



NH DIVISION OF  
Public Health Services

Improving health, preventing disease, reducing costs *for all*  
Department of Health and Human Services



# Economic Burden of Environmentally Attributable Illness In Children of New Hampshire



NH Department of Health and Human Services  
Division of Public Health Services  
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July 2014

# Acknowledgments

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## A special thanks to the following for editorial review and input:

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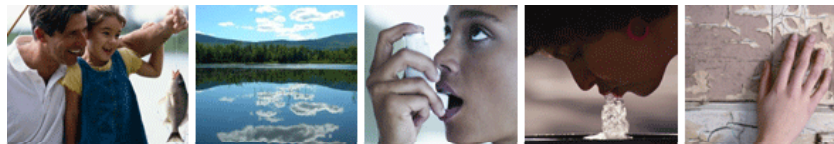
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This publication was supported by grant number #1U38EH000947-01 from the National Center for Environmental Health (NCEH) at the Centers for Disease Control and Prevention (CDC) in Atlanta. Its content is solely the responsibility of the authors and does not necessarily represent the official views of the CDC.



**"Improving Health, Preventing Disease,  
Decreasing Costs for All"**



# Table of Contents

Summary.....	1
Introduction.....	2
Methodology.....	5
Costs of Childhood Asthma.....	7
Costs of Childhood Cancer.....	12
Costs of Childhood Lead Exposure.....	17
Summary of Findings.....	26
References.....	29

# Summary

People who are exposed to environmental contaminants can develop significant health problems. Children are especially vulnerable because their bodies are still growing, they have different diets and behavior, and they have more future years of life. A toddler playing on a porch with flaking and peeling lead-based paint can become poisoned. A teenager with asthma in an environment with poor air quality may have an asthma attack. A child exposed to high levels of radon may develop lung cancer. Environmental exposures can also affect a child's growth and development. These health problems certainly impact the quality of life for children and families but they are also expensive in economic terms. A recent study determined that the costs of childhood illnesses resulting from exposures to environmental pollutants accounted for approximately \$76.6 billion in annual costs in the U.S. [1].

In order to understand the economic impact of environmentally related childhood illnesses in New Hampshire (NH), we estimated the economic costs associated with three environmentally related illnesses in children: asthma, cancer, and lead exposure. Based on previous scientific studies and applied to NH-specific data wherever available, our analyses included the number of

children affected by environmentally attributable illnesses, as well as the annual economic cost associated with these illnesses. Based on our calculations, the total costs were estimated to be \$250.1 million (range \$87.6–\$404.3 million): \$9.0 million for childhood asthma, \$0.74 million for childhood cancer, and \$240.4 million for lead exposure. The sum for these selected childhood illnesses amounted to 2.4% of the 2009 total NH health expenditures for all residents [2] and was equivalent to 0.4% of the 2012 total NH gross domestic product [3].

If environmental exposures and hazards were eliminated, environmentally induced childhood illnesses could be prevented, and the economic costs addressed in this report could be avoided. Information describing the health and economic burden of environmental exposures can inform policies to improve public health. Furthermore, understanding the costs of environmentally related illnesses is necessary when evaluating the costs and benefits of environmental policies, regulations, and remediation efforts. When directing resources toward appropriate prevention efforts, it is critical to estimate the costs of environmentally attributable illnesses in children.

# Introduction

## Children are not little adults

It is often said that “children are not little adults,” and we are only beginning to understand the truth of this statement. Because children are different in physiology and metabolism, have different diets and behavior, and have more future years of life, they are more vulnerable to environmental contaminants than adults [4]. Young children also interact with the environment differently. They spend more time on the ground in contact with dust, soil, water, and other elements of the environment. These environmental exposures have powerful influences on children both in lifelong health and in mental well-being [5]. Childhood health problems from environmental exposures can take years to develop and the impact of these exposures is not well known. Childhood health problems present a large burden to children and care givers, including costs in medical care and quality of life. However, since environmentally related health problems are preventable, it is our mission to protect our children from environmental hazards to ensure they live safer, longer, and healthier lives [6].

## Environmental risks in New Hampshire

Every day, children in NH are exposed to a wide array of environmental hazards including those from industrial activities, traffic, solid waste, fuels used for heating and cooking, secondhand smoke, pesticides, lead, and unsafe drinking water. The specific environmental risks differ depending on the source:

**1 in 5** private wells in New Hampshire have elevated levels of arsenic over 10 micrograms per liter (10 µg/L).

**Long-term, chronic, and low-level exposure to arsenic has been linked to increases in bladder, lung, and skin cancer and cardiovascular disease.**

**23%** of households in New Hampshire had radon test results above the U.S. EPA action level (4 pCi/L).

**Radon is the leading cause of non-smoking related lung cancer in the U.S. Smokers living in high radon homes are at greater risk of lung cancer. Thousands of NH residents are unaware of elevated radon levels in their homes and the silent risk it carries.**

- **Air pollution** – In NH ozone and fine particulate matter (PM<sub>2.5</sub>) are the primary pollutants of concern. Other contaminants, such as nitrogen-oxides and sulfur-dioxide occasionally occur at significant concentrations.
- **Water contaminants** – Arsenic is one of the major issues in drinking water in NH. Nearly one-fifth of private wells exceed U.S. Environmental Protection Agency (EPA)’s maximum contamination level (10 micrograms per liter) for arsenic in water [7]. Lead contamination is also a major concern,

especially when small children are involved. Lead in drinking water comes from the corrosive action of the water (especially soft water) on lead pipes and fittings, galvanized iron pipes and fittings, lead solder, and brass or chrome fixtures [8]. Other contaminants in water include nitrates/nitrites, uranium, radium, atrazine, and disinfection by-products.

- **Soil pollution** – Over 62% of NH’s housing stock was built prior to 1978 when the use of residential lead paint was banned in the U.S. Soil surrounding these homes contains high levels of lead from years of scraping and painting activities. This lead in soil is harmful to children. NH’s soil also contains lead from factory pollution and leaded gasoline in cars. Landfills are other sources of soil pollution. In 2007, NH generated more than 1.7 million tons of solid waste, with 45% going into landfills [9]. Other causes of soil pollution in NH are industrial activities, agricultural activities, and hazardous household products.
- **Housing** – Lead is a common environmental hazard because of NH’s aging housing stock. Lead painted surfaces that are chipping and flaking are a major risk to young children. Children are also at risk for lead contamination in toys, household products, and jewelry. Indoor radon exposure is also a major issue in NH. Over 23% of households had a radon test result above the U.S. EPA action level of 4 picocuries per liter (pCi/L), but only 56% of these households had radon venting systems installed according to a 2012 survey [10]. Secondhand smoke, dust mites, moisture, mold, and rodents are

environmental hazards found in housing are associated with negative health effects including asthma and chemical exposure.

These environmental risk factors can impact childhood health and impair a child’s ability to grow and learn. Health problems also become a financial burden for parents.

### Childhood illness in New Hampshire

NH has a total population of 1.3 million, and about 21% of the population is under 18. Children’s health in NH has improved greatly over the years. According to 2013 Kids Count data, NH was ranked highest in the U.S. for overall child well-being [11]. NH has a lower premature death rate of 3.2 per 10,000 children under the age of 18 in 2012, compared with the national rate of 5.2 per 10,000. The percentage of children with elevated blood lead levels ( $\geq 10 \mu\text{g/dL}$ ) dropped from 2.0% in 2003 to 0.5% in 2012. However, childhood cancer incidence increased by an average of 5.15% per year between 2001 and 2010 [12]. NH’s asthma rate is among the highest in the nation. Childhood asthma prevalence increased by 1.1% between 2007 and 2008.

**10.4%** of children in New Hampshire currently have asthma.

**53** children (0–14 years old) in New Hampshire were diagnosed with cancer in 2010.

**15.9%** of children under the age of 6 in New Hampshire underwent blood lead screening in 2012.



## **Childhood environmental illnesses are costly, yet preventable**

Even though children's health is improving, some environmental challenges persist, and new challenges are emerging. Recent estimates show that the annual cost of environmentally mediated childhood diseases and disabilities in U.S. children in 2008 was \$76.6 billion [1]. Massachusetts estimated costs ranging from \$1.1 to \$1.6 billion annually in 2003 [13]. Maine determined \$380.9 million could be attributed to environmentally related childhood illnesses in 2008 [14]. Since environmentally mediated childhood illnesses can be prevented, these substantial monetary outlays can also be prevented. No studies have previously estimated the costs of environmentally attributable illnesses for NH's children. This report presents economic information associated with environmental illnesses in children based on previous scientific evidence and applied to NH-specific data whenever available.

### **Purpose of this report**

This report estimates the illness burden and economic impact of the following childhood illnesses in NH:

- Asthma
- Cancer
- Lead exposure

Information describing the health and economic burden of environmental exposures can inform policies to improve public health. Furthermore, understanding the costs of environmentally related illnesses is necessary when evaluating the

costs and benefits of environmental policies, regulations, and remediation efforts. It is also critical for directing resources toward appropriate prevention efforts by revealing the estimated costs of environmentally related illness in children. This report provides useful information to policy makers, public health practitioners, health advocates, and others interested in improving children's health. The goal of this project is to make positive impacts on preventing environmental exposure to chemicals, reducing illness burden in children, and ultimately, saving millions of dollars in the state.

This report is part of the National Environmental Public Health Tracking (EPHT) Program's **Economic Burden of Childhood Environmental Illnesses** Project, led by the California EPHT Program. Participant states include California, Connecticut, Florida, Minnesota, New Hampshire, Oregon, and Utah. The EPHT Program provides environmental hazards and health outcomes data and works to identify the relationship between them. Quantifying the burden of childhood conditions, in both direct and indirect costs to the extent feasible, highlights the seriousness of these illnesses and both the economic and human impact on children and society. The report includes information about each illness, such as its connection to the environment, rates, and trends; describes the economic impact of each illness by estimating both direct and indirect costs; and details the methods used to calculate costs.

# Methodology

In this report, the economic burden of environmental illness in NH’s children was derived using the Environmentally Attributable Fraction (EAF) model and research outlined by Landrigan et al. in a national study [15]. This report followed similar efforts by other states to identify state-level costs of environmentally attributable illnesses in children, including Massachusetts [13], Washington [16], Minnesota [17], Oregon [18], Maine [14], and Michigan [19]. Data specific to NH were used when available. If NH data were unavailable, national data were used. Cost data from all sources were adjusted for inflation to reflect 2013 dollars [20].

## Definition of environmental risk factors

The definition of “environment” can include not only the surroundings and conditions that affect the health of a community or individual, but also the physical and social conditions in buildings and neighborhoods. In this report, environmental risk factors were defined as pollutants of human origin in air, water, soil, the home, and community. Other physical substances (e.g., pollen), social factors (e.g., poverty), or individual behaviors (e.g., first-hand exposures from smoking or dietary habits) were excluded from this definition, though these factors can have substantive impacts on the environment, health, and community well-being.

## Environmentally attributable fraction

We used the environmentally attributable fraction (EAF) to determine the proportion of

illnesses likely linked to preventable environmental risks. The EAF was defined as “the percentage of a particular illness category that would be eliminated if environmental risk factors were reduced to their lowest feasible levels” [21]. Expert review panels of prominent scientists and physicians were selected and assembled by Landrigan and colleagues in their 2002 study. These panels determined EAFs to be 30% for asthma (range 10–35%), 5% for cancer (range 2–10%), and 100% for lead exposure [15] (Table1). EAF represents the product of the prevalence of one or more risk factors multiplied by the relative risk of illness associated with the risk factor(s) [21].

**Table 1. Environmental attributable fraction for selected childhood conditions**

Illness/condition	EAF (range)
Asthma	30 % (10–35%)
Cancer	5% (2–10%)
Lead exposure	100%

Source: Landrigan et al. 2002

## Estimating illness burden

Illness incidence and/or prevalence were used to estimate the burden of illness, as well as to calculate cost estimates for children younger than 18 years of age, though exact age classifications vary by illness.

## Estimation of illness costs

The types of costs considered in this study included:



- Direct health care costs: inpatient, outpatient, and emergency room care, physician services, and medications.
- Indirect health care costs: lost work and school days, lost parental wages due to medical needs of the child, and lost future income of the child due to the impact of environmental toxins on intelligence quotient, or IQ.

Previously published estimates of per case direct or indirect costs, or both, were used for lead exposure and childhood cancer. Childhood asthma costs were estimated with the Centers for Disease Control (CDC) Chronic Disease Cost Calculator [22]. We used methodology from Grosse et al. to calculate lifetime economic productivity estimates [23]. Costs relating to legal and social services, childcare costs, and lost productivity due to family illness and care were not considered in this report. Lead exposure estimates did not take into account direct health care costs for screening and treatment or indirect costs such as special education and juvenile justice services.

### **Estimation of illness burden and costs due to the environment**

To estimate the burden of illness due to the environment, the EAF was combined with information on the size of the population at risk, the underlying rate of illness, and the cost per case, expressed as:

$$\text{Costs} = \text{EAF} \times \text{Illness rate} \\ \times \text{Population size} \\ \times \text{Cost per case}$$

### ***The NH Environmental Public Health Tracking (NH EPHT) Program***

- *Developing a secure network for the collection, access, analysis, and dissemination of environmental public health data and information;*
- *Guiding policy, practice, and other actions toward improving the health of New Hampshire residents;*
- *Fostering collaboration among the state's environmental and public health partners.*

*NH EPHT monitors information about environmental hazards and disease trends that may impact children's health, including air pollution, water quality, lead exposure, childhood asthma and cancer. For more information on NH EPHT, visit our data portal at [wisdom.dhhs.nh.gov/wisdom/?s=epht](http://wisdom.dhhs.nh.gov/wisdom/?s=epht)*

*Visit [www.cdc.gov/ephttracking](http://www.cdc.gov/ephttracking) to learn more about the National Environmental Public Health Tracking Program.*



# Costs of Childhood Asthma



## Asthma and the environment

Asthma is a common chronic disease of childhood that affects the airways that carry oxygen into and out of the lungs. Approximately 7 million children aged 0 to 17 in the United States have asthma [24]. The costs of childhood asthma associated with environmental risk factors are estimated to be \$2.2 billion annually [1]. Asthma triggers can come from both indoor and outdoor pollutants and allergens. The common triggers in the home or school environment include secondhand smoke, heating and cooking fuels, wood stoves, pets with fur or feathers, dust mites, molds, and pests, such as mice and cockroaches. The major outdoor environmental risk factors include pollens and air pollutants, including ground-level ozone ( $O_3$ ), fine particulate matter ( $PM_{2.5}$ ), nitrogen oxide (NO), and sulfur dioxide ( $SO_2$ ) [25]. According to the U.S. EPA AirCompare report, 2013 air pollution levels were unhealthy for sensitive groups (which includes children) a total of three days in Cheshire County, two days in Coos County, and one day in Rockingham County [26]. Some of these days occurred during the

winter months (November–March), but on average NH tends to have higher air pollution levels late spring through the summer. In NH, wood stove use has a major impact on winter outdoor  $PM_{2.5}$  pollution, especially in Concord, Keene, Henniker, Hillsborough, Newport, West Swanzey, and Winchester [27]. Children with asthma have greater hospitalization rates in the communities where the ratio of cold to warm weather  $PM_{2.5}$  is high [28].

## Childhood asthma in New Hampshire

### Asthma rate for children

NH's childhood asthma rate is among the highest in the nation. Childhood asthma prevalence in NH is estimated at 10.4%; roughly 28,000 children currently have asthma with on average 3,000 new children diagnosed with asthma every year [29]. In 2009, there were about 1,700 emergency visits and more than 200 hospitalizations for children with asthma as the primary diagnosis (Table 2). Child asthma prevalence varies across counties of the state, with estimates ranging from 5.1% in Grafton County, to 17.4% in Coos County (Figure 1). Asthma is also one of the leading causes of days lost from school among children ages 5 to 17 [30]—resulting in about 42,000 lost school days annually in NH, according to CDC estimates [22] (Table 2). Relatively few childhood asthma cases result in death. Between 2000 and 2013, five deaths occurred among NH children with asthma as the underlying cause of death. Even though childhood asthma deaths are rare, any asthma death is tragic and possibly preventable.

**Table 2. Children (0–17) with asthma in NH**

<b>Estimated number of children with current asthma in 2012</b>	28,634 (10.43%)
<b>Emergency department or observation visits in 2009</b>	1,701
<b>Hospitalizations in 2009</b>	228
<b>Deaths (2000–2013)</b>	5
<b>Estimated missed school days in 2010 due to asthma</b>	42,000

Source: NH Hospital discharges dataset, NH Vital Records Registry, CDC Chronic Disease Cost Calculator V2

**Charges for hospital services**

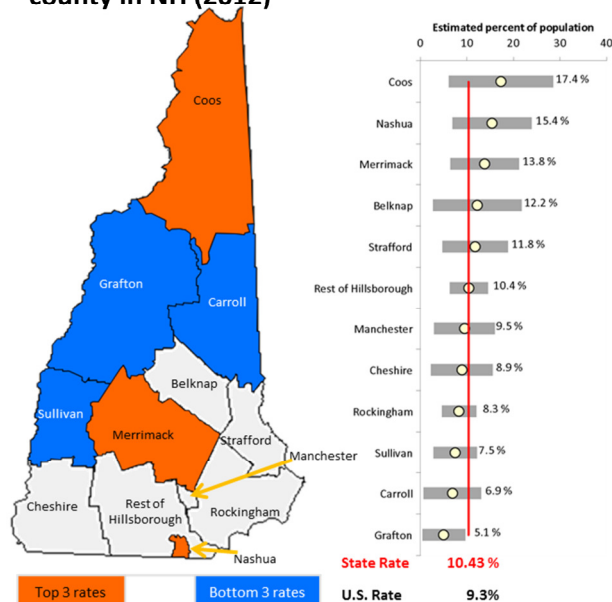
The total charge for inpatient and outpatient hospital services for childhood asthma in NH was approximately \$3.9 million in 2009.<sup>a</sup> Generally, charges per visit for hospital services for childhood asthma increase annually. In 2009, more than 200 children were admitted for

inpatient treatment, and the average length of stay was two days. Median charge per hospitalization was \$5,459 in 2009. About 1,700 children went to emergency rooms or observation beds, and the median charge was \$845 in 2009.

**Population at risk**

To calculate direct medical costs of asthma, we used children under age 18 in NH as our population at risk. Children from low-income families and minority groups are at higher risk of developing asthma than other subgroups. Children in households that earned less than \$25,000 per year were 1.7 times more likely to have asthma than those who lived in households that earned at least \$25,000 per year based on the NH Asthma Control Program report [29]. These factors were not included in the analysis.

**Figure 1. Childhood asthma prevalence by county in NH (2012)**



Source: NH BRFSS 2012

<sup>a</sup> The ICD 9 code for asthma used in the report is 493. Charges are in 2009 dollars.

**Environmentally attributable fraction (EAF) for asthma**

The Landrigan team estimated the EAF for asthma to range from 10% to 35%, with a best guess of 30% [15]. The EAF estimates were related to outdoor non-biologic pollutants from sources such as vehicle exhaust and industrial activities. Asthma triggers due to second-hand smoking or climate conditions were not included in the EAF estimates.

**Economic burden—cost estimate**

To estimate childhood asthma costs, we utilized the CDC Chronic Disease Cost Calculator. The Cost Calculator helps states estimate the economic burden of six selected chronic diseases including asthma. The Cost Calculator provides state-level estimates of medical expenditures (direct costs). It also estimates the number of work/school days

missed and provides absenteeism cost estimates (indirect costs), as well as cost projections to 2020 [22].

- Direct health cost: included all medical expenditures, including physician visits, emergency department visits, hospitalizations, and prescription medication. Did not include expenditures associated with persons residing in institutions.
- Indirect costs: included loss of wages due to caring for a child who missed school because of asthma attack. Did not include productivity losses through premature mortality and reductions in the quality of life.

We applied the following CDC estimates in our cost calculation:

- Proportion treated = 8.3%
- Population size = 293,358 (Children 0–17 in NH from 2008 Current Population Survey estimates)
- Cost per case = \$951 (adjusted to 2013 dollars)

The CDC estimated that 24,349 children with asthma were treated in NH in 2010. The

estimated direct health cost among children treated was \$23 million and the total loss in parental earning was \$7 million. For childhood asthma, the total for both direct and indirect costs was estimated at \$30 million (Table 3).

**Table 3. Estimated direct and indirect annual costs of childhood asthma in NH**

Type of cost	Included in cost	Inputs	Estimated annual cost (in 2013\$)
Direct	Physician visits, ER visits, hospitalizations, prescription medication	\$951 (estimated average cost) x 24,349 children (0-17) treated	\$23,155,899
Indirect	Lost parental earnings due to missed school days	\$167 (estimated daily wage) x 41,607 missed days	\$6,948,369
<b>Estimated total</b>			<b>\$30,104,268</b>

Source: CDC Chronic Disease Cost Calculator V2

### Impact of the environment on asthma

Applying the EAF of 30% (range 10–35%), we estimated that out of 28,634 children with asthma in NH, 8,600 of these cases could be suffering from asthma as a result of non-genetic

environmental exposures. The estimated total cost of these environmentally attributable asthma cases was \$9 million annually (Table 4).

**Table 4. Impact of the environment on asthma and annual costs in NH**

EAF	Estimated number of children with current asthma	Estimated number of environmentally attributable cases per year	Estimated total annual cost (in 2013\$)	Estimated annual cost of environmentally attributable asthma (in 2013\$)
10%	28,634	2,863	\$30,104,268	\$3.0 million
<b>30%</b>		<b>8,590</b>		<b>\$9.0 million</b>
35%		10,022		\$10.5 million

Source: Landrigan et al. 2002, NH BRFSS 2012

*In New Hampshire, reducing preventable environmental hazards would...*

- *Alleviate asthma among 8,600 children every year*
- *Save \$9 million annually*

## Public action

Childhood asthma is a complex disease that is not yet curable. Environmental risk factors play a role in both the development and burden of asthma. By determining and remediating the environmental risk factors that trigger asthma, we can reduce asthma attacks, health care use, and costs associated with caregiver lost work days, and subsequently save millions of dollars a year in NH. Working together, we can ensure that children with asthma enjoy a high quality of life. To minimize children's risk of asthma, simple actions can be taken:

- Improve understanding of environmental risks and their impact on childhood asthma and its cost burden.
- Promote the Air Quality Index (AQI) as a reference to air pollution and asthma.
- Fund programs to teach parents and children asthma self-management and environmental trigger reduction.
- Promote opportunities to teach caregivers (i.e. school nurses, coaches) about asthma management.
- Promote community-wide efforts to clean outdoor environments.
- Collaborate with state and region-wide efforts to limit air pollution.
- Develop policies that encourage smoke-free housing and integrated pest management practices, especially in multifamily and low-income dwellings and businesses.
- Ensure access to high-quality and affordable health care for children with asthma.

*“Cleaning up the air we breathe prevents non-communicable diseases as well as reduces disease risks among women and vulnerable groups, including children and the elderly...”*

*~Dr Flavia Bustreo,  
WHO Assistant Director-General Family,  
Women and Children's Health~*

*EPA's AirNow website provides an Air Quality Index that shows outdoor air quality and informs the public of health risks from outdoor air pollution. Visit [www.AirNow.gov](http://www.AirNow.gov)*

*Help your children live a healthy symptom-free life. Visit the NH Asthma Control Program [www.dhhs.nh.gov/dphs/cdpc/asthma](http://www.dhhs.nh.gov/dphs/cdpc/asthma)*

*AsthmaNowNH  
[www.asthmanow.org](http://www.asthmanow.org)*

*Breathe New Hampshire  
[www.breathenh.org](http://www.breathenh.org)*





# Costs of Childhood Cancer

## Childhood cancer burden in the U.S.

In the U.S., approximately 1 in 408 children will be diagnosed with cancer before the age of 15 [31]. Pediatric cancers make up about 1% of all cancers diagnosed each year. According to the American Cancer Society, an estimated 10,450 new cases and 1,350 cancer deaths are expected to occur among children (0–14 years old) in 2014 in the U.S. [31] Unlike many cancers in adults, the specific causes of cancer in children are largely unknown (80–90%). About 10–15% of childhood cancer cases may be attributed solely to genetic and familial factors, and only 5–10% or less may be linked to environmental risk factors [15]. The environmental risks may come from hazardous air pollutants, pesticide use, ionizing radiation exposure, road traffic, or parental pesticide exposure [32].

## Childhood cancer burden in New Hampshire

### Cancer rate for children

Childhood cancer ranks as the 4th leading cause of death among children under the age of 15 (2000–2010) in NH (Table 5). Each year about 46 children in NH (0–14 years old) are diagnosed with cancer, and 5 children die due to cancer. The average age of diagnosis with cancer is 6.3 years old. The most common childhood cancers in NH are leukemia (29%), brain and central nervous system tumors (22%), and lymphoma (12%). The cancer incidence rate has increased gradually, yet the death rate seems to be decreasing (Figure 2).

### Charges for hospital services

The total charge for inpatient and outpatient hospital services for childhood cancer in 2009 was approximately \$6 million.<sup>b</sup> Forty-four children were admitted for hospitalization, and the

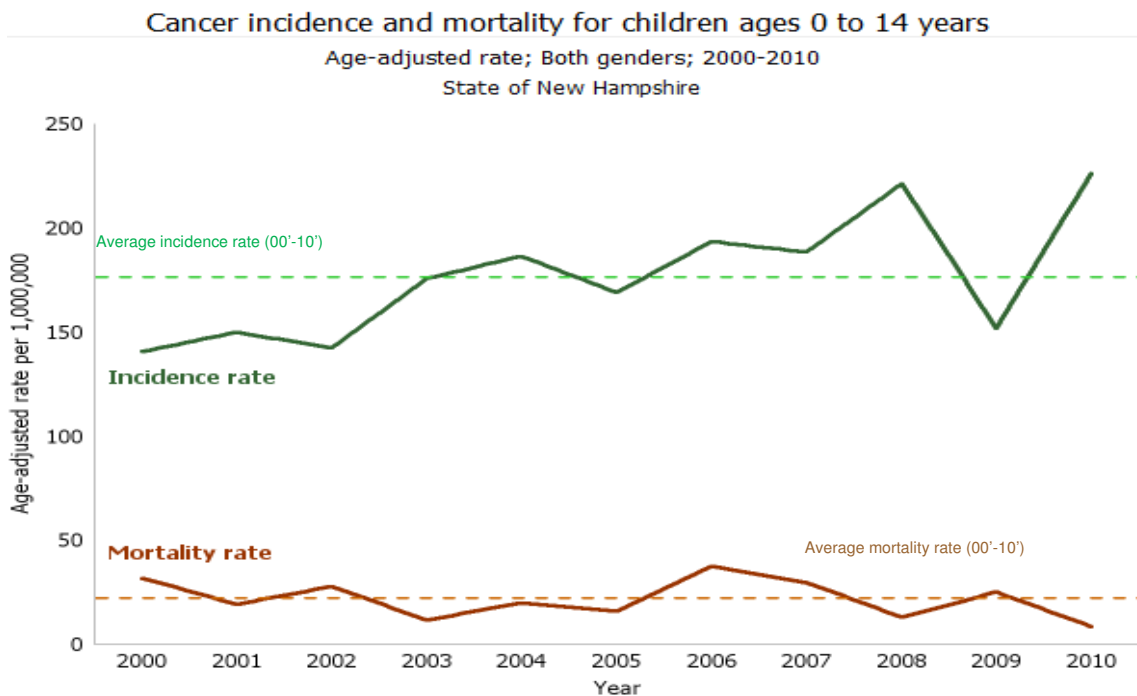
**Table 5. Leading causes of death of children under 15 year old in NH (2000–2010)**

Rank	Cause of Death	No. of Deaths	% of Total Deaths
	All Causes	971	100%
1	Certain conditions originating in the perinatal period	299	30.80%
2	Congenital malformations	140	14.40%
3	Accidents (unintentional injuries)	133	13.70%
<b>4</b>	<b>Cancer</b>	<b>59</b>	<b>6.10%</b>
5	Intentional self-harm (suicide)	16	1.60%
6	Assault (homicide)	14	1.40%
7	Cerebrovascular diseases	13	1.30%
8	Diseases of heart	11	1.10%
9	Influenza and pneumonia	11	1.10%
10	Septicemia	9	0.90%
10	In situ neoplasms	9	0.90%
	Other or unknown causes	257	26.50%

Source: NH Vital Records Registry

<sup>b</sup> The cancer ICD 9 codes used in this report is 140 – 209. Charges are in 2009 dollars.

**Figure 2. Childhood cancer incidence and mortality rate in NH**



average length of stay was 16 days. Median charge per hospitalization was \$100,388 in 2009. A total of 12 children went to emergency rooms or observation beds, and the median charge was \$2,271.

**Population at risk**

Childhood and early adolescent cancer is normally defined as children diagnosed with cancer at age 14 years and younger. However, the definition of childhood cancer sometimes includes young adults between 15–19 years old. In this report, we focused on children in NH aged 14 years and younger.

**Environmentally attributable fraction (EAF) for cancer**

The Landrigan team estimated the EAF for childhood cancer to range from 2% to 10%, with a best guess of 5% [15]. These numbers were

conservative since there is a great deal of uncertainty regarding the environmental risk factors for cancer. In addition, these numbers did not account for childhood environmental exposures that lead to cancer development later in life.

**Economic burden—cost estimate**

**Annual Costs**

To estimate childhood cancer costs, we utilized the direct cost per case calculated by Trasande and Liu, which they obtained on a per case basis from the available national health surveys [1]. All cases of cancer in children less than 15 years old were included in the estimates.<sup>c</sup> In the most recent 5-year period of complete data, 2006–2010, a total of 232 children under age of 15 were diagnosed with cancer in NH, an annual age-

<sup>c</sup> Cancer cases in this report refer to malignant/invasive cases only.

adjusted rate of 196 cases per million [33]. Trasande and Liu limited childhood cancer cost analysis to direct medical costs only based on their study in 2011, which includes inpatient care, outpatient care, and prescription drug costs. Using the Trasande and Liu analysis, total annual cost per childhood cancer case was estimated to be \$154,367 (in 2013 dollars).

We applied the following current data in our cost calculations:

- Disease rate = 196.22 / million
- Population size = 219,370 (Children 0–14 years old in NH from U.S. Census 2013 population estimates) [34]
- Cost per case = \$154,367 (adjusted to 2013 dollars)

The direct health costs among children with cancer were estimated at approximately \$6.6 million (Table 6).

**Lifetime costs**

Among children with cancer, relatively few cases

result in death. However, any childhood death is tragic and premature, with many years of life lost. In the most recent 5-year period, 2006–2010, a total of 27 children in NH (11 boys and 16 girls) died due to cancer, an annual mortality rate of 23 per million children[35]. There are an average of five childhood deaths (2 boys and 3 girls) due to cancer each year in NH. We took 2007 average lifetime earnings for boys and girls, using the Grosse et al. study for 10- to 14-year-olds as an estimate, and adjusted to 2013 dollars (boys: \$1,798,891, girls: \$1,490,272). We then multiplied the number of premature deaths due to childhood cancer for boys and girls in the state by average lifetime earnings. It is important to note that these calculations estimated unrealized lifetime earnings of children, not costs to families, though premature deaths of children impose enormous social, emotional, and economic burdens on families.

- Boys: 2 premature deaths per year X \$1,798,891 = \$3,597,782
- Girls: 3 premature deaths per year X

**Table 6. Estimated annual health costs of childhood cancer in NH**

Type of cost		Estimated annual costs (in 2013\$)	
Health care costs	Incremental inpatient costs	\$79,825	\$154,367
	Incremental emergency room costs	\$4,549	
	Incremental prescription drug costs	\$1,135	
	Other outpatient costs for cancers	\$68,858	
Childhood cancer incidence		196.22 per million	
Population of children (0-14) in 2012		219,370	
<b>Estimated total</b>		<b>\$6,644,694</b>	

Source: Trasande and Liu 2011, Source: NH Cancer Registry, NH population dataset

\$1,490,272 = \$4,470,816

➤ Total: \$8,068,598

Estimated premature cancer deaths resulted in over 300 years of life lost and in approximately \$8 million of lost potential earnings over the lifetime.

**Impact of the environment on childhood cancer**

Due to small population size of the state and the generally low rate of childhood cancer, 46 cancer cases would be expected annually at the current

NH cancer rate in children 0–14 years of age. The conservative estimate of 5% for the EAF suggests that two of these cancers may be caused by environmental exposures annually. We estimated that \$0.74 million was spent on preventable childhood cancers in NH (Table 7). It is important to note that the estimates did not reflect on the potential economic impact of adult cancers related to childhood exposures or economic burden on parents due to wages lost.

**Table 7. Impact of the environment on childhood cancer and total costs in NH**

EAF	Average annual number of children (0–14) with cancer	Estimated number of environmentally attributable cases per year	Annual cost		Lifetime cost		Estimated total cost of environmentally attributable cancer (in 2013\$)
			Estimated total annual cost (in 2013\$)	Estimated costs with EAF (in 2013\$)	Estimated total lifetime cost (in 2013\$)	Estimated costs with EAF (in 2013\$)	
2%	46	1	\$6,644,694	\$0.13 million	\$8,068,598	\$0.16 million	\$0.29 million
<b>5%</b>		<b>2</b>		<b>\$0.34 million</b>		<b>\$0.40 million</b>	<b>\$0.74 million</b>
10%		5		\$0.66 million		\$0.81 million	\$1.47 million

Source: Landrigan et al. 2002, NH Cancer Registry

*In New Hampshire, reducing preventable environmental hazards would...*

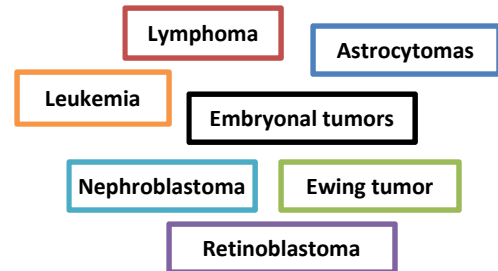
- *Alleviate 2 new cases of childhood cancer every year*
- *Save \$0.34 million in health costs annually*
- *Save an additional \$0.4 million over the lifetime*

## Public action

Even though the major causes of childhood cancers remain unknown, a few environmental risk factors, such as radiation exposure, have been linked with childhood cancer risk. About 5% of childhood cancers can be attributed to environmental risk factors. To minimize environmental risk factors related to childhood cancer, simple actions should be taken:

- Improve the understanding of environmental risk impacts for childhood cancer and of the economic burden of these cancers.
- Educate mothers to avoid environmental exposures during pregnancy, such as pesticide exposures.
- Promote proper treatment and self-management.
- Improve the quality of life for child cancer survivors.
- Ensure access to high-quality and affordable health care for children with cancer and survivors.

*Childhood cancers are often found in different areas of the body than adult cancers. For example:*



*In New Hampshire, childhood cancer incidence increased by an average of 5.15% per year between 2001 and 2010. About 5% of childhood cancers can be linked to environmental risk factors.*

*The NH Comprehensive Cancer Control Program and NH Comprehensive Cancer Collaboration are committed to preventing and eliminating cancers in the state. To find out detailed information about cancer control activities, visit [www.NHCancerPlan.org](http://www.NHCancerPlan.org)*



# Costs of Childhood Lead Exposure

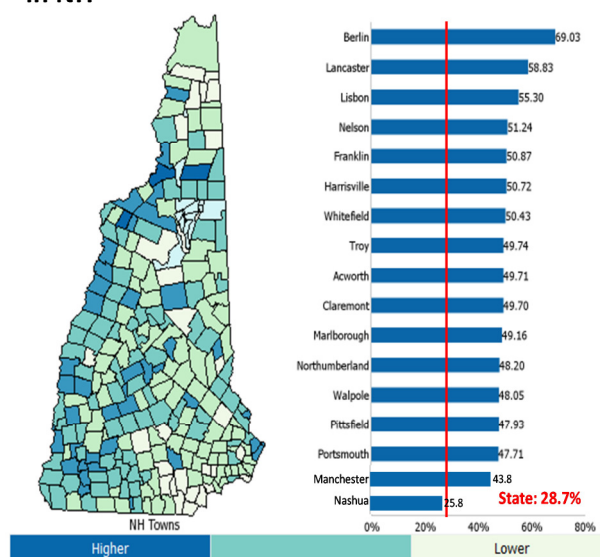
## Lead exposure and the environment

Childhood lead poisoning is a serious environmental health problem with a lifetime of negative consequences for the child, family, and society as a whole. Yet lead poisoning is 100% preventable. Lead is one of the most common and best-recognized environmental toxins for young children. In most cases, children are exposed to lead by ingesting it from household dust or soil through normal hand-to-mouth activities [36]. The dirt or dust on their hands, toys, and other items, often invisible to the naked eye, may have lead particles in it. In children, lead is associated with impaired cognitive, motor, behavioral, and physical abilities [37]. Although regulations reducing lead in gasoline, paint, and other products have greatly reduced exposure in the U.S. during the past 40 years, lead poisoning continues to affect children throughout NH, especially those living in homes built before 1978 and especially pre-1978 homes being renovated. In NH, the city of Berlin has more than 69% of housing built before 1950, Claremont has 49%, and Manchester has 43% (as measured in the 2000 Census) (Figure 3). Communities with a higher percentage of old houses, especially those built pre-1978, have a higher risk of lead exposure for children so housing stock should be inspected for lead.

## Population at risk

Though lead poisoning can happen to anyone, children are at the highest risk for lead exposure because they are more likely to: live in older,

**Figure 3. Percentage of homes built before 1950 in NH**



Source: NH Health

poorly maintained rental properties; live at or below the poverty line; be recent immigrants; have parents who are exposed to lead at work; or be members of racial-ethnic minority groups, [38]. According to 2010–2012 American Community Survey, 15.6% of NH children under 6 years old lived below the poverty line (in the past 12 months). The city of Manchester ranks as the NH community with the most children under 6 years old living below the poverty line, followed by Strafford County and Coos County (Figure 4). Immigrant and refugee children have a particularly high risk for lead poisoning. Some refugee children arrive in the U.S. with elevated blood lead levels attributable to leaded gasoline, traditional medicines and folk remedies, and many other culture-specific routes of exposure [39]. Others encounter lead hazards after they



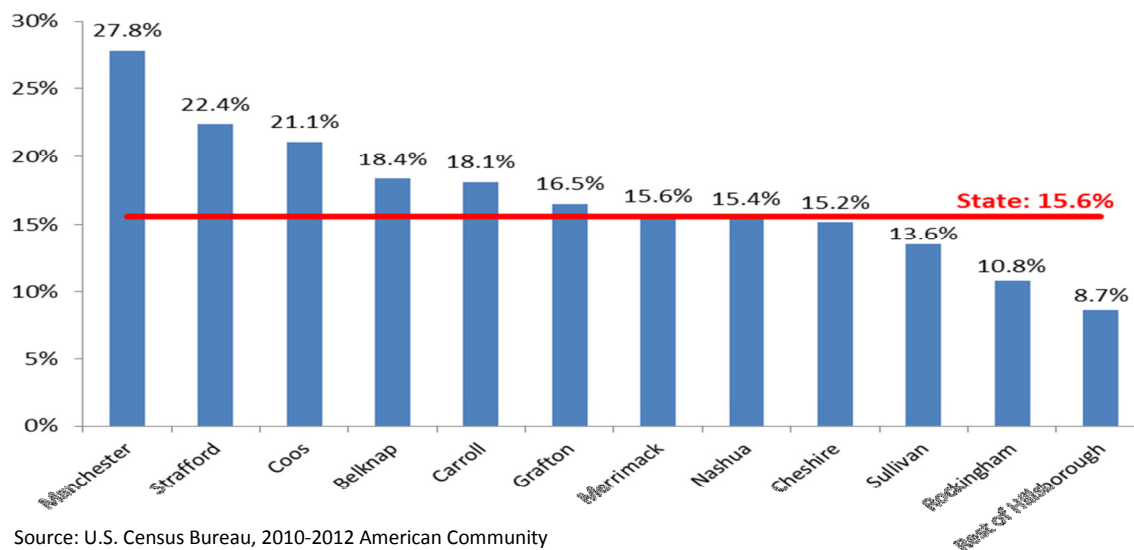
immigrate, often as a result of living in inexpensive housing with flaking lead-based paint [39]. Pre-existing health burdens such as chronic malnutrition also compound refugee children's risk for lead poisoning [40]. Data suggest that for some refugee children, living in the U.S. is their first exposure to lead [41]. Many of NH's refugees live in Manchester, Concord, Nashua, and Laconia. During 2003–2004, a total of 242 refugee children resettled in NH; of these, 216 (89%) resettled in Manchester due to the unavailability of affordable housing units in other towns [41]. NH requires blood lead screening of newly arrived refugee children aged 6 months to 16 years.

### Exposure to environmental lead

The blood lead level (BLL) is a useful indication of the extent of exposure to lead, a common environmental toxin. At one time, levels below 10 micrograms per deciliter ( $\mu\text{g}/\text{dL}$ ) were considered acceptable. More recent studies show that blood lead levels below 10  $\mu\text{g}/\text{dL}$  have a negative impact

on children's IQ scores [42]. In 2012, the CDC updated the reference level from 10  $\mu\text{g}/\text{dL}$  to 5  $\mu\text{g}/\text{dL}$  as the cutoff for identifying children with elevated blood lead levels [43]. Children exposed to high levels of lead can suffer from damage to the nervous system, brain, and kidneys; behavior and learning problems; reduced growth; and even death. Even lower ranges of BLLs (2–10  $\mu\text{g}/\text{dL}$ ) are known to be a risk factor for impaired cognitive and behavioral outcomes in children [44]. Over a lifetime, the damage and declines in IQ have substantial economic and social impacts. Therefore, there is no safe level of lead exposure for children; all children should be lead free. Reducing lead exposure yields economic benefits by avoiding health care and special education costs and by preventing reductions in intelligence, academic achievement, future productivity, and violent criminal behavior [45], [46].

**Figure 4. Poverty rate for children under 6 years old in NH**



Source: U.S. Census Bureau, 2010-2012 American Community

## Childhood blood lead levels in New Hampshire

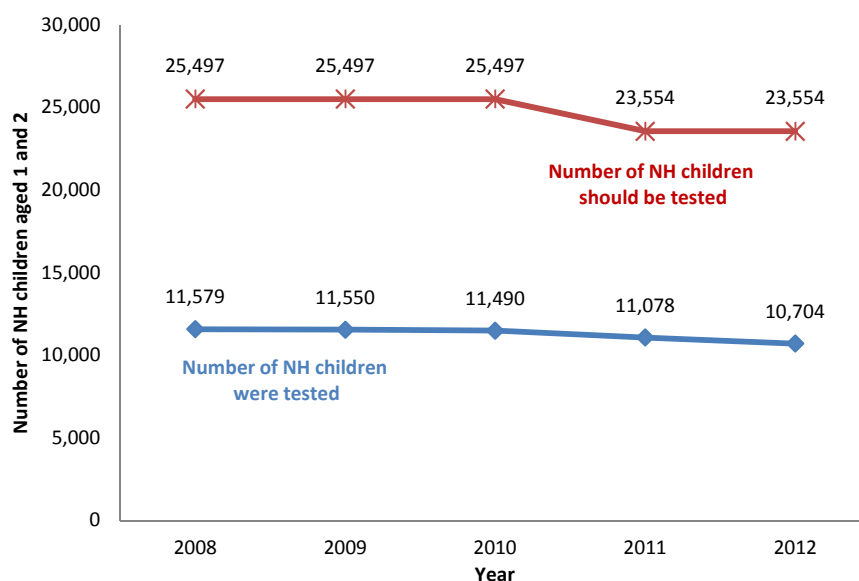
The NH Healthy Homes and Lead Poisoning Prevention Program (NH HHLPPP) monitors blood lead levels (BLLs) in adults and children in NH. In accordance with recommendations from the CDC, cities and towns with 27% or more pre-1950 housing stock are considered high risk. Some communities have even higher risk for lead poisoning due to additional factors, such as the percentage of the population that is under the age of six; the percentage under the age of six living in poverty; the percentage of children under the age of six enrolled in Medicaid or other federal assistance programs; and special populations living in the communities. Through a review of these factors for all 240 NH communities, the NH HHLPPP has designated each community as either a “Universal”<sup>d</sup> or a “Target”<sup>e</sup> community based on risk factors. Fifty-five percent of NH’s communities require “Universal” blood lead testing for all children under six years of age [47]. Based on NH HHLPPP estimates, more than

<sup>d</sup> In the high-risk “Universal” communities, the HHLPPP recommends that all children are tested at one year of age and again at two years of age. Older children up to six years of age who have not previously been tested, have moved to a new home or exhibit additional risk factors should also be tested.

<sup>e</sup> Target test means test all children at ages one and two who have NH Medicaid insurance or are receiving WIC benefits. Assess all other children with a risk questionnaire at ages one and two. Also administer questionnaire for three to five year olds not assessed or tested at age two.

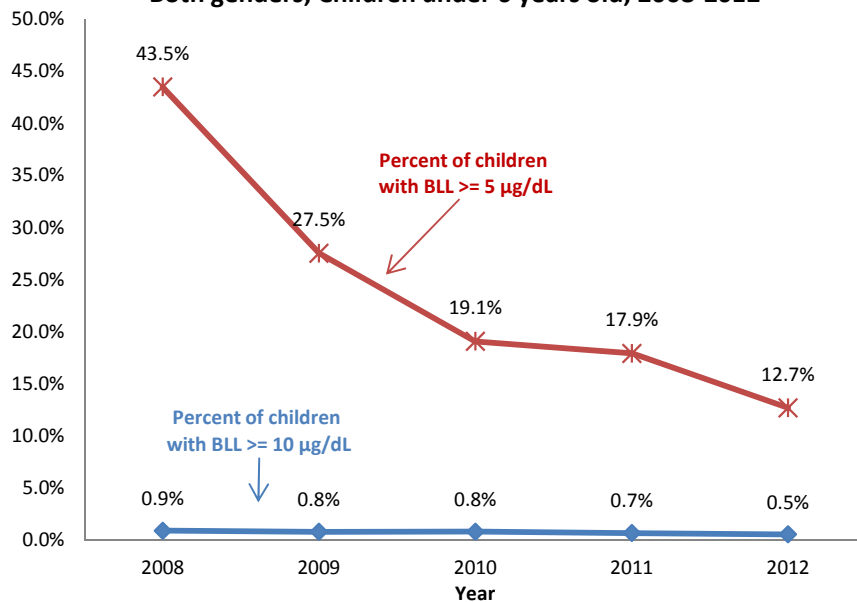
24,000 children aged one and two in NH *should* have been tested for lead in 2012. However, only 10,704 children aged one and two were tested for lead in 2012, meaning that 55% of these children who were at high risk of being exposed to lead did *not* receive the recommended test for lead (Figure 5).

**Figure 5. Number of NH children should be tested and were tested for lead  
Both genders; Aged 1 and 2 ; 2008-2012**



Berlin, Claremont, Newport, Franklin, Laconia, Manchester, Nashua, and Rochester continue to be classified as the State’s “highest risk” communities according to 2012 NH childhood lead poisoning surveillance data [48]. Among all 85,000 children under age six statewide, 15.9% were tested in 2012. The rate of children with BLLs greater than or equal to 10 µg/dL dropped from 0.9% in 2008 to 0.5% in 2012. Using the new BLL 5 µg/dL reference value, 12.7% of tested children had levels of 5 or higher in 2012, compared with 0.5% at 10 or higher (Figure 6).

**Figure 6. Children blood lead level test in NH  
Both genders; Children under 6 years old; 2008-2012**



### Estimated costs of preventive interventions

The estimated costs of preventive intervention included the costs of screening for children aged one and two who should be tested for lead and the costs of lead abatement for homes at highest risk. The total estimated costs of preventive intervention were between \$4.7 and \$35.2 million (see description below).

#### Cost of preventive screening

The NH HHLPPP recommends all children in high-risk communities should be screened for blood lead level before the age of six. Children receiving Medicaid or WIC benefits are required to have blood lead tests at one and two years of age [47]. The cost of a single blood lead screening averages \$38 (in 2013 dollars), including the test and the venous blood draw [45]. Applied to 24,000 children ages 1 and 2 that should be tested, the costs of preventive screening were \$912,000. Blood lead screening tests are covered by Medicaid and most private health insurance.

Testing for blood lead levels can identify if a child would require appropriate treatment, and/or educational and environmental intervention.

#### Cost of lead abatement

More than 57% of NH occupied homes built before 1980, or about 300,000 homes, were deemed to have lead hazards [49]. Around 18,000 of these housing units housed young children, of

which 2,478 homes were at highest risk with low-income families and children six and under. Based on research conducted by Gould in 2009, the cost of lead abatement was in the range of \$1,387 to \$12,450 per housing unit (in 2013 dollars) [44]. To remove lead from these targeted 2,478 homes, the estimated cost for abatement was between \$3.8 and \$34.3 million.

### **One death is too many**

*In the spring of 2000, in Manchester, a 2-year-old Sudanese refugee child died of acute lead poisoning from exposure to lead paint, the first U.S. child known to die from lead poisoning in 10 years. The blood lead level was six times the level that would normally require a child to be*

#### **Environmentally attributable fraction for lead exposure**

All lead poisoning cases are reasonably assumed to be of environmental origin, primarily from

deteriorating lead paint and contaminated dust and soil. The environmentally attributable fraction (EAF) for childhood lead poisoning was therefore set at 100%, and no range was calculated.

**Benefits to blood lead level reduction in children**

**Estimated cost of special education**

Children with high BLLs may be in need of special education because of their slower development, lower educational success, and related behavioral problems [44]. Moreover, environmental lead exposure in children has been confirmed as a risk factor for attention deficit hyperactivity disorder (ADHD). When children have BLLs of 2 µg/dL or greater, the risk of ADHD is four times more than children with BLLs at or below 1 µg/dL [50]. Ronnie Levin assumed that about 20% of children with BLLs greater than 10 µg/dL should get special education,<sup>f</sup> therefore, 15 out of 77 children with BLLs at 10 µg/dL or over should receive special education. Applied to the estimated NH average special education tuition cost per student for fiscal year 2013 which was \$13,587 [51], it projected that the total annual costs of lead-related special education were roughly at \$209,000 annually.

**Estimated cost of medical treatment**

In 2012, the CDC established a new “reference level” for BLLs at 5 µg/dL, which implies children need appropriate treatment with elevated BLL. The main treatment for elevated BLL is to stop the exposure by removing environmental or dietary sources of lead. Treatment for low BLLs (5–19

µg/dL) involves followed-up monitoring and lead education for diet and environment [52]. Treatment for higher lead levels (20–44 µg/dL) entails further diagnostic lead testing, complete physical exams, neurodevelopment monitoring, and/or abdominal X-ray. Children with BLLs at 40 µg/dL or above may need to be hospitalized and/or undergo chelation therapy according to NH HHLPPP guidelines [47]. We applied Gould’s study (2009) and extended recommended action to the new elevated BLL [44]. The annual health treatment costs in NH were estimated at approximately \$178,000 (Table 8).

**Table 8. Estimated annual lead-related health treatment costs in NH**

BLL (µg/dL)	Estimated cost of medical action (in 2013\$)	Number of children with EBLL (2012)	Estimated annual health cost (in 2013\$)
5 - 14	\$95	1,634	\$159,505
15 - 19	\$95	18	\$1,710
>= 20	\$1,549 <sup>g</sup>	11	\$17,039
<b>Estimated total</b>			<b>\$178,254</b>

**Estimated cost of crime related to lead exposure**

There is a strong relationship between lead exposure during early childhood and future criminal activity, especially violent crime. Research has shown that childhood lead exposure affects the risk of criminal behavior later in life [46] [53] [54]. Crimes included murder, rape, aggravated assault, robbery, and burglary. To estimate the total cost of lead-related crime, we

<sup>f</sup> Ronnie Levin, personal communication, June 20, 2014

<sup>g</sup> Due to small number, BLLs above 20 µg/dL are grouped together. The cost is the average cost of 20–44 µg/dL and 45–69 µg/dL from Gould (2009)

used Gould’s estimate (from Nevin, 2007) of the proportion of lead-related crime with a 1 µg/dL reduction in the average preschool blood lead level, calculated number of lead-related crimes, and applied the direct costs estimated by McCollister et al [53] [55]. A 1 µg/dL reduction in the average preschool blood lead level may result in an estimated 889 fewer burglaries, 2 fewer robberies, 78 fewer aggravated assaults, 17 fewer rapes, and 1 fewer murders (Table 9). The total direct cost of lead-linked crimes was estimated at approximately \$9 million, including direct victim costs, costs related to the criminal justice system, and productivity losses associated with perpetrators of crimes. For the purposes of this conservative analysis, only the direct costs of each crime were considered.

**Potential lifetime earning loss on lead exposure**

To estimate the lifetime earning loss due to lead exposure, we followed the economic forecasting model to determine the impact of lead in the environment on economic productivity [56]. This model was based on the relationship between

lead exposure and IQ point loss, the latter in turn being associated with decreased lifetime earning power. The cost model limited the estimated cost of lead exposure to the decrease in expected lifetime earnings due to IQ loss in exposed children. The lost lifetime earnings due to lead exposure was calculated using the following equation:

$$\text{Cost} = \text{EAF} \times \text{BLL} \times (\text{IQ loss}/\text{BLL}) \\ \times (\text{Lost economic productivity}/\text{IQ loss}) \\ \times \text{Population at risk}$$

- **Estimation of blood lead levels:** The specific data on BLLs was not available in NH. We used the most recent population-based sampling by the CDC’s National Health and Nutrition Examination Survey (NHANES) (2009–2010) which provided an estimate of the geometric mean BLL for U.S. children aged 1–5 years at 1.17 µg/dL [57].
- **IQ loss:** Studies show a nonlinear, negative relationship between IQ loss and BLL. Due to blood lead data availability in NH, we assumed that each 1 µg/dL of blood lead was

**Table 9. Estimated annual lead-related crime costs in NH**

Type of crimes	Number of cases in 2012	Proportion of crimes linked to childhood lead <sup>h</sup>	Estimated lead linked crimes	Estimated tangible cost per crime (in 2013\$)	Estimated total tangible costs (in 2013\$)
Burglaries <sup>i</sup>	30,693	2.90%	889	\$6,675	\$5,935,832
Robberies	472	0.39%	2	\$23,126	\$42,394
Aggravated Assaults	1,545	5.07%	78	\$21,069	\$1,651,073
Rape	449	3.70%	17	\$44,635	\$740,873
Murder	15	2.87%	0.4	\$1,390,523	\$598,092
<b>Total</b>	<b>33,174</b>		<b>987</b>		<b>\$8,968,264</b>

Source: Federal Bureau of Investigation (Uniform Crime Reporting Program 2012), Gould (2009), McCollister et al. 2008; inflated to 2013 USD.

<sup>h</sup> Proportions were calculated based on figures from Gould (2009) derived from Nevin (2007).

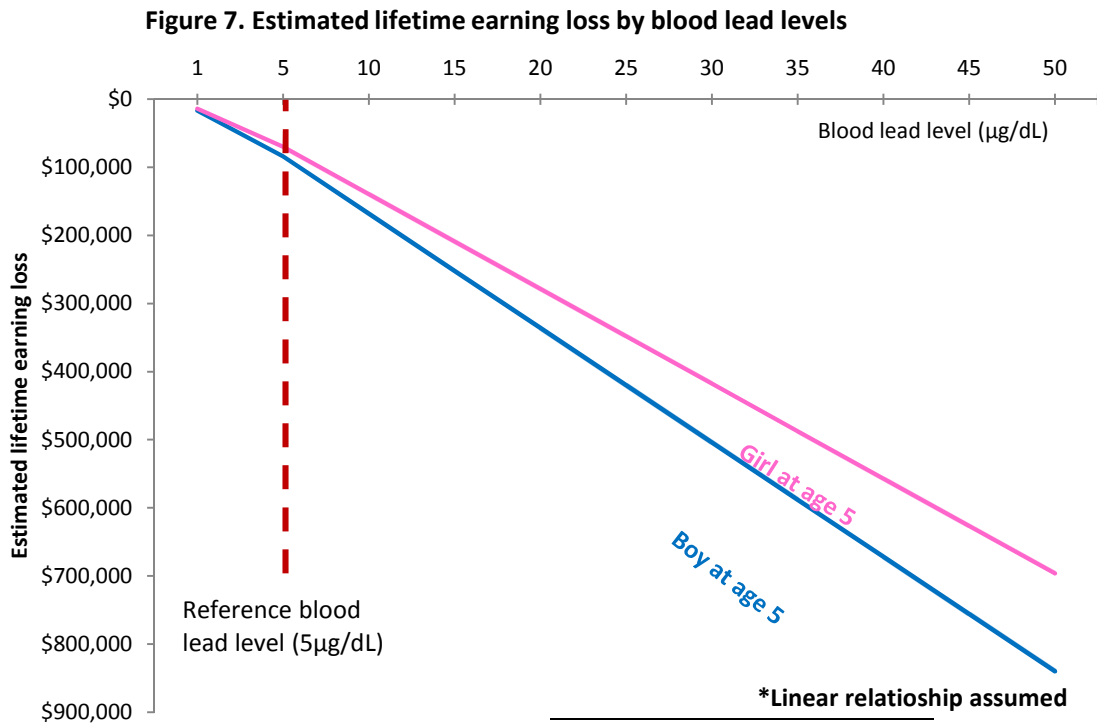
<sup>i</sup> “Burglaries” includes larceny and motor vehicle theft.

associated with an average 0.57 decline in IQ points at 5 years of age with range from 0.2 to 0.93 IQ points [42].

- Loss in economic productivity:** We adopted the data from the Trasande and Liu study that each 1 point decline in IQ was responsible for a 2% loss of lifetime earnings [1], and referred to the economic productivity in 2007 calculated by Grosse et al. [23]. The total value of lifetime expected earnings was \$1.5 million for 0- to 4-year-old boys and \$1.2 million for 0- to 4-year-old girls in 2013 dollars.
- Population size:** The population at risk in the estimates was a single cohort of 5-year -old NH children (NH children born in 2009). When children enter school at age 5, the neurological damage caused by lead often is first noticed [15]. Additionally, no reduction

in exposure or medical treatment would restore mental capacity to children with lead exposure beyond that age [14].

Applying a linear assumption between blood lead level increase and IQ point decrease, we estimated lost lifetime earnings by blood lead level (Figure 7). For example, a 5-year-old boy with blood lead level at 50  $\mu\text{g}/\text{dL}$  may lose more than \$0.8 million of his lifetime earnings. Total cost estimates for the economic impact of childhood lead exposure in NH were calculated (Table 10). The present value of NH’s economic losses attributable to lead exposure in the 2013 cohort of 5-year-olds was estimated to be \$240.4 million with a range from \$84.3 to \$392.3 million.<sup>j</sup>



<sup>j</sup> The cost of range of childhood lead exposure is estimated on lower and upper boundary of IQ loss per blood lead level. The EAF of childhood lead exposure is 100%.



### Impact of the environment on lead exposure

With an average BLL at 1.17 µg/L, children in the 2013 cohort of 5-year-olds would lose \$240.4 million potential earnings due to lead exposure. These costs should be interpreted as the lost value of future wage earnings that accrue over a lifetime. Therefore, they are not representative of direct annual expenditures, but are instead indicative of lost potential in the current cohort of 5-year-old children in NH.

Additionally, to minimize children’s lead exposure may save \$0.17 million in health treatment costs, as well as \$0.2 million in special education due to lead poisoning. Moreover, to reduce 1 µg/dL blood lead level in children may decrease 987 crimes and save \$9 million in related costs.

**Table 10. Impact of the environment on lead exposure and lifetime cost in NH**

EAF	100%	
Mean blood lead level	1.17 µg/dL	
Estimated IQ loss per BLL	0.57	
(Lower limit - Upper limit)	(0.2 - 0.93)	
Estimated lost economic productivity per IQ loss	Boy	Girl
	\$1,473,670 X 2%	\$1,221,581 X 2%
Population size in NH	6,835	6,510
Estimated loss of economic productivity	\$134,347,464	\$106,070,342
(Lower limit-Upper limit)	(\$47,139,452 - \$219,198,450)	(\$37,217,666 - \$173,062,146)
Estimated total lifetime earnings loss	<b>\$240.4 million</b>	
(Lower limit - Upper limit)	<b>(\$84.3 million - \$392.3 million)</b>	

***In New Hampshire, reducing preventable environmental hazards would...***

- ***Cost \$4.7-\$35.2 million for lead preventive interventions***

***Benefit of prevention:***

- ***Save \$240 million over the lifetime of all children born within a single year.***

***Additionally***

- ***Result in 987 fewer crimes and save \$9 million in related costs.***
- ***Save \$0.2 million in both health costs and special education costs annually.***

## Public actions

No level of lead in the blood is safe. Even low BLLs pose a health risk. To minimize children's risk of lead exposure, simple actions should be taken:

- Educate contractors on the U.S. Environmental Protection Agency Renovate, Repair, and Paint (RRP) law for pre-1978 housing and the use of lead-safe work practices.
- Educate physicians on the NH Childhood Lead Poisoning Screening and Management Guidelines.
- Educate parents about the lead risks associated with pre-1978 housing and lead-safe work practices.
- Increase blood lead testing for children under age six, especially children at higher risks.
- Repeat blood lead level testing of all refugee children under age six after refugee children are resettled in permanent residence, regardless of initial test results.
- Educate high-level decision makers (i.e. education, real estate, contractors, legislators) on the risks of lead and its economic burden.
- Promote awareness of potential lead-contaminated toys, imported spices, and cultural powders.
- Ensure access to high-quality and affordable health care for all children, especially low socioeconomic children.

*“As long as attention focuses on the costs of lead paint abatement and ignores the costs of not abating and as long as people add up the costs of removing paint but not the costs of medical care, compensatory education, and school dropouts, substantial action is unlikely.”*

*~ Joel Schwartz (1994, p. 105)*

*Tenants and home buyers have a right to live in housing that is free from lead paint hazards.*

*The new reference value is 5 µg/dL. There is NO safe blood lead level for children, and parents should have children tested for lead.*

*To find out more about the hazards of lead paint, contact the NH Healthy Homes and Lead Poisoning Prevention Program at 603-271-4507.*



# Summary of Findings

## Conclusion

The estimated children’s health costs attributable to the environment in NH were \$250.1 million, with \$9.34 million annual costs and \$240.8 million lifetime costs, for childhood asthma, childhood cancer, and lead exposure. The annual costs for asthma were high, and lifetime costs for lead exposure were 96% of the total costs. The costs included annual health care expenditures, while monetary impact of lost parental wages or reduced lifetime earnings depended on the childhood illness. These cost estimates were conservative and rely on NH-specific data wherever available. The estimated sum for selected childhood illnesses amounted to 2.4% of the 2009 total NH health expenditures for all residents [2] and was equivalent to 0.4% of the

2012 total NH gross domestic product [3]. It is important to note that all of the economic costs addressed in this report could be avoided, and environmentally induced childhood illnesses could be completely prevented if environmental exposures and hazards were eliminated. Although it is not our purpose to make specific policy recommendations, reducing environmental risk factors is critical to the health of our children and would bring economic benefits to the state.

	<b>Estimated annual costs (range) – in 2013\$ (million)</b>	<b>Estimated lifetime costs (range) – in 2013\$ (million)</b>	<b>Estimated total cost of environmentally attributable illnesses (range) – in 2013\$ (million)</b>
<b>Asthma</b>	\$9.0 (\$3.0 - \$10.5)	N/A	\$9.0 (\$3.0 - \$10.5)
<b>Cancer</b>	\$0.34 (\$0.13 - \$0.66)	\$0.4 (\$0.16 - \$0.81)	\$0.74 (\$0.29 - \$1.47)
<b>Lead Exposure</b>	N/A	\$240.4 (\$84.3 – \$392.3) <sup>k</sup>	\$240.4 (\$84.3 – \$392.3)
<b>TOTAL</b>	<b>\$9.34</b> <b>(\$3.1 - \$11.1)</b>	<b>\$240.8</b> <b>(\$84.5 - \$393.1)</b>	<b>\$250.1</b> <b>(\$87.6 - \$404.3)</b>

<sup>k</sup> The cost of range of childhood lead exposure is estimated on lower and upper boundary of IQ loss per blood lead level (µg/dL). The EAF of childhood lead exposure is 100%.

## Key challenges and limitations

**1. The environmental attributable factor (EAF) relied on expert judgment with narrow environmental risks definition** (e.g., chemical exposures in the environment, excluded social factors and individual behaviors), except lead exposure. It didn't account for risk factors or illness outcomes depending on geographic location and time period. The EAFs were not adjusted based on state-specific conditions, and significant uncertainty remains on the EAF's applicability to a specific state or county. This report can only consider environmental chemicals for which there is evidence that they may impact health.

**2. Cost estimates vary by illness and study:** Each childhood illness was estimated in a different way, some included both direct costs and indirect costs and some included either direct costs or indirect costs.

- a. For childhood asthma, we relied on the CDC Chronic Disease Calculator which provided costs of both health care and absence due to asthma, and did not include lost productivity due to premature death.
- b. For childhood cancer, we applied the Trasande and Liu estimation, which calculated health care costs but did not cover costs associated with lost work productivity for parents. We also analyzed mortality costs to reflect lifetime earning loss due to cancer death.
- c. For lead exposure/poisoning, only lost lifetime earnings were included in the total costs. However, the costs of health

treatment, special education tuition, and the costs of lead-related crime were presented as a reference.

**3. Cost estimates were conservative:** Some of the costs would be incurred immediately, while some would be expected to accrue over the lifetime of the affected child. This report is limited to a small subset of childhood illnesses, but the full scope of impact of environmental exposures and hazards in children in NH is likely to be much larger than our estimates. In addition, exposures that occur during childhood that may contribute to illnesses in adulthood were not included here. Other costs related to the impact of each illness were difficult to measure and were therefore not included.

**4. Some childhood illness data were not available:** Cost estimates relied heavily on national costs or previous studies. National data do not necessarily reflect NH-specific costs. There are many other factors that can vary across states and where NH may differ from the U.S. as a whole. Childhood blood lead level data were not available to calculate mean values.

**5. Some data were not accurate to use:** Charges for hospital services for asthma, cancer, and lead exposure were available in NH. They gave an idea of the charges by case as a reference, but they were not accurate enough to calculate overall childhood cost for the following reasons:

- a. They represented the amount the hospital charged the payer, not the amount which was actually paid which is

oftentimes negotiated by insurance companies.

- b. These charges and their discount were not consistent between hospitals.
- c. Other providers often bill the patient separately for services related to the hospital stay. This also varies between hospitals.

efforts to make more data available and accurate.

### **Lessons learned**

1. Our estimates suggested that the economic costs of environmental childhood illnesses were substantial. Understanding the costs related to environmental hazards can assist policy makers, government agencies, and individuals in how to evaluate options to reduce the economic burden of the environmental illness and improve quality of life of children.
2. The environmentally attributable fraction model provided a method for identifying the combinations of contaminants and exposure pathways with the most substantial public health impacts. This information can be considered in planning which problems to address first.
3. This report highlights and identifies population subgroups that may be at higher risk due to environmental exposures. It provides a reference that policy makers can use to help chart a path toward sustainable development.
4. The estimation of environmental burden of childhood illness inevitably reveals gaps in environmental and public health data. The results of this report can inform further

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