Minnesota
Department of Health
ENVIRONMENTAL PUBLIC HEALTH TRACKING

The Economic Burden of the Environment on Two Childhood Diseases: Asthma & Lead Poisoning in Minnesota

December 2014

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Minnesota Department of Health
Minnesota Environmental Public Health Tracking

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For more information, contact:
Minnesota Department of Health
Minnesota Environmental Public Health Tracking
PO Box 64882, St. Paul, MN 55164-0882

Phone: 651-201-5900
Toll Free: 1-800-205-4987

Email: health.tracking@state.mn.us

Introduction

Childhood diseases have substantial impacts on families and communities. Several reports published over the past decade have estimated the costs to individuals and to society due to chronic diseases and developmental disorders in children (U.S. Environmental Protection Agency, 2013; World Health Organization, 2006).

This report focuses on two important environmentally-related health conditions in Minnesota's children: asthma and blood lead poisoning. It documents the economic cost of both conditions in one year, 2010, from current surveillance data and estimates the fraction that is attributable to environmental causes. It focuses on environmental factors that are amenable to interventions.

To estimate the economic value of preventive actions, this report demonstrates a method for using quality environmental public health tracking (surveillance) data. Using this approach, policy decisions and resources can be directed towards actions that have a measurable impact both in reducing childhood disease and saving money.

The Minnesota Environmental Public Health Tracking Program (MN Tracking) was established in 2007 by the Minnesota Legislature (MN Statutes, sections 144.995-998) and, in 2009, joined 23 other states as part of the Centers for Disease Control and Prevention (CDC) National Tracking Network. For this report, MN Tracking collaborated with CDC and other states with tracking programs including California, Connecticut, Florida, New Hampshire, Oregon and Utah. The Tracking Network is committed to making quality public health data more accessible and useful to the public for informing and evaluating environmental public health actions and policies.

MN Tracking worked closely with the Minnesota Department of Health (MDH) Asthma Program and the MDH Lead and Healthy Homes Program on this report.

KEY FINDINGS

•

The total economic burden of childhood asthma in Minnesota in 2010 attributable to the environment was $31.6 million (in 2014$) (range: $10.5 million – 36.9 million)

•

The total economic burden of childhood lead poisoning in Minnesota on lifetime earnings is $1.9 billion (in 2014$).

KEY LIMITATIONS

The costs calculated in this report likely underestimate the true cost to Minnesota's economy of asthma episodes and lead poisoning in children that are attributable to environmental risk factors.

•

The burden and cost of environmentally attributed disease in Minnesota's children is not shared equally across all communities of the state.

•

The Environmentally Attributable Fraction (EAF) is an uncertain estimate.

Methodology Overview

This report adopts methods established in previously published works (Landrigan, Schechter, Lipton, Fahs, & Schwartz, 2002; Trasande & Liu, 2011) and updates these methods with current state data and information.

The formula

The formula for estimating the economic burden of environmentally-related disease relies on the components described below:

ECONOMIC BURDEN:
DISEASE COUNTS X COST PER CASE X ENVIRONMENTALLY ATTRIBUTABLE FRACTION (EAF)

Economic burden is estimated as the number of cases of disease in a defined population and specified time period, multiplied by the environmentally attributable fraction (EAF) and the estimated cost per disease case. The time period used in this report was the 2010 calendar year.

Counts of disease cases

The estimated number of children treated for asthma came from the CDC Chronic Disease Cost Calculator. MN Tracking staff worked closely with the MDH Asthma Program to obtain data on child asthma deaths.

MN Tracking staff worked closely with the MDH Lead and Healthy Homes Program to determine the average blood lead level in Minnesota children born in 2004 based on MN Blood Lead Information System data.

Estimating costs per disease case, direct and indirect

For asthma, cost estimates were derived from the CDC Chronic Disease Cost Calculator for direct medical care costs per case in 2010 including the costs of clinic visits, hospitalizations, emergency department visits, and medications. Indirect costs, including wages lost from a parent who cares for a child with asthma, were also derived from the calculator, while the cost of a premature death was derived from Max, Rice, Sung & Michel (2004).

For childhood lead poisoning, cost estimates were calculated using wages lost from the impact of a lower IQ on lifetime earning capacity, derived from market productivity estimates in Grosse, Kreuger & Mvundura (2009).

The environmentally attributable fraction (EAF)

The environmentally attributable fraction (EAF) is the estimated proportion of disease cases that are thought to be causally associated with environmental risks. Environmental risks for this report include modifiable physical and chemical factors in our home, work and community environments. The calculations in this report exclude naturally occurring risks, such as radon, and behavioral risk factors such as smoking and diet, and are limited to risk factors that could be quantified based on the available scientific evidence.

EAF estimates the fraction of the disease that would be avoided or eliminated if the environmental risk were removed or reduced to the lowest level possible. Published relative risk estimates from the epidemiological literature and the prevalence of the exposure in the population are used to calculate the EAF. This report uses the EAF estimates first published by Landrigan et al. (2002).

The Costs of Childhood Asthma

Asthma burden and trends in Minnesota

About one in 14 Minnesota children (under 18) currently have asthma, or about 90,000 children.

Many indicators of the burden of asthma in Minnesota have been improving over time. Asthma hospitalization rates continue to decline in the seven-county Twin Cities metropolitan area, particularly among children. However, rates of asthma-related emergency department (ED) visits have remained relatively stable since 2005, and after a dramatic decrease through 2006, statewide asthma mortality rates have been rising slowly.

DISPARITIES OBSERVED

Asthma prevalence in Minnesota is currently lower than the national average; however, there are significant disparities in prevalence by race/ ethnicity.

According to data from the 2013 Minnesota Student Survey,

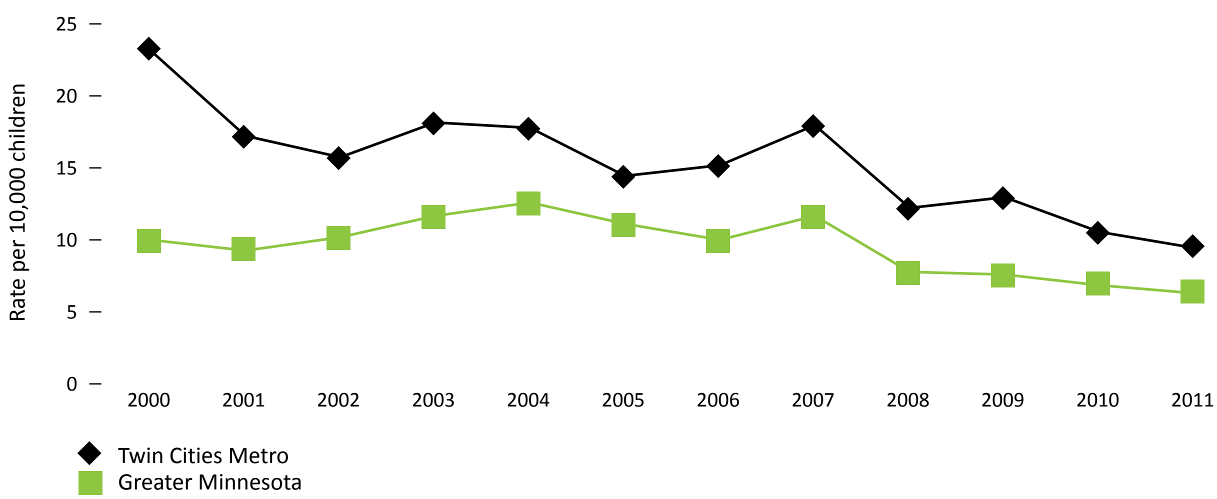
21% OF AMERICAN INDIAN AND 24% OF AFRICAN AMERICAN YOUTH REPORT AN ASTHMA DIAGNOSIS COMPARED TO 16% OF WHITE AND HISPANIC STUDENTS, AND 13% OF ASIAN STUDENTS.

According to 2012 data from the Behavioral Risk Factor Surveillance System,

ASTHMA PREVALENCE AMONG ADULTS IS HIGHER AMONG BLACKS (14%) THAN WHITES (8%).

Disparities in asthma prevalence by race/ethnicity are also evident among enrollees in Minnesota's medical assistance programs, with the highest prevalence among Blacks (Minnesota Department of Health, 2012).

ASTHMA HOSPITALIZATIONS FOR MINNESOTA CHILDREN



Source: Minnesota Hospital Association; MDH Asthma

There are striking geographic disparities in rates of asthma-related ED visits and hospitalizations in Minnesota. Asthma hospitalization rates among children living in the Twin Cities metropolitan area are 54% higher than among children living in Greater Minnesota. Rates of asthma-related ED visits are nearly twice as high among children in the Twin Cities metro area compared to children in Greater Minnesota.

RISK FACTORS

Most asthma episodes (also referred to as asthma exacerbations), including those resulting in hospitalizations, are preventable if asthma is properly managed according to established medical guidelines, which include reducing exposures to environmental triggers (National Asthma Education and Prevention Program, 2007). A variety of factors can trigger an asthma episode, including viral respiratory infections; exposure to allergens (e.g. dust mites, dander (protein particles shed by cats and dogs), and pollen; exercise; tobacco smoke; air pollution; strong emotions; chemical irritants; and drugs (e.g., aspirin and beta blockers).

Air pollution, such as particulate matter (PM), is associated with increased hospitalizations for asthma (Barnes, Rodger, & Thomson, 1998, p. 589-596; Trasande & Thurston, 2005).

In the Eastern U.S., summer ozone pollution is associated with more than 50,000 hospitalizations per year for asthma and other respiratory conditions. U.S. and Canadian studies have shown warm season ozone-associated increases in respiratory hospital admissions ranging from 2-30% per 20 ppb (24 hours), 30 ppb (8-hours) or 40 ppb (1-hour) (U.S. EPA, 2006).

EAF for asthma

Estimate: 30% (ranges from 10% to 35%)

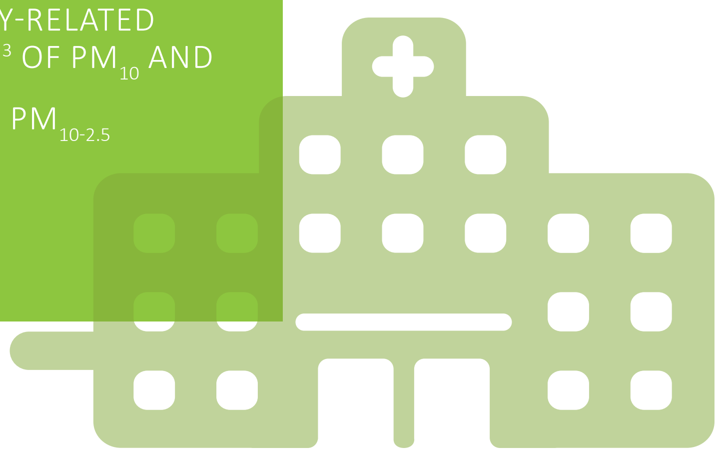
A panel of experts (Landrigan, et al., 2002) determined 30% of asthma episodes (exacerbations of childhood asthma) can be attributed to outdoor air pollution (e.g., vehicle exhaust and power plant emissions). This estimate does not include exacerbations due to other triggers such as mold, secondhand cigarette smoke, pollen, or respiratory infections.

STUDIES HAVE SHOWN

5-20% INCREASES IN RESPIRATORY-RELATED HOSPITALIZATIONS PER 50MCG/M^3 OF PM$_{10}$ AND

5-15% PER 25MCG/M^3 OF PM$_{2.5}$ OR PM$_{10-2.5}$

WITH THE LARGEST EFFECT ON ASTHMA HOSPITALIZATIONS (U.S. EPA, 2004)



Economic Burden

The CDC Chronic Disease Cost Calculator (Centers for Disease Control and Prevention, 2013) estimates the number of asthma cases and then calculates the direct and indirect costs per case accrued over the course of one year for children ages 0-17 years, adjusted to 2014 dollars.

The number of childhood deaths in Minnesota due to asthma is quite small and can vary from year to year. Therefore, a five year average was used to calculate the annual average number of premature deaths; there were an average of 2 deaths due to asthma from 2007 to 2011 in Minnesota. Mortality cost for the premature death of a child was estimated using the present value of lifetime earnings (Max, et al., 2004). Values were averaged for both boys and girls for 0-17 years of age.

The following costs estimates are included in this report:

- Direct medical and non-medical costs
- Indirect costs, such as lost parental earnings due to school absenteeism
- Lost potential earnings due to premature death

The total costs of childhood asthma in Minnesota in 2010 was $105 million (in 2014$), including direct medical costs, indirect cost of missed school days, and deaths due to asthma. Applying the 30% EAF to this annual cost, **the total economic burden of childhood asthma in Minnesota in 2010 attributable to the environment was $31.6 million (in 2014$) (range: $10.5 million – 36.9 million).**

TABLE 1: ANNUAL COSTS OF CHILDHOOD ASTHMA IN MINNESOTA IN 2010.

Type of cost	Included in cost	Inputs	Annual value (2014$)
Direct (medical)	Physician visits, ED, hospitalizations, prescription medication	$940 average cost x 78,900 children treated	$80,190,000
Indirect (missed school)	Lost parental earnings due to missed school days	$156 (daily wage) x 141,000 school days missed	$23,840,000
Indirect (mortality)	On average, there were 2 premature deaths due to asthma (2007-2011 combined)	$700,000 per premature death x 2 deaths (average)	$1,400,000
		Estimated total cost:	**$105,430,000**
		EAF:	30%
		Environmentally attributable cost of childhood asthma:	**$31.6 million**
		Range (10%-35%):	($10.5- $36.9 million)

Source: CDC Chronic Disease Cost Calculator; EAF = environmentally attributable fraction

The Costs of Childhood Blood Lead Poisoning

Disease burden in Minnesota

Lead poisoning is a medical condition that occurs when lead builds up in the body. Elevated blood lead levels (EBLLs) in young children are associated with adverse health effects, including learning impairment, behavioral problems, and even death at very high levels.

The proportion of children with lead poisoning has declined over time in Minnesota, from about 2% of children born in 2000 to less than 1% of children born in 2009, among children tested before 3 years of age.

THRESHOLD LOWERED

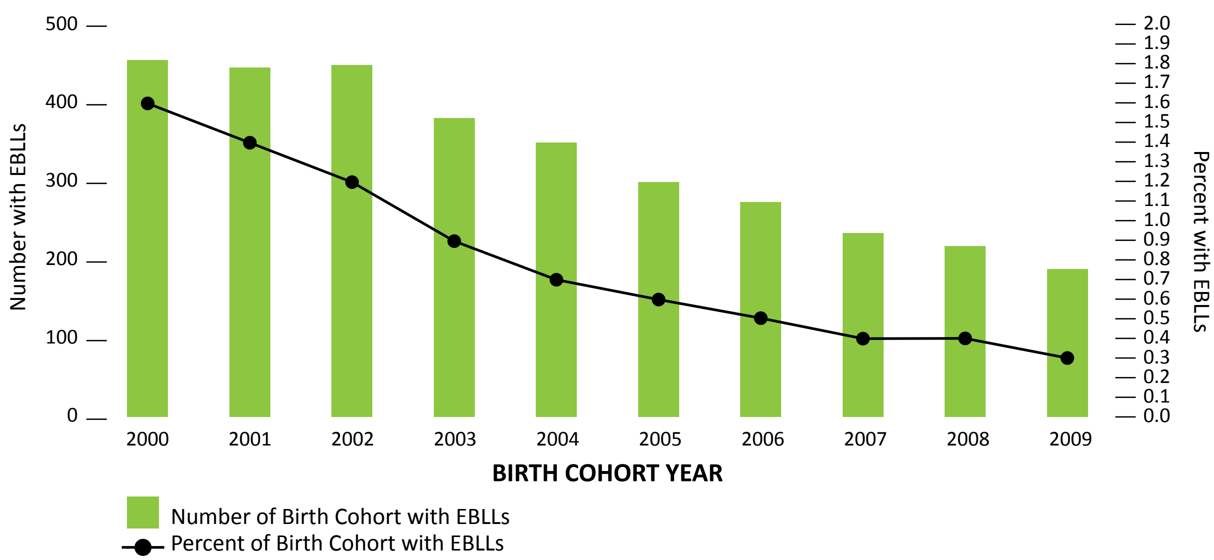
There is no safe level of exposure to lead. The threshold for an "elevated blood lead level" in Minnesota was recently lowered from 10 to 5 µg/dL (Minnesota Department of Health, 2014a). The CDC also recently lowered the threshold to 5 µg/dL, and future reductions are likely. This threshold is used to trigger actions for investigation and remediation of sources of lead in the home.

BLOOD LEAD LEVELS ARE DECLINING IN MINNESOTA

Testing for lead poisoning is important as it often occurs with no identifiable symptoms. The percentage of tested children with elevated blood lead, levels previously defined by the state of Minnesota as a level of 10 µg/dL or higher, has been decreasing.

Blood lead testing in Minnesota is targeted and not universal, meaning not every child is tested. That means this measure is not generalizable and cannot be used to interpret the prevalence or incidence for all children living in Minnesota.

CHILDREN WITH CONFIRMED ELEVATED BLOOD LEAD LEVELS (EBLLs) IN MN



µg/dL means micrograms for lead per deciliter of blood

DISPARITIES OBSERVED

Children in poverty are at greater risk for lead poisoning. About 15% of all children (<18 years) and about 17% of all children under age 5 in Minnesota live in poverty. The majority of counties in northern Minnesota have a higher percentage of children living in poverty, compared to the state average of 15%, as do Hennepin and Ramsey Counties.

RISK FACTORS

Children less than 6 years old living in homes built before 1978 are most at risk for lead poisoning. Younger children are more at risk because their bodies absorb lead more easily and their brains are still developing. Lead-based paint is a common cause of lead poisoning. People can be exposed to lead by ingesting dust from deteriorated lead paint, consuming other materials contaminated with lead, or breathing aerosolized lead paint dust. Young children frequently put their hands or other objects, which may be contaminated with lead, into their mouths. The U.S. EPA estimates that more than 80% of all homes built in the U.S. before 1978 contain lead-based paint.

EAF for childhood lead poisoning

EAF: 100% (no range)

A panel of experts (Landrigan et al., 2002) determined that all cases of lead poisoning are assumed to be of environmental origin. Therefore, the EAF is 100%, and no range was calculated.

Economic Burden

About 54,000 Minnesota children born in 2004 were tested before the age of 6, or about 76% of the 2004 birth cohort. The average peak blood lead level (BLL) was 2.5 micrograms of lead per deciliter of blood (µg/dL) – among children born in 2004 and tested up to age 6. This BLL was converted into lost IQ points, then into lost lifetime earnings for boys and girls, separately. **The total economic burden of childhood lead poisoning in Minnesota on lifetime earnings is $1.9 billion (in 2014$).**

TABLE 2: CALCULATION OF PERCENT LIFETIME EARNINGS LOST DUE TO CHILDHOOD LEAD POISONING AMONG THE 2004 BIRTH COHORT IN MINNESOTA.

Mean peak BLL	IQ points lost due to lead poisoning	Total IQ points lost due to lead poisoning	Lifetime earnings lost due to IQ points lost	Total lifetime earnings lost
2.5 µg/dL	0.47 IQ points per 1 µg/dL	1.19 IQ points	2.39% per IQ point lost	2.85%

TABLE 3: COST OF CHILDHOOD LEAD POISONING ATTRIBUTABLE TO THE ENVIRONMENT FOR THE 2004 BIRTH COHORT IN MINNESOTA.

Lifetime earnings lost due to lead poisoning		Lifetime earnings per child (2007$)	Lifetime earnings lost per child	Number of children	Lifetime earnings lost	Final economic burden (2014$)
2.85%	Boys	$1,055,542	$30,117	35,988	$1,083,833,838	$1.9 billion
	Girls	$622,653	$17,765	34,626	$615,145,548	

Strategies to reduce environmental risks and improve children's health

Despite the limitations of the data (see page 14), this report points to important actions that Minnesotans can take to reduce exposure to environmental risks and lower the economic burden.

Actions Addressing Air Pollution and Asthma

According to a recent report, air quality in Minnesota has been steadily improving over the past 10 years (Minnesota Pollution Control Agency, 2013). Both ozone and particulate matter levels, which are known asthma triggers, are declining for most Minnesotans. Local initiatives, which include the Minnesota Emissions Reduction Project (reduced particle pollution from three metro area power plants), Project Green Fleet (reduced diesel emissions from school buses and other vehicles), and school bus anti-idling laws are examples of recent actions that are making a difference.

Soon, more stringent air quality standards will be adopted, and new initiatives will be needed, such as those proposed by Clean Air Minnesota (Environmental Initiative, 2014) for reducing wood smoke, retiring older, polluting vehicles, and incentives for alternative fuels. In 2014, the Minnesota Pollution Control Agency and MDH are working on developing new tools for urban communities for monitoring and addressing local sources of air pollution that exacerbate asthma.

The MDH Asthma Program educates health care providers, people with asthma, their caregivers, and others about ways to improve asthma care and reduce exposure to asthma triggers (Minnesota Department of Health, 2014b). Since 2005, the program has received funding for projects to conduct low-cost home environmental interventions. These projects have led to decreased asthma symptoms, fewer missed school days and health care visits following the intervention; the original project was included in CDC's Community Guide Asthma Control: Home-based Multi-trigger Multicomponent Environmental Interventions (www.thecommunityguide.org/asthma/multicomponent.html).

Actions Addressing Childhood Lead Poisoning

The MDH Lead and Healthy Homes Program is a leader for childhood lead poisoning prevention efforts statewide, working toward the elimination of childhood lead poisoning as a public health problem through lead education, by identifying at-risk homes and children, and supporting people exposed to lead (Minnesota Department of Health, 2010).

Efforts to reduce lead exposure may be resulting in fewer cases of elevated blood lead among Minnesota children. This is similar to trends across the nation. Housing rehabilitation programs, such as those funded by the U.S. Department of Housing and Urban Development (HUD), have focused on making homes lead-safe. Lead has also been eliminated from paint, gasoline, and many consumer products and children's toys. Lead-related manufacturing has also introduced greater controls to reduce occupational and environmental lead exposures.

Recent State Policies Addressing Chemical Exposures in Children

In *The Price of Pollution* (Schuler, Nordbye, Yamin & Ziebold, 2006), the policy recommendations to address these costs in Minnesota included phasing out chemicals in certain products; reforming regulation to prevent exposure, and improved data collection through the establishment of a system for disease tracking and biomonitoring (Schuler et al., 2006). In recent years, the Minnesota Legislature has passed several significant laws to address these recommendations.

The *Toxic Free Kids Act* (MN Statutes, sections 116.9401 - 116.9407) was passed in 2010. This law requires MDH to create two lists of chemicals: one list called "Chemicals of High Concern" and one called "Priority Chemicals." Through this program, MDH is identifying the potential for hazardous chemical exposures which may be harmful to health, particularly to children and pregnant women.

In 2007, the Legislature passed a law that established the *Minnesota Environmental Health Tracking and Biomonitoring Program* (MN Statutes, sections 144.995-998, 2007). This law directed MDH to collect and share existing health and environment data and to conduct a series of community-based biomonitoring projects. Today, MDH's capacity for measuring and tracking chemicals in people (biomonitoring) has expanded beyond blood lead. MDH has monitored people in several Minnesota communities, measuring exposures to arsenic, perfluorochemicals (PFCs), mercury, lead, cadmium, bisphenol-A (BPA), parabens, and cotinine (tobacco smoke). More information about biomonitoring at MDH is available on the Minnesota Biomonitoring Program website (www.health.state.mn.us/biomonitoring).

Minnesota Environmental Public Health Tracking (MN Tracking)

MN Tracking brings greater availability, public access and transparency to our public health data. MN Tracking collects, analyzes and tracks data on over 20 public health topics including asthma, air quality, cancer, developmental disabilities, pesticide poisoning and childhood lead poisoning. Data are displayed in charts and maps, available online to the public on Minnesota Public Health Data Access (https://apps.health.state.mn.us/mndata).

In the future, MN Tracking will work to refine the methods used in this report, updating them as new data become available. MN Tracking will continue to monitor disparities in disease burden, improving the available data needed to support public health strategies that are targeted at improving health for all Minnesota's children.

MnTracking
Environment, Exposure & Health

References

Primary references:

THIS REPORT IS BASED ON METHODOLOGY DEVELOPED BY THE NATIONAL ACADEMY OF SCIENCES, AND BY PHILIP LANDRIGAN AND COLLEAGUES, AND PUBLISHED IN ENVIRONMENTAL HEALTH PERSPECTIVES IN 2002:

Landrigan, P. J., Schechter, C. B., Lipton, J. M., Fahs, M. C., & Schwartz, J. (2002). Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. Environmental Health Perspectives, 110(7), 721-728.

All references:

Barnes, P., Rodger, I., & Thomson, N. (Eds.). (1998). *Asthma: Basic Mechanisms and Clinical Management (3rd edition)*. London: Academic Press.

Bureau of Labor Statistics. BLS Inflation Calculator. Retrieved March, 2014, from http://data.bls.gov/cgi-bin/cpicalc.pl

Canfield, R. L., Henderson, C. R., Jr., Cory-Slechta, D. A., Cox, C., Jusko, T. A., & Lanphear, B. P. (2003). Intellectual impairment in children with blood lead concentrations below 10 microg per deciliter. *The New England Journal of Medicine, 348*(16), 1517-1526. doi: 10.1056/NEJMoa022848

Centers for Disease Control and Prevention. (2013, November 22). Chronic Disease Cost Calculator Version 2, 2014, from http://www.cdc.gov/chronicdisease/resources/calculator/

Environmental Initiative. (2014). Clean Air Minnesota. Retrieved May, 2014, from www.environmental-initiative.org/projects/clean-air-minnesota/clean-air-minnesota-resources

Grosse, S. D., Krueger, K. V., & Mvundura, M. (2009). Economic productivity by age and sex: 2007 estimates for the United States. *Medical Care, 47*(7 Suppl 1), S94-103. doi: 10.1097/MLR.0b013e31819c9571

Landrigan, P. J., Schechter, C. B., Lipton, J. M., Fahs, M. C., & Schwartz, J. (2002). Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. *Environmental Health Perspectives, 110*(7), 721-728.

Max, W., Rice, D. P., Sung, H. Y., & Michel, M. (2004). Valuing Human Life: Estimating the Present Value of Lifetime Earnings, 2000. *Center for Tobacco Control Research and Education (UC San Francisco).*

Minnesota Department of Health. (2010). Childhood Lead Poisoning Elimination Plan (Aug 2010 ed.).

Minnesota Department of Health. (2012). Asthma in Minnesota: 2012 Epidemiology Report.

Minnesota Department of Health. (2014a). Finding of the Commissioner of Health. *In Re: Definition of Elevated Blood Lead Level Under Minnesota Statutes, Section 144.9501, subdivision 9*

Minnesota Department of Health. (2014b). A Strategic Plan for Addressing Asthma in Minnesota 2014 to 2020.

Minnesota Pollution Control Agency. (2013). Air Quality in Minnesota: 2013 Report to the Legislature.

MN Statutes, sections 116.9401 - 116.9407 (2010).

MN Statutes, sections 144.995-998 (2007).

Muennig, P. (2009). The social costs of childhood lead exposure in the post-lead regulation era. *Archives of Pediatrics & Adolescent Medicine, 163*(9), 844-849. doi: 10.1001/archpediatrics.2009.128

National Asthma Education and Prevention Program. (2007). Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma-Summary Report 2007. *The Journal of Allergy and Clinical Immunology, 120*(5 Suppl), S94-138. doi: 10.1016/j.jaci.2007.09.043

Schuler, K., Nordbye, S., Yamin, S., Ziebold, C., Minnesota Center for Environmental Advocacy, & Institute for Agriculture and Trade Policy. (2006). The Price of Pollution: Cost Estimates of Environment-Related Childhood Disease in Minnesota.

Trasande, L., & Liu, Y. (2011). Reducing the staggering costs of environmental disease in children, estimated at $76.6 billion in 2008. *Health Affairs, 30*(5), 863-870. doi: 10.1377/hlthaff.2010.1239

Trasande, L., & Thurston, G. D. (2005). The role of air pollution in asthma and other pediatric morbidities. *The Journal of Allergy and Clinical Immunology, 115*(4), 689-699. doi: 10.1016/j.jaci.2005.01.056

U.S. Environmental Protection Agency. (2013). America's Children and the Environment, Third Edition (ACE3).

U.S. EPA. (2004). Air Quality Criteria for Particulate Matter (Final Report, Oct 2004). Washington, DC.

U.S. EPA. (2006). Air Quality Criteria for Ozone and Related Photochemical Oxidants (Vol. 2006 Final). Washington, DC.

World Health Organization. (2006). Preventing disease through healthy environments: Towards an estimate of the environmental burden of disease.

Appendix: About the Data (Technical Notes)

Childhood Asthma Data Analysis

METHODS FOR ASTHMA

The data for asthma analysis were obtained from the Chronic Disease Cost Calculator (version 2) (Centers for Disease Control and Prevention, 2013). The cost calculator was developed to provide state level estimates of medical expenditures for certain chronic diseases. Expenses included direct medical costs (physician visits, emergency department visits, hospitalizations and prescription medicine) as well as indirect costs resulting from absenteeism. Data for children in the cost calculator are only available for asthma and depression. The methods utilized by the cost calculator are described in great detail in the technical appendix for the cost calculator. Briefly, data were collected from multiple sources to estimate the treated population and per-person medical and absenteeism costs. Complex survey weights were used to incorporate data from Medicaid Statistical Information System, Current Population Survey and Medical Expenditure Panel Survey. Regression models were used to estimate the costs associated with asthma.

The number of children who died from asthma was obtained from the Asthma Program (Minnesota Department of Health, 2012). Death from asthma in children is a relatively rare event in Minnesota. To deal with annual variation in the numbers, an annual average was calculated over 5 years of data: 2007-2011. The estimate of the economic cost of premature death in children used data from Center for Tobacco Control Research and Education, University of California, San Francisco (Max, et al., 2004). The appendix of Max et al. (2004) contains present value of lifetime earnings by age. For asthma, the values for 0-17 years were averaged to get one value to assign for a premature death of a child.

All costs were converted to 2014 dollars (2014$) using the Consumer Price Index Inflation Calculator (Bureau of Labor Statistics). The low and high end estimates of the EAF were applied to the costs to show a range of estimates of the economic burden.

Childhood Lead Poisoning Data Analysis

METHODS FOR MEAN PEAK BLOOD LEAD LEVEL (BLL)

This analysis included children born in 2004 and tested up to age 6 (2004-2010 test years), and therefore represents the status of average peak BLLs as of 2010, using the cumulative incidence of children exposed to lead up to age 6, similar to Landrigan et al. (2002).

If there were multiple lead tests between 2004 and 2010 for a child, the highest (peak) BLL was selected. Venous lead tests were selected over capillary tests because capillary tests have a greater rate of false positives. Detectable results were preferred over BLLs below the limit of detection (LOD), also known as nondetects. The LOD changes depending on the laboratory due to differences in analytic methods, equipment, and reporting limits. Nondetects were addressed using robust linear regression on order statistics (ROS) methods, which applies a theoretical distribution to the data in order to calculate a mean and confidence interval.

RESULTS FOR MEAN PEAK BLL

The average peak blood lead level (BLL) among children born in 2004 and tested up to age 6 is 2.5 micrograms of lead per deciliter of blood (µg/dL). This estimate is specific to Minnesota children testing for blood lead.

About 54,000 Minnesota children born in 2004 were tested before the age of 6, or about 76% of the 2004 birth cohort. Lead testing is not universal in Minnesota. Instead, high risk children (such as those that live in older housing that may have lead-based paint) are targeted for lead testing. Because lead testing in Minnesota is targeted and not random, any measures calculated using lead testing data are not generalizable and cannot be used to measure the prevalence or incidence for the overall population of children living in Minnesota.

METHODS FOR ECONOMIC COST (SEE TABLE 2)

The measurable costs of lead exposure for this report exclude crime due to lead exposure as well as health, earnings, and welfare use due to loss of IQ from lead exposure (Muennig, 2009). Landrigan et al. 2002 only includes the direct effect of lost IQ points on lifetime earnings, as does the MN Center for Advocacy's *The Price of Pollution* (Schuler, Nordbye, Yamin & Ziebold, 2006). Therefore, we calculated the economic burden of lead poisoning using only lost lifetime earnings.

Using Canfield (2003) to convert BLLs into loss of IQ points, there is an estimated loss of 0.47 IQ points (ranging from 0.25 to 0.70 IQ points lost) for every 1 µg/dL increase in BLLs (see Table 2, unadjusted estimate of IQ loss using the peak blood lead at 5 years of age). Therefore, the 2004 birth cohort in Minnesota has lost an average of approximately 1.25 IQ points per child due to the cumulative incidence of lead poisoning up to age 6.

According to Landrigan (2002), there is a loss of 2.39% of lifetime earnings for every IQ point loss. Therefore, the 2004 birth cohort in Minnesota has lost an average of 2.98% of lifetime earnings.

RESULTS FOR ECONOMIC COST (SEE TABLE 3)

Market productivity data were obtained for boys and girls separately (Grosse, et al., 2009). The total lifetime earnings (in market productivity) was $1,055,542 for boys and $622,653 for girls (2007$). Multiplying those amounts by 2.85% in lifetime earnings lost equates to $30,117 lost per boy and $17,765 lost per girl. There were 35,988 boys and 34,626 girls in the 2004 birth cohort in Minnesota, which equates to $1.1 million lost in lifetime earnings for boys and $615 thousand lost in lifetime earnings for girls in the 2004 birth cohort overall. That sums to $1.7 billion (2007$), and by applying an inflation index from the Consumer Price Index calculator (Bureau of Labor Statistics) to convert to 2014 dollars, the total economic burden of childhood lead poisoning in Minnesota on lifetime earnings comes to $1.9 billion (in 2014$). In summary, the mean peak blood lead level in the 2004 birth cohort, through a decrease in IQ points due to lead exposure and a subsequent loss in lifetime earnings, resulted in a total economic burden of $1.9 billion (2014$).

Limitations of this analysis

COSTS LIKELY UNDERESTIMATE THE TRUE ECONOMIC BURDEN

This report addresses specific costs that are measurable with the available data and focuses on environmental risks that are amendable to change. Several costs are not included in the estimates. For example, the costs to treat childhood lead poisoning or conduct environmental assessments of lead exposure are not included, either because the cost is at least an order of magnitude smaller than the cost of lost lifetime earnings or because the cost cannot be estimated. This report does not capture the longer term effects of environmental exposures that occur at a young age, but do not appear as disease until later in life. Therefore, **the costs calculated in this report likely underestimate the true cost to Minnesota's economy of asthma episodes and lead poisoning in children that are attributable to environmental risk factors.**

THE ENVIRONMENTALLY ATTRIBUTABLE FRACTION (EAF) IS AN UNCERTAIN ESTIMATE

The EAFs for asthma used in this report are based on published scientific studies that measure the relationship between specific risks and disease in populations. However, estimating the EAF is itself not a scientific measurement, but is based on judgment by experts. The studies used to estimate the EAFs are not specific to Minnesota populations, and the estimates do not include the most recent science published in the past few years. The true fraction of these diseases that is attributable to environmental factors in Minnesota is unknown. The EAF can change over time in a given population, and it can be different from one population to the next. The EAF can also be modified over time by better population health care that leads to reduced population vulnerability, and environmental interventions that reduce exposure.

THE HEALTH AND ECONOMIC BURDEN IS NOT SHARED EQUALLY

We know that **the burden and cost of environmentally attributed disease in Minnesota's children is not shared equally across all communities of the state.** Ample evidence points to significant disparities in our state with respect to the occurrence of childhood asthma episodes, and the prevalence of blood lead poisoning, both of which are known to be greater in lower income communities. In addition, environmental exposures to pollutants are not shared equally. For example, residential communities located close in proximity to high traffic corridors experience greater pollutant levels from vehicle exhaust. Communities that are economically disadvantaged are less able to take actions to avoid environmental risks in their homes and neighborhoods, which further leads to a disparate burden.

For more information, contact:
Minnesota Department of Health
Minnesota Environmental Public Health Tracking
PO Box 64882, St. Paul, MN 55164-0882

Phone: 651-201-5900
Toll Free: 1-800-205-4987

Email: health.tracking@state.mn.us