# Economic Assessment of Children's Health and the Environment in Maine

by Mary E. Davis

*Reducing children's exposure to environmental toxins is important for both moral and economic reasons. Mary Davis discusses the economic impact of environmentally related childhood illnesses in Maine, focusing on disease categories with fairly strong evidence connecting environmental pollution to childhood diseases: lead poisoning, asthma, neurobehavioral disorders, and cancer. Lead poisoning and neurobehavioral conditions are the most expensive because they lead to chronic diseases that are largely incurable and not easily treated. She concludes that state funding for initiatives aimed at reducing childhood exposure to environmental pollutants "would be money well spent."*

## INTRODUCTION

Children in Maine today are growing up in an environmental landscape that is significantly altered from that of either their parents or grandparents. More than 80,000 synthetic chemical compounds have been created over the past 50 years in the U.S. alone, and information on the health effects of the vast majority of these chemicals is scarce to nonexistent, especially with respect to their impact on children. The proliferation of environmental toxics has been accompanied by an equally striking change in the pattern of childhood illnesses, termed the "new pediatric morbidity," which has emerged in U.S. children and across the developed world (Landrigan et al. 2002). These changes represent a shift from infectious diseases and genetic abnormalities to illnesses related to an environmental cause or stressor. Childhood diseases are now more often the result of a combination of factors, including both environmental triggers and genetic susceptibility. Maine children appear to be no exception to this alarming health trend, and actually suffer disproportionately from many preventable diseases when compared to children from other parts of the country (Davis 2009).

Reducing childhood exposure to environmental contaminants is important for a number of reasons. Certainly, there is a moral imperative to protect our most vulnerable citizens, and children are typically unable to make informed decisions on their own to limit exposure to toxic chemicals. Equally important is the fact that children are also more susceptible than adults to environmental pollutants due to their developing organ systems and small size, along with their unique activity patterns (crawling and hand to mouth contact) and exposure pathways (breast milk and placenta). In response to this emerging health threat, Maine passed the Toxic Chemicals in Children's Products Law in 2008 (38 MRSA Ch. 16-D) to identify and regulate some of the worst toxic chemicals that threaten Maine children. The "Kids Safe Product Law," as it is also known, built upon previous legislative efforts that established limits on lead content in children's products (PL 2007 Ch. 604). The 2008 legislation is modest in its scope, given lack of resources, and is limited to products to which children are exposed. Although there is certainly a larger moral question involved in protecting our children, it is also important to evaluate the economic benefit of improving health outcomes. These cost savings are directly relevant to the state's investment in the process that the Maine legislature has set into motion.

This article seeks to outline the potential economic impact of environmentally related childhood illnesses in the Maine by focusing on several disease categories where the scientific evidence connecting environmental pollution to childhood diseases is relatively strong. These numbers represent the potential cost savings if environmental exposures were eliminated in Maine children, which is admittedly unlikely to occur even under the strongest legal protection framework. However, the severity of the negative health impact from environmental exposures is still largely unknown and our understanding of this topic is constantly evolving. Therefore, the current economic cost analysis is more likely to underestimate the true impact and should be updated as the scientific evidence becomes clearer.

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## ECONOMIC COST OF POLLUTION

The economic cost estimates outlined here are derived using the approach outlined in Landrigan et al. (2002) and Davis (2007 and 2009). [For a detailed description of the cost approach and data see these earlier papers.] Briefly, the disease rate and size of the population at risk are combined to provide an estimate of the total number of children suffering from a given disease regardless of the source, which is in turn multiplied by the percentage of those cases that are likely attributable to environmental causes.

**TABLE 1: Elevated Blood Lead Levels (EBLLs) and Pre-1950 Housing Units by County**

| County | Number Screened* | Number EBLL* | Percentage EBLL* | Percentage Pre-1950 Housing Units** |
|---|---|---|---|---|
| Androscoggin | 6,674 | 149 | 2.2 | 41.6 |
| Aroostook | 3,916 | 10 | 0.3 | 39.4 |
| Cumberland | 12,888 | 173 | 1.3 | 36.9 |
| Franklin | 1,828 | 22 | 1.2 | 32.1 |
| Hancock | 2,329 | 28 | 1.2 | 35.4 |
| Kennebec | 6,338 | 64 | 1.0 | 35.3 |
| Knox | 1,549 | 41 | 2.6 | 44.0 |
| Lincoln | 1,088 | 10 | 0.9 | 38.1 |
| Oxford | 4,098 | 45 | 1.1 | 36.8 |
| Penobscot | 8,195 | 95 | 1.2 | 34.6 |
| Piscataquis | 968 | 20 | 2.1 | 35.2 |
| Sagadahoc | 1,976 | 25 | 1.3 | 36.5 |
| Somerset | 3,915 | 44 | 1.1 | 34.2 |
| Waldo | 1,699 | 18 | 1.1 | 32.1 |
| Washington | 2,408 | 26 | 1.1 | 38.0 |
| York | 9,616 | 139 | 1.4 | 29.8 |
| State Average | 69,715 | 913 | 1.3 | 35.8 |

*EBLLs based on data obtained from ME Childhood Lead Poisoning Prevention Program for children < 72 months of age (data collected between 2003 and 2007).

**Source: CDC 2008

This number is then multiplied by the cost per case (in 2008 dollars) to provide an overall estimate of the economic burden of childhood diseases attributable to environmental causes in the state. These cost estimates are limited to four broad disease categories, including lead poisoning, asthma, cancer, and neurobehavioral conditions. The last category is further broken down into subcategories for mental retardation, autism, ADD/ADHD, and cerebral palsy. Maine-specific data relevant to the health risks, economic impact, and environmental exposures were used wherever possible, while national data were substituted when Maine-specific information was unavailable.

## *Lead Poisoning*

Lead exposure in children can lead to significant health consequences, including brain and kidney damage, anemia, and death at very high levels of exposure (National Research Council 1993). In response to these negative health effects, much has been done over the past few decades to reduce lead exposure in children and consequently blood lead levels have declined significantly over this time period, including in Maine. Despite the reductions in lead exposure among children, however, subtle neurological and cognitive impairments remain at the comparatively low exposure levels observed today.

Children living in old homes are especially susceptible to lead exposure through residual lead paint (air and dust) and contaminated water (lead pipes) and soil. According to the Centers for Disease Control and Prevention (CDC) (data provided in Table 1), 35.8 percent of Maine houses were built prior to 1950 at a time when lead paint and piping was commonly used, compared with the national average of 22.3 percent. Also, a recent study of the Portland peninsula provided evidence of urban soil contamination from historical industrial activities along with residual lead from gasoline and paint sources. The study reported that nearly 100 percent of the properties sampled in the area had lead concentrations in excess of the EPA recommended public health levels (Wagner and Langley-Turnbaugh 2008).

The Maine Childhood Lead Poisoning Prevention Program provided data on the percentage of children tested in the state with elevated blood lead levels (see Table 1). Although the technical definition of elevated blood lead levels (EBLLs) in children establishes a benchmark of 10 µg/dL, substantial evidence has accrued to suggest that the negative health effects can be seen at even lower levels and that there is no safe amount of lead exposure in children.[1] These small and often difficult-to-detect changes in cognitive function related to low-level lead exposure have been shown to affect school performance, educational attainment, IQ scores, and ultimately the lifetime job prospects and earning potential of exposed children. In particular, the association between lead exposure and IQ and earnings is well established in the scientific literature (Landrigan et al. 2002).

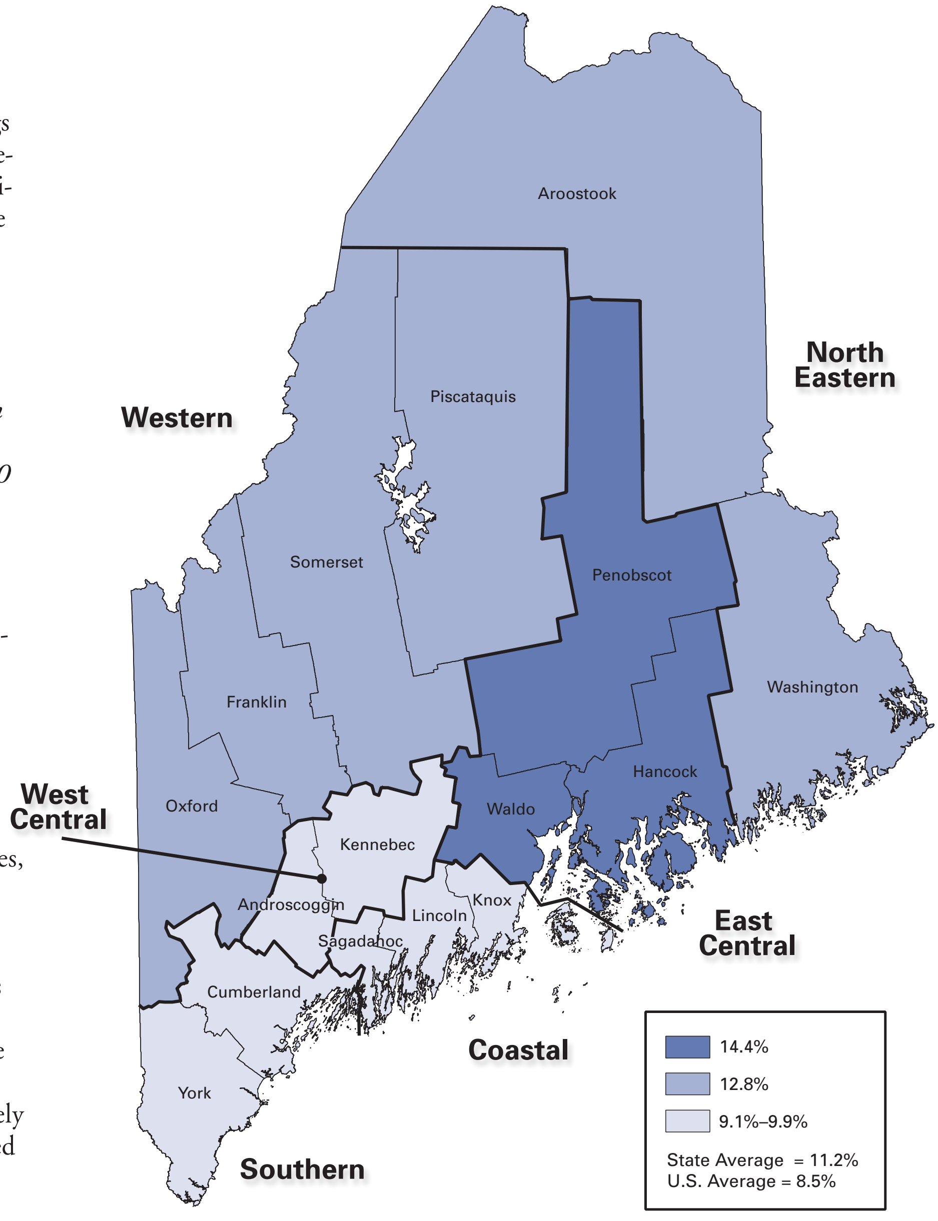
Following this reasoning, the cost estimates for childhood lead poisoning in Maine are conceptualized as a decrease in the expected earnings due to IQ loss. These costs will accrue over a lifetime and will materialize in forgone wages associated with lower mental abilities. Therefore, these estimates are indicative of lost *potential* in the current birth cohort and exclude the additional cost of actual direct or indirect expenditures for disease treatment and abatement. *At current levels of lead exposure, each new cohort of babies born in Maine annually will suffer on average a one-point loss in IQ score and as a result can expect to earn as an aggregate $270 million less over their lifetimes.*

## *Asthma*

Asthma is the most prevalent illness in children and the most common cause of childhood hospitalizations (Landrigan et al. 2002). The national rate of asthma among children doubled between the years of 1980 and 1995 (from 3.6 percent to 7.5 percent) and is currently estimated to be 8.7 percent. Exposure to outdoor and indoor air pollutants, including household chemical products and pesticides, has been associated with the both the onset and severity of asthma in children (U.S. IOM 2000). There is also growing evidence to suggest that chronic exposure to air pollutants such as ozone and particulate matter are causally related to decreased lung function and the development of asthma in children. Overall, the available science suggests that approximately 30 percent of all asthma cases can be attributed in some way to the environment (Landrigan et al. 2002).

The prevalence of asthma in Maine children has been increasing in recent years and is currently estimated at 11.2 percent (Tippy 2005). Maine has one of the highest asthma rates in the nation and ranks fifth for adults currently diagnosed with asthma. The asthma rate varies across regions of the state (see Figure 1), with estimates ranging from 9.1 percent in coastal areas to 14.4 percent in east central Maine. The prevalence of asthma is higher in the MaineCare population (15.1 percent compared to 9.5 percent for privately insured children). The cost of caring for children with asthma in Maine was derived from a recent study that incorporated both the direct

FIGURE 1: **Asthma Prevalence by Region of the State**




Source: Tippy 2005

health care costs (e.g., emergency room visits, medications, etc.) along with the indirect cost of care, such as parental time missed from work (Davis 2007). *Out of the more than 30,000 children with asthma in Maine, approximately 9,000 of these cases can be linked to environmental causes. The total cost of these environmentally attributable asthma cases is $8.8 million every year.*

### *Neurobehavioral Disorders*

Neurobehavioral disorders affect between three percent and eight percent of infants born in the U.S. each year, and 28 percent of these conditions can be linked either directly or indirectly to environmental factors (U.S. National Research Council 2000). Of the approximately 80,000 chemicals registered for commercial use with the EPA, more than 200 have been shown to have neurotoxic effects in adults, and a handful of others (lead, methylmercury, polychlorinated biphenyls [PCBs], arsenic, and toluene) have been clinically proven to cause neurodevelopmental disorders in children. The developing brain is highly susceptible to environmental exposures, much more so than fully formed adult brains. The neurological development process that begins *in utero* continues after birth, and if any stage of development is impeded during this process, the effects are often permanent. The placenta is not an effective shield against most neurotoxins, and the blood-brain barrier that protects adults is not fully formed until about six months of age.

Over last 10 years, the number of Maine children receiving special education services related to neurological impairment has been increasing, and nearly one in five public school students now receives special education services from the state (Maine DOE 2008a). The total cost to provide those services has been growing at 6.7 percent per year, and was estimated to be nearly $300 million in 2006 (Maine DOE 2008b). Although overall student enrollment has declined, the share of special education students has increased from 12.7 percent in 1986 to 17.7 percent in 2007 (Maine DOE 2008a). Growth in the number of special education students categorized as autistic is especially alarming, increasing 58.6 percent over the last three years of available data (2004–2007) (Maine DOE 2008c).

**Table 2: Developmental Disability as a Percentage of Total Enrollment (2006)**

| Disability Category | Total Number of Students | Percentage of Total Enrollment (n = 194,232) |
|---|---|---|
| Mental Retardation | 798 | 0.4 |
| Speech and Language Impairment | 8,612 | 4.4 |
| Emotional Disability | 2,943 | 1.5 |
| Other Health Impairment | 5,528 | 2.9 |
| Specific Learning Disability | 10,053 | 5.2 |
| Multiple Disabilities | 3,082 | 1.6 |
| Developmentally Delayed | 888 | 0.5 |
| Autism | 1,990 | 1.0 |
| Total | 33,894 | 17.5 |

Source: Maine DOE 2008c

Table 2 provides a list of special education enrollment in the relevant disability categories.

Although recent evidence suggests that up to 28 percent of neurobehavioral conditions are attributable to the environment, or non-genetic factors, this paper uses 10 percent as a conservative downward adjustment to exclude potential double counting with lead poisoning cases (which also cause neurological impairment) and those related to substance abuse such as fetal alcohol syndrome. The current estimate also controls for double counting across the four neurological disease categories.

Neurological disorders that result from environmental exposures represent lifelong challenges for affected children, and future cleanup will not improve the health of children already suffering from a condition. For this reason, the estimates are derived for each birth cohort, i.e., the numbers represent the expected impact at current exposure levels on the group of children born in Maine each year. The cost of caring for children with neurobehavioral conditions in Maine was derived from a recent study that estimated health care costs associated with each of the four disease categories—mental retardation, cerebral palsy, ADD/ADHD, and autism—and included the costs of special education services (Davis 2009). *Based on the available information, the economic costs associated with environmentally attributable cases of these four neurobehavioral conditions in Maine total more than $100 million annually.* This estimate includes the ballooning cost of special education expenditures in the state, along with the costs related to lifetime treatment and care for attributable cases. *Using the less conservative attributable fraction of 28 percent reported by the National Academy of Sciences (NAS 2000b), this cost increases to $325 million per year.* Certainly, the true cost estimate is likely to lie somewhere between these two extremes.

### *Cancer*

Cancer-related deaths in children have been declining over the last 20 years due to medical advances in treatment options. However, the same time period has witnessed a troubling increase in the incidence of childhood cancers, i.e., the number of new cancer cases each year (Landrigan et al. 2002). There is a great deal of uncertainty on the underlying causes of childhood cancer. While the available evidence suggests that no more than 10 percent to 20 percent can be attributed solely to genetic factors, leaving the remaining 80 percent to 90 percent potentially linked to environmental causes, only a small number of toxic chemicals have been adequately researched and definitively linked to childhood cancers. For this reason, the cost calculations used here assume that only five percent of the childhood cancers are related to environmental causes. However, there is growing evidence to suggest that this estimate is overly optimistic, and that a large increased risk of cancer exists especially for leukemia and brain cancers in children with high pesticide and industrial exposures (Schuler et al. 2006).

Based on unpublished data from 1995 to 2004 made available by the Maine Cancer Registry, there are approximately 62 new cases of childhood cancers each year in the state in the under 20 population, with an average of 12 cancer deaths expected annually. More than half of the childhood cancers in Maine can be attributed to leukemia, lymphoma, and cancers of the central nervous system, which correspond to the most frequently occurring childhood cancers nationally. The incidence of childhood cancers in Maine over the 10-year period observed was reportedly 186 per million children, which is higher than the national rate of 164 per million. This translates into an additional six childhood cancers in the state each year when compared with the national average. The elevated incidence of cancer among children is not surprising given that Maine also has the highest incidence of adult cancer in the nation (526.1 per million compared to 458.2 per million nationally).

*At the average cost of cancer treatment of $840,500 and based on the conservative assumption that five percent of all cases will be related to environmental exposures, three children in the state each year are diagnosed with preventable cancer at an annual cost of more than $2.5 million. Under the less conservative assumption that 80 percent to 90 percent of childhood cancers are caused by environmental factors, 44 children are diagnosed with environmentally related cancers each year at an annual cost of nearly $40 million.* Certainly, the true cost estimate is likely to lie somewhere between these two extremes.

TABLE 3: **Total Annual Cost of Environmentally Attributable Childhood Diseases in Maine (in 2008 dollars)**

| Childhood Disease Category | Low-Range Estimate | High-Range Estimate |
|---|---|---|
| Lead Poisoning | $270.0 million | $270 million |
| Asthma | $9.0 million | $9 million |
| Neurobehavioral | $100.0 million | $325 million |
| Cancer | $2.5 million | $40 million |
| Total | $381.5 million | $644 million |

## POLICY IMPLICATIONS AND CONCLUSIONS

The aggregate annual cost of environmentally attributable illnesses in Maine children for lead poisoning, asthma, neurobehavioral conditions, and cancer under the most conservative assumption is estimated to be around $380 million per year (see Table 3, page 41). Under less conservative assumptions, but still validated by the existing health literature, the estimates go as high as $644 million. This suggests a per child cost in Maine of between $1,350 and $2,300 per year. These cost estimates represent both direct health care expenditures and indirect costs related to parental time off work or the reduced lifetime earning potential of exposed children. For this reason, some of the cost will occur immediately while some would be expected to accrue over the lifetime of the affected child.

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Maine children appear to suffer disproportionately from environmentally related illnesses such as cancer and asthma, although childhood exposure to environmental chemicals is not a problem unique to Maine. Other states concerned with this issue have estimated costs using this same approach and have found similar results. The comparable per child cost (in 2008 dollars) was $1,246 in Minnesota (Schuler et al. 2006), $1,015 in Massachusetts (Massey and Ackerman 2003), and $1,317 in Washington State (Davies 2005). On the national level, the Obama adminstration recently recognized the importance of this issue by soliciting Congress to draft tougher chemical regulations that shift the burden of proof regarding the safety of new chemicals to the manufacturers by requiring them to provide health risk-related information to the EPA.

It is interesting to note the relative distribution of costs across the disease categories. Lead poisoning and neurobehavioral conditions make up the lion's share of the total cost estimates. These categories are elevated in part due to the higher costs associated with chronic care, but also because they involve largely incurable diseases that are not easily treated with medication. The numbers for lead poisoniong are further compounded by the fact that all lead exposure in children can be attributed to environmental causes (100 percent). Maine has made great strides in reducing childhood lead exposure by establishing the Lead Poisoning Prevention Fund, resulting in a significant decline in blood lead levels in Maine children over time. Maine spends approximately $2 million per year on lead primary prevention programs, and the evidence presented in this paper suggests that this money is well spent.

Since these cost estimates are limited to a small subset of childhood illnesses, the full impact of environmental exposures in Maine children is likely to be much larger. For example, a recent *Newsweek* (Begley 2009) article reviewed the mounting evidence linking chemical exposure with obesity, a relationship that appears to be especially strong in developing fetuses and children. The scientific evidence is also growing that links endocrine disrupting chemicals in our environment with congenital abnormalities, lower sperm counts, and gender identity disorder. Based on the lack of sufficient data and research on the cumulative and synergistic effects of multiple contaminant exposures, the cost assessment presented here is most likely a conservative one and may understate the true risk to our children. Finally, within the included disease categories such as cancer, there are important and unaccounted for costs such as adult cancers that are related to childhood exposures. Many cancers have a long latency period so would not be expected to materialize until much later in life.

Recent work has been done in the state to address the growing concern about chemicals in consumer products (Governor's Task Force 2007), suggesting that a more comprehensive chemicals policy that promotes transparency and consumer education is necessary. This paper points to a clear economic benefit of reducing childhood exposure to environmental pollutants in the state. Since nearly half of all children participate in

 

MaineCare and the number of students receiving publicly funded special education services is approaching 20 percent, much of the cost of these illnesses is already borne directly by the state (and indirectly by taxpayers).

Finally, it is important to emphasize that all of the economic costs outlined in this report represent preventable childhood illnesses and as such could be fully avoided if environmental exposures in children were eliminated. Beyond the economic impact, the unique susceptibility of children to environmental pollutants and their inability to make informed decisions to limit their risks makes the issue of reducing childhood exposures a moral imperative. Based on these results, it is clear that state funding for health care prevention and protection initiatives such as those aimed at reducing childhood exposure to environmental pollutants would be money well spent.

## ENDNOTE

1. The EBLL 10 μg/dL is a risk management benchmark reflecting both a level of concern for harm and a level at which it is believed intervention will be successful. Although it is not intended to be representative of a threshold level for negative health effects, it is often interpreted as such for policy purposes.

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RS/2010