	McMartin et al. 2002 Wisborg et al. 2000
Neurological development	Exposure to SHS associated with lower test scores, reduced cognitive function, growth, and behavioral problems	Eskenazi and Castorina 1999 Yolton et al 2005
Tooth decay	Increased rate of dental caries in children exposed to SHS	Aligne et al 2003 Shenkin et al. 2004

Maine-specific prevalence rates.[5] The prevalence of asthma in Maine children has been increasing in recent years, and is currently estimated at 11.2% (ME CDC 2005). However, this

[4] This report assumes that the risk estimates for "either parent smoking" provide an accurate proxy for the risk associated with children in Maine that are reported to be regularly exposed to SHS (ME CDC 2005).

[5] Prevalence data is based on a state-wide survey of kindergarten and third graders (ME CDC 2005). This report assumes that prevalence is uniform across the entire underage population, since no other age-specific data source is currently available. Also, due to a low response rate for the survey used, the results can not be considered to be generalizable beyond the population sampled. However, the results were similar to those provided by more robust national surveys of US children under 18 [13% "ever asthma" and 9% "current asthma" (Bloom et al. 2006)], of US high school students [17% "ever asthma" and 14.5% "current asthma" (CDC YRBS 2006)], and of Maine adults [14.1% "ever asthma" 9.7% "current asthma" (CDC BRFSS 2006)].

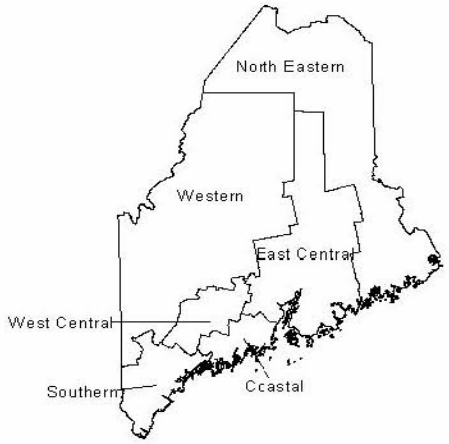
rate varies across regions of the state (see Table 3), with estimates ranging from 9.1% in coastal Maine (Knox, Lincoln, Sagadahoc counties), to 14.4% in western Maine (Franklin, Oxford, Piscataquis, Somerset counties). Similar trends are identified for wheeze: 8.9% of children had current wheeze; in the past year and as a result of wheezing, 19% (5%) had one or more doctor's (emergency room) visits, 13% had experienced sleep disturbances, 9% reported being wheezy after exercise, and 14% had experienced at least one wheeze attack (ME CDC 2005).

There are also significant differences in asthma and wheeze prevalence across healthcare coverage types. Approximately 29.5% of children in the state are in the MaineCare program (ME CDC 2005), and these children are more likely to have and receive healthcare services for asthma and wheeze based on insurance claims and hospitalization rates (ME DHHS 2002a), which is not surprising given the high rate of smoking among the adult MaineCare population (43%; ME DHHS 2005).

Table 3: Prevalence of SHS exposure and asthma prevalence by region

	Current Asthma	Current Wheeze	Regular SHS Exposure
Total	**11.2**	**8.9**	**25.7**
Western	12.8	10.1	34.8
North Eastern	12.8	12.0	31.1
West Central	9.9	10.1	29.3
East Central	14.4	8.1	23.3
Coastal	9.1	7.7	21.9
Southern	9.6	6.6	17.5

Source: ME CDC 2005



There is currently no state-wide surveillance system to determine the prevalence of other SHS-related chronic illnesses, such as OM and pneumonia (ME DHHS 2002b). To estimate the prevalence of pneumonia among children in Maine, it is assumed that preschool children in the state contract the disease at the national average (4%).[6] Finally, an estimate of OM prevalence in Maine is determined using comparative national statistics, which suggest that nearly half of all infants have an episode of OM before reaching the age of one, with the number increasing to 80% before the age of three.[7] This report assumes that 40% of children under the age of five will have between one and two cases of OM annually. Although the causal association between SHS and pneumonia and OM is not limited to children under the age of five, these cost estimates do not incorporate them due to the absence of data on the prevalence of these illnesses in the

[6] Online source: http://www.usaweekend.com/05_issues/050313/050313health_coughs.html. Accessed on 9/1/07.

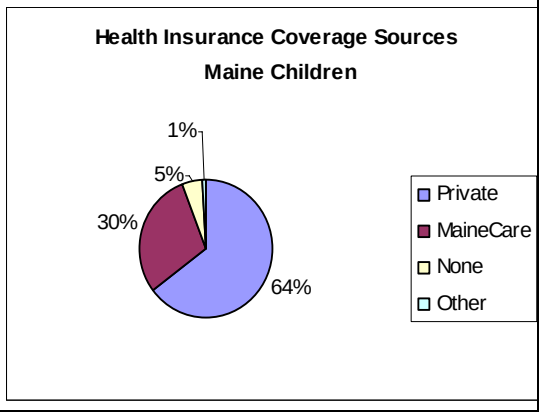
[7] Online source: http://www.emedicine.com/EMERG/topic351.htm. Accessed on 9/1/07.

older group. For this reason, the estimates provided in this report should be viewed as conservative with respect to both OM and pneumonia.

Table 4: Prevalence of SHS exposure and asthma prevalence by health insurance coverage

	Current asthma	Current Wheeze	SHS exposure rate
Private	9.5	7.7	15.1
MaineCare	15.1	11.6	47.2
None	5.4	9.0	38.5

Source: ME CDC 2005



Exposure to SHS

Exposure to SHS in children can be identified in a number of different ways. The first and most often used method is with survey data, which relies on self-reporting to determine exposure rates. SHS has also been identified by monitoring smoke concentrations in the home or other micro-environments such as vehicles, or more directly through biological sampling of nicotine and cotinine levels that identify exposure to SHS in serum plasma, urine, saliva, and hair samples. These different methods of exposure characterization have generally provided similar results, although direct measurement is usually preferable (Marbury et al. 1993).

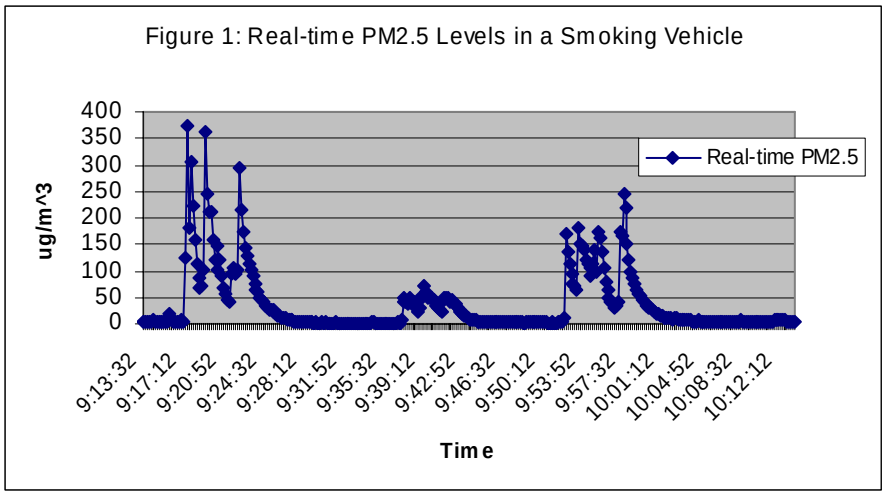
According to a recent survey of adult smoking rates in Maine (ME DHHS 2005), 21% of adults smoke and 43% of smokers have children. The adult smoking rate is slightly above the national average of 20%, although this difference is not statistically significant (CDC BRFSS 2006). Smoking rates are higher among low income groups, those without health insurance, and the less educated. An estimated 43% of adult Medicaid recipients in the state are current smokers (ME DHHS 2005). SHS exposure to children has been on the decline in recent years (Soliman et al. 2004), although children continue to be exposed to SHS at rates much higher than non-smoking adults. Measured cotinine levels have been found to be two times higher on average in children than in nonsmoking adults (SG 2006), and children are also significantly more likely than adults to live in a household with at least one smoker (SG 2006). Children of smokers are especially susceptible to the ill effects of SHS exposure, since they are unable to withdraw from a smoking setting and are exposed over extended time periods in both the home and in vehicles. Maternal smoking has often been identified as a primary driver of child exposures to SHS, likely the result of the increased level of interaction between mother and child.

National surveys indicate that between 35% and 43% of US children are currently exposed to SHS in the home (Pirkle et al. 1996; Shuster et al. 2002; Gergen et al. 1998). In a study conducted in the late 1980s of 500 households with infants in the Portland area (Chilmonzik et al. 1990), 55% of infants lived in a house with at least one smoking member, and 27% of

mothers smoked. The level of urinary cotinine was 27 times higher in infants living in smoking homes (both parents smoke) versus infants living in a nonsmoking environment. Elevated exposure levels have also been noted in children where the smoking parent actively seeks to reduce child exposures by smoking outdoors only. SHS exposure was still five to seven times higher on average than completely non-smoking homes (Matt et al. 2004).

Based on a recent report of school age children in the state (ME CDC 2005), 25.7% of Maine children are currently exposed to SHS on routine basis. Tables 3 and 4 show the different rates across regions of the country and health insurance status. Similar to the asthma prevalence rates, the highest regional SHS exposure rates are noted in western Maine (34.8%), and the lowest exposures in coastal and southern Maine (9.1 and 9.6%, respectively). SHS exposure rates were three times higher for children on MaineCare (47.2%) than those receiving private insurance (15.1%).

Exposure patterns in vehicles. Based on a national survey of time activity patterns (Leech et al. 2002), US children spend around one hour per day in a vehicle. In 2006, 39.2% of Maine youth (grades 6-12) reported being exposed to smoking in cars at least one day during the previous week (MYDAUS 2006). The prevalence of smoking in cars has been shown to be higher among economically disadvantaged populations, putting children from low income families at greater risk (Martin et al. 2006). Although smoking in cars represents a relatively low proportion of the time spent exposed to SHS for children, the nature of the vehicle exposure setting, i.e., small enclosed space and low rate of air exchange, can lead to dangerously high exposure levels well in excess of the acceptable limits in place to protect human health.



To illustrate this, continuous levels of respirable suspended particulates less than 2.5µm in diameter ($PM_{2.5}$; DustTrak™ Aerosol Monitor) were monitored during an approximately 50 mile car trip from Bar Harbor to Bangor. To simulate a routine exposure scenario for a child, a monitor was taped to the middle of the back seat at the approximate position of a child's head in a car seat. After a baseline period of four minutes, a cigarette was lit (and smoked) on three separate occasions during the trip with the window partially open. After each smoking period, the window was closed until a new cigarette was lit. The vehicle tested was a 2006 Toyota Matrix, with an EPA passenger volume of 96.2 cubic feet reported by the manufacturer. The air conditioning was also running on low during the entire trip so that there was a continual recycling of air during both the smoking and nonsmoking periods. Figure 1 graphs the real-time exposure levels during the one hour car ride. The first and third cigarettes were smoked by the passenger (in the front passenger

seat), and the second cigarette was smoked by the driver. Average baseline levels of around 4μg/m^3 were observed throughout the non-smoking periods. Elevated concentrations were observed during each of the smoking periods, with about a four minute lag of high concentrations after each cigarette was extinguished. $PM_{2.5}$ concentrations peaked to 375μg/m^3 when the first cigarette was lit by the passenger, and average smoking period concentrations were 150μg/m^3, 40μg/m^3, and 100μg/m^3, respectively. Significantly lower exposures were observed when the driver smoked, which is likely indicative of outdoor wind patterns favorable for transport outside the left side of the vehicle.

For comparison purposes, the 24-hour standard for $PM_{2.5}$ is 35μg/m^3 (US EPA 2007a), while concentrations above 100μg/m^3 are listed as "unhealthy for sensitive groups" such as children, and values above 200μg/m^3 are noted as "very unhealthy" for all groups (US EPA 2007b). Given the conditions of the experiment, i.e., slightly open window during the smoking period, relatively large inside air volume, and air conditioning running throughout, these observations are likely to represent a low estimate of typical exposures for children in Maine riding in a vehicle with one or more smoking adults. This is particularly true during colder temperatures when the windows would remain shut and air exchange inside the vehicle would be more limited. The significant differences in $PM_{2.5}$ concentrations observed across smokers from the right and left side of the vehicle suggests that external conditions are important predictors of in-vehicle exposures.

A more rigorous characterization of in-vehicle SHS exposures was performed in the Boston area (Rees and Connolly 2006) using forty-five independent driving trials under various operating conditions. In-vehicle exposures to $PM_{2.5}$ were significantly elevated over baseline during both the smoking and post smoking periods, and was highest under the "closed" ventilation condition (only the driver side window was slightly open). Average $PM_{2.5}$ concentrations were 272 μg/m^3 (closed) and 51 μg/m^3 (open), with peak levels of 505 μg/m^3 (closed) and 104 μg/m^3 (open). These concentrations were similar to levels observed in smoking pubs, with average $PM_{2.5}$ in this adult microenvironment reported to be between 200 and 412 μg/m^3 (Rees and Connolly 2006). Another study was recently released that examined the rate of air exchange and subsequent SHS exposure in vehicles in California (Ott et al. 2007). This research concluded that vehicle speed, ventilation settings, and window positions were all important mitigating factors for in-vehicle SHS exposure. Opening a single window substantially reduced SHS exposure, although infiltration from outside pollution sources would be expected to be higher under this scenario (Davis et al. 2007). With the air conditioning on and the windows closed, $PM_{2.5}$ concentrations peaked above 2000 μg/m^3 when smoking was present, and the average concentration from a single cigarette was 1113 μg/m^3 over a half hour period.

Healthcare Cost of SHS-related Illnesses

The CDC has estimated that Maine spends an annual $169 million on smoking-related medical costs for adult Medicaid recipients alone (ME DHHS 2005), with overall expenditures on smoking attributable illnesses for all insurance types estimated to be around $470 million annually (SAMMEC 2007). However, these estimates include only the costs of smoking-related illnesses in current or former smokers, such as treatment and loss of life from lung cancer,

emphysema, etc., and exclude the effects of SHS exposures to non-smoking adults and children that are the focus of this report.

The cost estimates derived here are limited to the smoking attributable fraction of asthma, wheeze, pneumonia, and OM in children. Although there is a widely recognized causal relationship between the severity of asthma and other non-asthma respiratory symptoms such as cough, breathlessness, and phlegm, in addition to bronchitis, these adverse health outcomes are difficult to quantify from both a health and economic standpoint. There is currently no surveillance system in place to monitor the prevalence of such chronic conditions in Maine (ME DHHS 2002b). For this reason, these symptoms are grouped together under the wheeze category described below.

Since Maine has one of the highest asthma rates in the nation (ranks 5th for adults currently diagnosed with asthma; CDC BRFSS 2006) there have been recent efforts in the state to collect data on this disease (ME DHHS 2002a). There have also been studies on the overall cost burden of asthma nationally (Weiss et al. 2000), which this study draws from to generate asthma cost estimates. The direct healthcare costs of asthma (hospital inpatient stays, emergency room visits, outpatient care in hospitals and doctor's offices, and medications) are estimated to be $552 annually (Weiss et al. 2000). This estimate is comparable to that observed in an earlier study using similar methods ($578; Lozano et al. 1997). The indirect cost of asthma care, including time missed from work (parents/caregivers), time missed from school (children), and increased morbidity/mortality, adds approximately 62% to the direct costs, for a total of $895 (Weiss et al. 2000).

The direct cost estimates of wheeze, pneumonia, and OM are derived using the Medical Expenditure Panel Survey (MEPS 2004)[8] using the category for "acute bronchitis and upper respiratory infections" ($246 per case) to estimate wheeze-related costs, the "pneumonia" category to estimate costs related to this illness ($3,886), and the otitis media category to estimate costs related to OM ($466). The construction of the wheeze category assumes that a child diagnosed with current wheeze symptoms is likely to suffer on average two respiratory infections during a given year, or that their wheeze symptoms would prompt an annual level of care similar to that received for these other illnesses. For OM, the cost estimate accounts for annual per person expenditures, where each person typically experienced between 1-2 events per year. For these non-asthma SHS-related illnesses, the indirect healthcare costs were assumed to be proportional to those reported for asthma (Weiss et al. 2000; increase of 62% above direct costs). All cost estimates are adjusted for inflation to represent 2007 dollars.[9]

[8] This cost data is not specific to children, and many of the attributable illnesses are known to be higher for younger age groups. For example, children under the age of four are significantly more likely to be hospitalized for asthma-related illnesses, increasing the relative costs for this age group (ME DHHS 2002a).

[9]Source: Consumer Price Index, US Department of Labor, Bureau of Labor Statistics (http://www.bls.gov/cpi/)

Economic Impact of SHS in Maine

Data on the health risks associated with SHS exposures from Table 1, as well as the Maine-specific exposure rates in the general population from Tables 3 and 4, were used to calculate the percentage of annual cases in Maine attributable to SHS using the following formula (Breslow and Day 1980):

$$\text{Smoking Attributable Risk} = \frac{\text{Prevelance}_{SHS} * (RR - 1)}{1 + \text{Prevelance}_{SHS} * (RR - 1)}$$

RR equals the relative risk[10] of the health condition associated with exposure to SHS, and assumes that RR is approximated by the odds ratios presented in Table 1.[11] Tables 5 and 6 below provide the estimates for the expected number of cases per year attributable to SHS and the projected cost of care (direct and indirect).

Table 5: Smoking Attributable Fraction and Total Healthcare Costs*

	Total number of expected cases** (all causes) per year†	% of cases attributable to SHS	Total number of attributable cases per year	Total treatment cost per case/person‡	Total annual cost attributed to SHS
Asthma	30,937	8.7%	2,692	$895	$2,409,340
Wheeze (under 5)	11,956	12.4%	1,483	$398	$590,234
Wheeze (5 and over)	37,212	5.8%	2,158		$858,884
Pneumonia (under 5)	2,687	12.2%	328	$6,284	$2,061,152
Otitis Media (under 5)	26,868	11.0%	2,956	$721	$2,131,276

*All cost estimates rounded to the nearest dollar and adjusted for inflation to represent 2007 dollars.
**For asthma, a case represents a child with the diagnosis; for the other illnesses, it is the presence of the condition (could occur multiple times per year)
†Calculated using population size data from the US Census Bureau (2005 American Community Survey): 276,219 total underage population (<18); 67,169 total preschool population (<5); 209,050 total school age population (between 5 and 17).
‡Asthma costs taken from Weiss et al. 2000, all other costs taken from MEPS 2004.

Asthma. Calculation of the overall smoking attributable fraction suggests that 8.7% of all asthma cases in Maine children can be attributed to SHS exposure. Based on an estimated asthma prevalence rate of 11.2% (ME CDC 2005), approximately $2.4 million of the annual costs can be attributed to SHS exposure. Similar calculations were done by insurance coverage type[12]. Due to a higher exposure rate to SHS (47.2%) and asthma prevalence (15.1%) in children receiving MaineCare, the smoking attributable fraction increases to 14.9%. Using the lower SHS exposure rates estimated for both the privately insured and those with no insurance,

[10] Relative risk defined as the probability of disease in children exposed to SHS divided by the probability of disease in children not exposed to SHS.

[11] For justification of OR≈RR, see Pagano and Gauvreau 2000.

[12] Only direct expenditures are examined since these are the only expenses the state would be expected to cover for illnesses (MaineCare does not cover the cost of time missed from work, transportation, and other related expenses).

approximately 5.3% and 12.5% of asthma cases in these groups can be attributed to SHS exposure, respectively.

It is widely recognized that persons with asthma utilize a higher level of healthcare resources than those without asthma for non-asthma conditions as well. For example, asthma sufferers generally experience nearly double the rates of medication usage, emergency room visits, and doctor visits for all conditions. Given these differences in healthcare utilization patterns, and viewing the cost of asthma as the total differential between the cost of care for asthma and non-asthma sufferers for all illnesses,[13] the SHS-attributable cost estimate for asthma alone jumps to over $6 million dollars per year (data not shown).

Table 6: Smoking Attributable Fraction and Total Healthcare Costs by Insurance Coverage*

		Total number of expected cases (all causes) per year**	% of cases attributable to SHS	Total number of attributable cases per year	Total treatment cost per case/person (direct only)	Total annual cost attributed to SHS
Asthma	MaineCare	12,304	14.9%	1833	$552	$1,011,816
	Private	17,004	5.3%	901		$497,352
	None	716	12.5%	90		$49,680
Wheeze (under 5)	MaineCare	4,598	20.6%	947	$246	$232,962
	Private	6,704	7.7%	516		$126,936
	None	580	17.5%	102		$25,092
Wheeze (5 and over)	MaineCare	14,308	10.2%	1,459		$358,914
	Private	20,862	3.5%	730		$179,580
	None	1,806	8.5%	154		$37,884

*Estimates represent **direct costs** only; group-specific RR's and SHS exposure rates are used to calculate the attributable fraction; OM and pneumonia not included due to lack of prevalence data by insurance status
**Estimated population sizes: 81,485 for MaineCare, 178,990 for privately insured, and 13,259 for none.

Wheeze. Using the same methods to calculate the smoking attributable fraction for wheeze-related respiratory conditions in preschool and school-age children, approximately 12.4% and 5.8% of wheeze can be linked with SHS exposure, respectively. The differences in the estimates by age group is driven by the differential health risks associated with exposure to SHS (higher for the under 5 group). These numbers increase to 20.6% and 10.2% for the MaineCare population. Assuming that current wheeze status is indicative of an average of two respiratory illnesses in a given year, the total smoking-attributable costs are nearly $1.5 million per year. Given the higher rate of current wheeze in the MaineCare population (11.6%) and the greater exposure to SHS (47.2%), expenses for this population alone account for approximately 65% of the direct costs.

Pneumonia. Based on pneumonia risk estimates for preschool age children derived from the medical literature and the current overall SHS exposure rate for Maine children, the smoking attributable fraction of pneumonia cases is 12.2%. Using the reported healthcare costs associated with pneumonia cases, total SHS-attributable costs are over $2 million per year. These costs are not broken down for the MaineCare population, since there is currently no data available on the

[13] Total cost differential of $2,540 provided by the Maine Lung Association; study population restricted to those with private health insurance.

prevalence of pneumonia in Maine children by health insurance status, i.e., no way to derive the total number of expected cases (all causes) per year. However, one would expect pneumonia costs to follow the same pattern as asthma and wheeze.

Otitis Media. Based on the reported relative risks derived from the medical literature, as well as the cost of the condition, 13% of all OM cases are attributable to SHS, with an estimated direct healthcare cost of over $2.1 million per year. As is the case for pneumonia, these estimates are not broken down by healthcare coverage types since this data is not currently available.

Conclusions

This report provides a healthcare cost assessment of the burden of SHS exposure in Maine children, and estimates that $8-$11.5 million is spent annually on attributable illnesses. In general, 6-12% of childhood illnesses examined can be attributed to SHS exposure, while this range jumps to 10-21% for MaineCare children. These cost estimates and smoking attributable fractions were derived only for childhood illnesses where the scientific evidence is very strong (respiratory illnesses and otitis media), and excludes the effects of other health conditions suspected to be related to SHS exposure in children. These estimates also exclude the potential lifetime impacts of chronic exposure to SHS such as developmental abnormalities and cancer, which are potentially very large. The results suggest that a significant fraction of the total economic costs are paid by the state through the MaineCare program. Although this program insures less than a third of children in the state, it is responsible for 65% of the direct SHS-related healthcare costs. These inflated costs for MaineCare children are due to higher rates of SHS exposure and greater prevalence of asthma and wheeze.

These results represent the economic burden from childhood exposure to SHS from a primary caregiver, and are not limited to in-vehicle exposures alone. Although SHS exposure in cars represents a small fraction of the potential time profile of exposure for children, due to the smaller space and decreased rate of air exchange inside a vehicle, this exposure setting can reach dangerously polluted levels. These conditions would be expected to worsen in the colder temperatures due to decreased ventilation (closed windows), making children in Maine especially susceptible to the adverse conditions. For a child with asthma, chronic wheeze, recurrent otitis media, or other illness exacerbated by SHS, a car likely represents the most damaging exposure scenario in terms of symptom exacerbation. As shown in the example car trip from Bar Harbor to Bangor, particulate levels observed in smoking vehicles are high enough to prompt public health warnings, and are similar to pollution levels observed in smoky adult bars. The state has recognized the public health concern for non-smoking adults by banning smoking in bars, while nearly one-quarter of Maine's children remain exposed to similar levels in vehicles on a regular basis.

Finally, this report highlights the need for further data collection and research in this area. With the exception of recent data collection efforts for asthma and wheeze (ME DHHS 2002a; ME CDC 2005), there is currently no ongoing state-wide surveillance system in place to monitor other chronic diseases relevant to SHS exposure in either children or adults. For this reason, rough conservative estimates using only the preschool age population were made for pneumonia

and OM based on national averages. In order to more accurately quantify the health and economic impact of these and other chronic diseases in children, especially as it relates to SHS, more effort must be made at the state level to characterize the prevalence of these conditions in the current population. Improving the accuracy of the data for both the prevalence of SHS-attributable illnesses, as well as the cost of care (both direct and indirect), would strengthen the healthcare cost assessment provided in this report. However, the repeated conservative assumptions made in this report make it highly likely that the identified costs represent a lower bound estimate of the total economic burden of SHS-related illnesses in Maine children.

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