WORKING PAPER

Children's Lead Poisoning and Asthma

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This document contains two analyses of children's health as related to lead poisoning and asthma. Included in this study is a comprehensive review of research relating to the costs and benefits of medical treatment and disease prevention with particular attention to school readiness, loss of school days, school achievement, lifetime earnings, and health care costs. Also included are the costs of non-action and the benefits of treatment, disease management, and irritant abatement (e.g. lead paint). Included as well are overall costs to the United States with a focus on the cities of Philadelphia and Los Angeles.

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Children and Lead Poisoning

The prevalence of lead paint poisoning among children younger than six years of age has fallen dramatically over the last several decades largely due to public health initiatives at the national, state, and municipal level. According to the most recent estimates by the Center for Disease Control (CDC), the geometric mean for blood lead levels (BLLs) for children under six fell to 2.2µg/dL (micrograms per deciliter) in 2000 from 14.9µg/dL in 1976. The number of children under the age of six with BLLs greater than 10µg/dL (the level most associated with the harmful health risks resulting from lead exposure) has fallen from an estimated 13.5 million to 434,000. This promising trend has overwhelmingly been caused by the reduction of the lead content in gasoline and paint.[1] Unfortunately, however, the sustainability of this trend seems unlikely.

Removing the last significant and persistent causes of lead poisoning appears to be the most challenging. The most prevalent source of lead exposure to children now is from lead paint used in housing prior to its ban in 1978. Pre-1950 house paint has the largest concentration of lead, but pre-1978 house paint also contained substantial lead content. And the most likely occupants of this housing are poor, non-Hispanic blacks living in the city. Since the costs of lead paint abatement are relatively high and the abatement must be done on a unit by unit basis (rather than imposed at an industry level), there must be a substantial and costly commitment from government to further reduce lead poisoning among vulnerable children. Additional significant sources of lead exposure, such as contaminated drinking water, also require large costs, like replacing older and corroded lead piping. Public health policy has been slow to address these lead poisoning risks, moving incrementally with targeted, more re-active policies. If the cost of pro-active, more universal lead abatement is seen as prohibitive, the costs of inaction have proven significantly more.

A growing body of literature has detailed the economic costs and risks of lead poisoning including several exhaustive analyses summarizing these costs and setting them against the estimated costs of lead paint abatement. These cost-benefit analyses have been particularly useful in making the case for more aggressive government action. However, new research has broadened still the scope of our understanding of the societal costs of lead poisoning. Health impairment, particularly in terms of mental development, has been found at significantly lower BLLs than the CDC marker of 10µg/dL. New studies have begun to analyze the correlation of lead poisoning to crime rates and costs. And studies have also begun linking early childhood lead exposure to health problems occurring later in life, even into elder years. In order to fully understand the societal costs resulting from lead poisoning, we must at least begin to take into consideration this research.

We begin with an assessment of the costs to lead removal. In this section, we detail the extent of the problem with particular attention to housing stock and lead paint. While drinking water is estimated to contribute about 10 to 20 percent of total lead exposure in young children, our focus in this section will be on lead paint abatement programs. Following this estimation of costs, we next discuss the benefits of lead removal and lowered blood lead levels on children, families, and

[1] Lead was banned from house paint in 1978 and lead was phased out of gasoline over a 25-year period ending in 1995.

society. We target costs in terms of lost future income, health care costs, special education, and criminal costs. Specifically, we examine the effects of high blood lead levels on intellectual impairment and the requisite special education costs and effect on lowered future earnings. We also investigate the effect of high lead on social behavior and increases in crime and the costs of this crime to both the criminal justice system and also to society. We present a brief assessment of the costs of lead poisoning to health later in life.

We conclude with a discussion of the incidence of lead poisoning and an assessment of the overall costs and benefits to lead removal. Our focus will be on rates of prevalence of children with 10μg/dL or higher, however we will also discuss the prevalence and effects of lead poisoning on children with 5μg/dL. In addition, we detail the prevalence of high lead levels in two cities, Philadelphia and Los Angeles, and provide an analysis of the costs and benefits of lead removal for these targeted populations.

In this paper, we demonstrate the cost-effectiveness of strategies to reduce lead exposure. Our most conservative estimates suggest that for every dollar spent on abatement, two dollars are returned in terms of health benefits, increased IQ, higher lifetime earnings, less spending on special education and less criminal activity. The more optimistic case, wherein the costs of abatement are estimated to be lower and the benefits to reduction utilize less conservative estimates on the number of children affected, the returns are eighteen-fold. That is, for every dollar spent on reduction of lead exposure, eighteen are gained in benefits for a total 21.4 billion dollars of net benefits to intervention.

COST OF ABATEMENT

While regulations on lead in gasoline and lead paint have greatly reduced the incidence of dangerous lead levels in children, many children are still at risk for lead poisoning. Lead paint and the related dust and chips from lead paint are the leading cause of high lead levels in US children. While high lead levels from paint is the focus of this study, lead in water has had a resurgence of interest in several cities, as recent studies have found elevated lead content in many city homes and pipelines. For example, an estimated 18% of homes in Washington, DC, have lead service pipes (MMWR, 2004).

Other lead exposure in the home include making stained glass, glazed pottery, remodeling homes, and toys or pottery containing lead-based paints (Mid-Atlantic Center for Children's Health and the Environment, 2003). Certain calcium supplements (which includes antacids and infant formula) were found to be another source of lead exposure (Scelfo et al, 2000). In addition, second-hand smoke was found to be a contributor of lead exposure in children (Mannino et al, 2003). Because 80-90% of lead in children is attributed to lead paint, this type of abatement is our focus.

Lead Paint Abatement in Housing

Up until the 1978 ban prohibiting the use of lead in new paint, lead paint was common in housing units. Therefore, older housing dwellers are at greater risk for lead exposure. For these older housing units, the US Department of Energy's National Environmental Policy Act (2003) lists four abatement possibilities: paint stripping, replacement, encapsulation, and enclosure. Paint stripping can be done through chemical or physical techniques, though both require special protective equipment for containment of waste and are impossible without the creation of dangerous lead dust. Replacement refers to the removal of components that have lead paint surfaces, such as windows, doors, and trim. While a long term solution, it can be very expensive and time-consuming. Encapsulation is a process of covering or sealing painted surfaces. Its disadvantage is the requirement to re-inspect and routinely maintain. The last method is enclosure, or the resurfacing or covering of surfaces by mechanically affixed materials, providing long-term protection.

Jacobs et al (2003) presents a case study in which the costs of improper lead based paint removal were examined. They found that when lead paint was removed by a power sander in an uncontrolled environment, the costs of decontamination was $195,693 for a single house. This greatly exceeded the incremental costs of incorporating lead-safe work practices into repainting, a cost they estimated to be $1000 for the individual homeowner. This unfortunate study underlies the importance of outreach and education in the safe reduction of lead in the home.

The President's Task Force (2000) estimates costs for two methods of abatement. The first is lead hazard screening and interim controls – specialized maintenance and safe repainting and renovation work practices. This is estimated to cost $1,000 per housing unit. These interim controls require managing lead paint on an ongoing basis to ensure it does not become hazardous. The second method, inspection, risk assessment, and full abatement of lead paint, is estimated to cost $9,000 per housing unit. Korfmacher (2003) finds the national average cost of making housing lead-safe are $7,000 per unit. Therefore, we estimate a range of costs of lead abatement, depending on the variation in abatement requirements, regional differences in costs, and condition of housing stock. Our generous cost range is between $1,000 and $9,000 per housing unit.

Table 1. Lead Paint Abatement.

National Average Cost	Number of Housing Units	Total Cost of Abatement
$1,000-$9,000 per unit	1.2 million	$1.2 billion - $10.8 billion

Using this national average, we can estimate the costs to total lead paint abatement. According to the Center for Disease Control (2003), 24 million housing units are subject to lead-based paint. Four million of these homes have young children.. Jacobs et al (2002) find that 1.2 million of the 4 million are at significant risk, defined as homes with low income families and children under 6. Overall, 17% of these units are government low income housing and 35% are low income housing of any type. These are the children most at risk. Targeting the homes most in need, the estimated costs of total lead paint abatement in homes with young children is $1.2 billion to $10.8 billion.

BENEFITS TO REDUCTION

It was originally thought that only extremely high blood lead levels (measured by micro grams per deciliter or µg/dL) were harmful to children, but recent research has found that lower levels can be harmful as well. In 1975, the Center for Disease Control (CDC) set the standard at 40 µg/dL. In 1991, the standards were lowered to 10µg/dL due to findings in the 1980s indicating negative effects such as decreased intelligence and other adverse neurodevelopmental effects at these lower lead blood levels.

Health Care Costs

High lead levels can cause various health problems, including learning disabilities, mental retardation, stunting of growth, seizures, coma, or death. Damage can be done to the nervous, hematopoietic, endocrine, and renal systems (Bernard, 2003). Lower lead levels can negatively impact cognitive and neurobehavioral functioning.

Treatment for high lead levels is essentially monitoring and attempting to keep the child from more harm. The damage of lead poisoning is irreversible, therefore the majority of health care costs are composed of diagnostic testing and environmental investigation, combined with visits to the nurse or doctor. In the most extreme cases, children are required to have oral or intravenous chelation, a method of removing excess lead from the body in an attempt to prevent further harm. Chelation can be very painful and expensive. Kemper et al (1998) provides the most comprehensive assessment of health care costs. In their analysis, they cost out each of the CDC's recommendations for each BLL.

In 1996 dollars, Kemper et al (1998) estimate costs of screening and treatment as follows: venipuncture ($6.53), capillary blood sampling ($3.27), lead assay ($17.42), risk assessment questionnaire ($2), nurse-only visit ($32), physician visit ($80), environmental investigation and hazard removal ($335), oral chelation ($253), and intravenous chelation ($1843). As children's blood lead levels increase, as do their medical costs. Based on Kemper et al (1998)'s assumptions and the CDC recommendations, we have assessed the health costs per child given the levels of lead found in the population.

Children with less than 10 µg/dl were not included as the CDC has no recommended action. For children with 10 to 20 µg/dl, further diagnostic testing is required including venipuncture ($6.53) and lead assay ($17.42) and an additional nurse-only visit ($32), for a total cost of $55.95 per child. For children with 20 to 45 µg/dl, eight visits for diagnostic testing including the nurse visit ($447.60), plus an environmental investigation ($335), for a total cost of $782.60 per child. For children with blood lead levels of 45 to 70 µg/dl, the recommended regime includes all of the above at a cost of $782.60 plus oral chelation ($235) for a total cost per child in this range of $1017.60. For children with 70 µg/dl or greater, oral chelation is replaced with intravenous chelation ($1,843) for a total cost of $2,625.60 per child.

Table 2. Health Care Costs.

Blood lead level	Cost of recommended medical action	Number of children affected	Total cost for each group
10 – 20 μg/dl	$55.95	60,673-559,929	$3.4m-$31.3m
20 – 45 μg/dl	$782.60	13,336-123,073	$10.4m-$96.3m
45 - 70 μg/dl	$1017.60	760-7,014	$773,376-$7.1m
Over 70 μg/dl	$2625.60	118-1,089	$309,821-$2.9m
All blood lead levels			$14.9m-$137.6m

Our estimates of the number of children affected in each group is a combination of two sets of data: the National Health and Nutrition Examination and state child blood lead surveillance data (Meyer et al, 2003). The lower estimate is the total number of confirmed children at each blood lead level, measured in micrograms per deciliter (μg/dl). The higher cost is derived from assuming fewer children were screened.

Table 2 reports the health care costs by blood lead level groups. Summing across groups, the total cost of treatment is between $14.9 million and $137.6 million.

Future Health Costs

The 14.9-137.6 million dollar range only includes health care costs for young children. Lead poisoning can cause negative health effects later in life such as neurological disorders, adult hypertension, elevated blood pressure, and osteoporosis. Wright et al (2003) find that lead exposure is inversely associated with cognitive performance among older men. That is, age associated cognitive decline might be accelerated by lead exposure. Korrick et al (2003) posit evidence that lead exposure leads to chronic disorders later in life. Latorre et al (2003) suggest a relationship between lead exposure and increased stores of bone lead during menopause. While little is still known about the long term effects of lead exposure, recent research points to a continuing relationship between high lead in childhood and future health problems.

Social and Behavioral Costs

The most common area of research on the scope of the effects of blood lead levels on children and society is the negative relationship between high lead levels and brain functioning. Aside from simply the health care costs due to elevated lead, high lead levels cause children to have lower IQ levels, increased need for special education, reduced likelihood of high school and college graduation, lower lifetime earnings, and a higher propensity to engage in criminal activity. In this section, we will take each of these factors in turn, assessing the evidence and determining the costs of elevated lead levels to the individual and society as a whole.

IQ

A variety of studies analyze the effects of high blood lead levels on intellectual functioning, measured by various forms of academic testing, the most common of which is the intelligence quotient, or IQ. All research supports the finding that as blood lead levels increase, IQ falls.

Pocock et al (1994) and Schwartz (1994b) both provide comprehensive analyses of research on lead and IQ. Pocock et al find for a typical doubling of body lead burden from 10 to 20 or 5 to 10, there is an average deficit in IQ of 1 or 2 IQ points. Averaging all 14 cross-sectional studies they used, they report a slope of -2.53 IQ points per 10 µg/dl. Schwartz (1994b) likewise finds an average slope of -2.57 IQ points.

Other researchers find similar results for varying incremental blood lead level increases. Tong et al (1996) found that a change in blood lead level (BLL) from 10 to 20 µg/dl was associated with a decline of 3 IQ points. After controlling for confounding information such as home environment and maternal intelligence, Wasserman et al (1997) found a change from 10µg/dl to 30µg/dl was associated with a difference in IQ of 4.3 points. Grosse et al (2002) estimate that for each 1 µg/dL increase results in between a .185 and .323 point decline in IQ score

Whereas most studies estimating the relationship between blood lead levels and IQ in children focus on 10µg/dL and greater, Canfield et al (2003) estimate the relationship of IQ and blood levels below 10µg/dL. Using a non-linear approach, their principal finding was that blood lead concentration of 10 µg/dL is associated with a decline in IQ of 7.4 points. Additionally, blood lead concentrations of 10 µg/dL to 30 µg/dL are associated with a decline of approximately 2.5 points. They stress the important point that the relationship between lead level and IQ is nonlinear. That is to say, a one point increase in lead level does not correspond to a constant decline in IQ. For lower levels of lead, an increase in blood lead concentration has a greater impact on IQ (more negative) than at higher levels of lead. Canfield et al (2003) indicate that targeting only children with over 10 µg/dL misses an important portion of the population who is negatively affected by lead. Therefore, more children than previously estimated may be at risk.

Because of the wide range of estimates in previous research and the nonlinearity of the relationship between lead levels and IQ, we choose Schwartz (1994a)'s estimate, which is commonly cited (Salkever, 1995; Korfmacher, 2003) as the standard. Since Schwartz's estimate of .245 IQ points per 1µg/dL falls in between many of the other estimate, we believe this is a reasonable estimate of the effect.

Assuming a uniform distribution of lead levels within each grouping of data (e.g. 10-14 µg/dL), we can determine the average BLL for children conditional on having a blood lead level of at least 10µg/dL. Therefore, a child in the 10-14 category would be assigned an average level of 12µg/dL. Using this methodology, the average blood lead level for children under 6 in the US is 16µg/dL. A more conservative estimate would be to assume that each child within a grouping of data takes on the minimum level in that category. Therefore, a child in the 10-14 category would be assigned a level of 10µg/dL, clearly a low-ball estimate. Using this methodology, the average blood lead level for children under 6 in the US is 14µg/dL.

According to the 1999-2000 National Health and Nutrition Examination (NHANES), 434,000 children aged 1-5 years had blood lead level at least 10μg/dL.

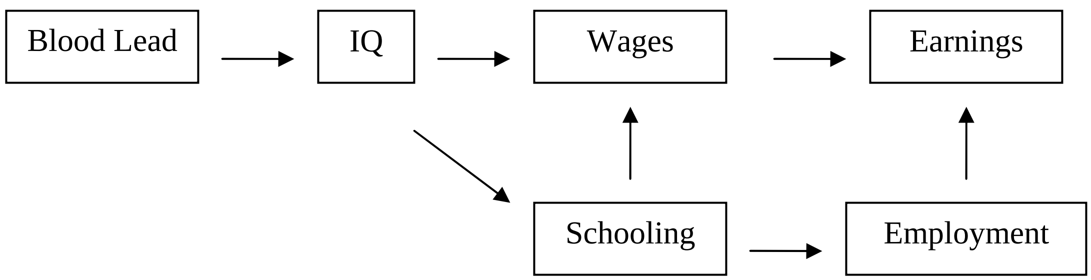
Table 3. Lead and IQ

Average Lead Level	Number of Children with Lead > 10μg/dL	Average IQ Loss per μg/dL	Total IQ Loss from Elevated Lead Levels
14μg/dL-16μg/dL	434,000	.245	1.5m-1.7m IQ points

Therefore, the total IQ loss from elevated lead levels is estimated to be 1.5 to 1.7 million IQ points. These losses are reflected in lost lifetime earnings.

Lifetime Earnings

Schwartz (1994) published one of the most influential papers in this area. He documents how blood lead levels influence IQ, then IQ has indirect and direct effects on earnings. See Figure 1 for these relationships. IQ has a direct effect on wages and thus on lifetime earnings. In addition, lowered IQ lowers the probability of more schooling, lower both wages and the likelihood of employment. Both of these in turn lower expected lifetime earnings.



Schwartz (1994) calculated the effect of a 1 point change in IQ is equal to a 1.76% difference in earnings. Salkever (1995) suggests that analysis based on this methodology are underestimating the effects of IQ on earnings because of recent changes to the labor market such as growing returns to education and differences in men and women's employment. He finds that total earnings lost should be increased by 50% to better reflect differences in lifetime earnings for those with high blood lead levels. Salkever (1995)'s estimate suggests that a 1 point change in IQ is equal to a 2.37% difference in earnings.

Grosse et al (2002) provides an updated assessment of the effect of IQ on earnings. Using the conservative Schwartz (1994) result of 1.76% loss in earnings for each IQ point, their lower bound estimate will be used as our conservative estimate of the effect. Taking the average discounted lifetime earnings at birth and at age five, they find the present value of discounted earnings of a average two years old in 2000 dollars to be $723,300. They calculated this number based on a standard 3% discount rate and a conservative 1% annual growth in productivity.

Putting this together, we can calculate the loss in earnings per 1 μg/dl increase by multiplying the IQ-BLL slope of .245 times the earnings-IQ slope of 1.76% time the present value of earnings of the average 2-year-old, or $723,300. We find a loss of $3,119 per 1 unit increase in lead level. Korfmacher (2003) estimated $3720 earnings loss/IQ for each 1 μg/dl increase in lead level. Therefore, we believe our estimate of $3,119 is not only reasonable but perhaps conservative.

To get the total lost earnings, we multiply the loss amount for each IQ level by the number of IQ points lost due to lead exposure to find the earnings lost due to increased lead exposure. The conservative estimate calculation is 1.5 million IQ points times lifetime earnings ($723,300) times lost lifetime earnings due to a 1 point IQ loss (1.76%). This amounts to $19 billion to $21.5 billion in lost earnings.

Table 4. Lifetime Earnings.

Total IQ Loss from Elevated Lead Levels	Pres Discounted Value (3%) of Lifetime Earnings	Earnings Loss Due to a 1 pt IQ Loss	Total Earnings Lost (3% discount rate)	Tax Revenue (15% marginal tax rate)
1.5m-1.7m IQ points	$723,300	1.76%	$19.0b-$21.5b	$2.8b-$3.2b

For these costs to the individual in lifetime earnings, there is also lost tax revenue. Korfmacher (2003), using the methodology of Grosse et al (2002) estimates that the state of New York is losing nearly $78 million in tax dollars each year due to lowered earnings due to lead poisoning. If we perform the same exercise with a 15% marginal tax rate (the second lowest marginal rate) for the federal government, lost tax revenue from lead poisoning is estimated to be about $2.8 to $3.2 billion.

Special Education

Children with high lead levels are in need of special education because of their slower development, lower educational success, and behavioral problems. Schwartz (1994a) found that 20% of children with BLL over 25 μg/dl needed special education. He suggests the children's needs span an average of three years, requiring assistance from a reading teacher, psychologist, or other specialist. Korfmacher (2003) estimates that the average annual cost of special education is $12,833 per child.

The number of children requiring special education is estimated at 20% of children over 25 μg/dl. According to the state data collected, a confirmed 7,342 children screened had levels of 25μg/dl or higher. This is likely an underestimate of the total number of children with high lead levels because they include only new cases and exclude children who were never tested. We treat this as a strict lower bound on the estimate of children affected. If this number is taken as a percentage of those screened (assuming random sampling), the number of children in the US with 25μg/dl or higher could be as many as 67,757. Again, there is reason to believe this is a upper bound as the sampling of children into screened groups though sometimes random is often subject to targeted testing (i.e. children at risk or in poverty or in public housing).

Table 5. Special Education.

Average cost per year	Children with 25μg/dl or more	20% of these need special ed	Years of special ed required	Total cost (present value) of special education
$12,833 per child	7342-67757	1468-13551	3 on average	$54.9m-$506.7m

Multiplying out these factors with the average cost per child for three years of special education, we reach a wide range of estimates. The most conservative is $56.5 million and the upper bound cost estimate is $521.7 million.

Behavior and Crime

Bellinger et al (1994) find that both social and emotional dysfunction correlates with increased lead exposure. Needleman et al (1996) examine schoolchildren between the ages of 7 and 11 years old who have had a clinical diagnosis of lead poisoning at an early age. They survey teachers and parents and find that by age eleven, there were worsening behavior patterns among children with high lead levels. They use this as evidence of a relationship between lead exposure and social behavioral problems, with the implication that lead exposure leads to criminality.

Nevin (2000) finds that the variation in childhood gasoline lead exposure from 1941 to 1986 explains about 90% of the variation in violent crime rates from 1960 to 1998. He also determined that lead paint explained about 70% of the variation in murder rates from 1900 to 1960. He first relates lead exposure in children (both gasoline and paint) to associated decreases in IQ. By estimating the degree of exposure, he correlates it with crime rates lagged by the number of years of age of the mean crime perpetrator. Reyes (2002) take the evidence of a relationship between lead poisoning and criminal behavior and estimates that the Clean Air Act in the 1970s and 1980s accounts for one-third of the drop in crime in the 1990s.

The evidence suggests that lowered lead levels will lead to lower crime rates. Needleman et al (2002) indicate that adjudicated delinquents are four times moe likely to have bone lead concentrations over 25 parts per million than non-deliquent adolescents. Korfacher (2003) translates Needleman et al's estimate into the conservative assumption that 10% of juvenile delinquency is attributed to lead poisoning. The cost of incarcerating a juvenile for one year ranges is $43,000 (Juvenile Justice FYI, 2000). The number of juveniles offenders held in residential placement at any given census day in 1999 was 108,931 (Statistical Briefing Book, 2001). If we make Kormacher (2003)'s assumption that 10% of juvenile crime caused by lead poisoning, then 10,893 individuals times 43,000 dollars a year per criminal is nearly half a billion dollars.

Table 6. Criminal Activity.

Cost of Juvenile Incarceration for One Year	Number of Juveniles Incarcerated in a Typical Day	Incidence Rate Attributed to Lead	Criminal Detention Costs For One Year
$43,000	108,931	10%	$468,403,300

Overall, this can be seen as a rather conservative estimate of the effects of lead poisoning on crime. While we have calculated the costs on the criminal justice system, we have ignored to costs to individuals and the costs to society for the criminal behavior, such as theft and property damage, the medical costs of victims and their economic losses related to reduced productivity or reduced quality of life, and the costs of prevention and protection through the government (Shapiro, 1999). In addition, we have only included the costs due to juvenile delinquency and not counted the likelihood of recidivism and repeat offenses in the adult criminal justice system.

PUTTING IT ALL TOGETHER

To demonstrate the cost-effectiveness of lead treatment, it is important to sum up all the benefits and costs of reduced lead to children. This is simply calculated by taking the number of children affected and multiplying it by the costs of high lead on their health and future earnings. Again, this number will be used to calculate the costs to society of special education and increased criminal activity. The sum of these factors is the benefits lost due to lead toxins in the home. When this is compared to the costs to abatement, we show how every dollar spent in abatement is more than offset by its benefits. In fact, we demonstrate that each dollar in abatement produces a benefit range of 2 to 19 dollars. The net benefit of intervention is 8.7 billion to 21.4 billion dollars depending on the assumptions of the model.

Table 7. Total Costs and Benefits.

Lead Abatement	Health Care Costs	Earnings Lost	Special Educ	Criminal Activity
$1.2b-$10.8b	$14.9m-$137.6m	$19.0b-$21.5b	$54.9m-$506.7m	$468.4m

Totals	Conservative Estimate	Optimistic Estimate
Total Benefits From Lead Reduction	$19.5 billion	$22.6 billion
Total Cost of Lead Abatement	$10.8 billion	$1.2 billion
Total Net Benefit	$8.7 billion	$21.4 billion
Cost/Benefit Ratio	1:2	1:19

The US DHHS (2002) documents a task force strategy to make 2.3 million homes lead-free by controlling lead paint hazard. They estimate that strategy's economic benefits will exceed costs of the effort by $8.9 billion. Our estimates are in line with theirs. However, these estimates of costs or benefits to avoided lead hazards is very conservative. Not only do we provided an extreme lower bound which assumes all children affected have already been tested, but also we have left out many important and potentially substantial costs. Some of these costs include health care later in life, neonatal mortality, cost of crime to victims and property loss, lost tax revenue, and the effects of lead levels less than 10 μg/dl on children's IQ, lifetime earnings, and criminal behavior.

Long Term Effects

While the costs of lead abatement are solely incurred in the first year, the benefits from better health, lower crime, and higher earnings will accrue over a longer term. To get a better picture of the true costs and benefits, therefore, we calculate benefits for a five year and ten year horizon, capturing kids who had not been affected previously (either because they had not been born or exposed). In each case, an estimate for the present value five and ten year benefits are estimated by discounting at 3% (as is done for lifetime earnings) and summing over the respective time span.

We believe this is a conservative methodology for calculating the multiyear benefits for a few reasons. First, we assume that the real cost savings from reduced special education needs and improved health is constant. Health care and education inflation, however, has been rising more rapidly than overall inflation—40% for education and 28% health care versus 15% overall since 1998—which would increase the real value of savings for each additional cohort. Second, there are certainly benefits for future generations from improving the well-being of current adolescents. In addition, because the poor are disproportionately affected, lead abatement will reduce income inequality; this benefit is not directly quantified in the benefit-cost calculations. Third, the estimates for savings from reduced crime and health ignore benefits realized in adulthood, thereby underestimating the benefits.

Table 8. Long Term Effects

Present value of benefits and costs of lead abatement				
Present Value	Health Care Costs	Earnings Lost	Special Education	Criminal Activity
Conservative Estimate				
5 years	$70.3m	$89.6b	$259m	$2,209.5m
10 years	$130.9m	$166.9b	$482.4m	$4,115.4m
Optimistic Estimate				
5 years	$649.1m	$101.4b	$2,930.2m	$2,209.5m
10 years	$1,209m	$188.9b	$4,451.9m	$4,115.4m

5 year benefit-cost analysis		
Totals	Conservative Estimate	Optimistic Estimate
Total Benefits From Lead Reduction	$92.1 billion	$107.2 billion
Total Cost of Lead Abatement	$10.8 billion	$1.2 billion
Total Net Benefit	$81.3 billion	$106 billion
Cost/Benefit Ratio	1:9	1:89

10 year benefit-cost analysis		
Totals	Conservative Estimate	Optimistic Estimate
Total Benefits From Lead Reduction	$171.6 billion	$198.7 billion
Total Cost of Lead Abatement	$10.8 billion	$1.2 billion
Total Net Benefit	$160.8 billion	$197.5 billion
Cost/Benefit Ratio	1:16	1:166

Over the longer term, therefore, the investment in lead abatement appears to be even more attractive. Even the conservative estimate for the five year horizon will yield benefits of $9 for every dollar spent. Give a set of more optimistic assumptions, the program could return $89 per dollar of cost over 5 years and $166 over ten.

INCIDENCE AND POLICY

We've discussed the health, social, and behavioral costs of high lead levels, and the costs of lead abatement. Now, we turn briefly to the populations affected; that is, how many children and families are affected and who is experiencing high lead levels. While a universal approach to abatement may certainly be viable considering the large benefits associated with full lead abatement, a targeted approach may be more realistic. Large strides towards lead poisoning reduction can be done under a targeted approach.

Lead poisoning is a significant factor in determining children's readiness for school (Rothstein, 2004). While lead poisoning rates have fallen substantial in the last thirty years, lead poisoning is now, more than ever, concentrated in low income communities. When lead was common in gasoline and paint, all children were likely to be exposed. Now, it is much less common for middle class children to be affected by high lead levels. The most cost-effective approach to eradicating lead poisoning is to direct it at those who are most likely to be affected.

Incidence differs by age, race, poverty status, and condition of housing. The number of children under the age of six with BLLs greater than 10μg/dL is an estimated 434,000. 80% of BLL greater than 20 μg/dl are Medicaid enrollees (GAO, 1999). Although state average lead poisoning rates have declined in recent years, the rate among poor and minorities may actually be increasing.

According to the CDC (1997), 21.9% of black children, ages 1-5, who were living in older housing had blood lead levels over 10 μg/dl. 16.4% of poor children living in older housing, and 11.5% of children living in older housing in large urban areas had elevated blood lead levels. Overall, 4.4% of all children had elevated blood lead levels in 1994. Pirkle et al (1998) find that prevalence was greatest for non-Hispanic Black children living in homes build pre-1946. 21.9% of these children had elevated blood lead levels. 16.4% of all children in low-income families, living in pre-1946 housing, had elevated blood lead levels.

Rather than waiting for children to be tested and finding their health deteriorated before stepping in to ameliorate the situation, a better approach would be pro-active, fixing the problem before the non-reversible damage is done. The main focus of this solution is on improving housing stock. This solution may be surprisingly inexpensive. And, for the high costs of lead poisoning in children in this country, lead abatement is well worth the expense.

CASE STUDIES

While abatement for the entire US and reduction of overall lead levels is an important goal, targeted lead reduction in highly concentrated cities may be a start. Substantial improvements to children's health and thus intelligence, school readiness, and success in later life can be done through targeted lead abatement programs. In this section, we outline the incidence of children at risk for high lead levels based on demographic information and housing stock and demonstrate the vast cost savings to lead abatement. Philadelphia and Los Angeles were chosen as cities with particularly old housing stock and high numbers of children at risk. The comparison provides a powerful example of the rampant problem lead has been to children in cities throughout the country.

Philadelphia

Pennsylvania has 210,000 housing units with a high risk of lead hazards, ranking third in the nation. Overall, 4.4% of Pennsylvania housing units have a high risk of lead hazards. Nearly 2 million housing units were built before 1950, and over ½ million are housing units with low income residents. In Pennsylvania, 160,000 children under 5 are living below poverty.

On all counts, Philadelphia County is ranked the highest in Pennsylvania in terms of lead hazards. In Philadelphia County, 75,000 housing units are at a high risk of lead hazards, 340,000 housing units were built before 1950, 130,000 housing units have low income residents, and 39,000 children under 5 live below poverty. In addition, 13% of housing units have a high risk of lead hazards, 22% of housing units are low income, and 41% of children under 5 are below poverty. Philadelphia County ranks fourth in the nation for number of housing units as high risk of lead hazards, ranks sixth for housing units build before 1950, and ranks seventh for low income housing units. Melman et al (1998) found that Philadelphia had the "highest reported prevalence within a US pediatric clinic population." 68% of the study patients had blood level at least 10 μg/dl.

For estimation of lead paint abatement, we use the range of $1,000 - $9,000 per unit cost as in the US estimates. For number of housing units, we use an estimate of number of housing units with high risk of lead hazards. This is defined as housing units with the two key risk factors linked to elevated blood lead levels in children. This is both a housing unit built before 1950 and low income residents in the housing unit. There are 75,000 such units in Philadelphia County. Note: this is an overestimate of number of units in the city of Philadelphia as the county is larger than the city.

Table 9. Lead Abatement in Philadelphia

	Per Unit Costs	Number of Units	Total Abatement Cost
Lead Paint Abatement	$1,000-$9,000	75,000	$75m-$675m

Health care costs for children with blood lead levels higher than 10 μg/dl were estimated for Philadelphia following the same model as for the US as a whole. The range of estimates reflects varying distributions of number of children affected. The smaller number provides a lower bound on the estimate, determined by the number of children directly screened at that level. The larger number is an estimate based on the percentage of children in each level as a share of the total population of children under 6 in Philadelphia.

Table 10. Medical Costs in Philadelphia

Blood lead level	Cost of recommended medical action	Number of children affected	Total cost for each group
10 – 20 μg/dl	$55.95	2990-8,714	$167,291-$487,522
20 – 45 μg/dl	$782.60	657-2,229	$514,168-$1.7m
45 - 70 μg/dl	$1017.60	37-164	$37,651-$167,300
Over 70 μg/dl	$2625.60	6-8	$15,754-$20,555
			$734,864-$2.4m

Tale 11. Effect of Lead on IQ in Philadelphia

Average Lead Level	Number of Children with Lead > 10μg/dL	Average IQ Loss per μg/dL	Total IQ Loss from Elevated Lead Levels
14-17μg/dl	3,690-11,114	.245	12,657-46,290

The effect of IQ loss on lifetime earnings.

Table 12. Lifetime Earnings Lost in Philadelphia

Total IQ Loss from Elevated Lead Levels	Pres Discounted Value (3%) of Lifetime Earnings	Earnings Loss Due to a 1 pt IQ Loss	Total Earnings Lost (3% discount rate)	Tax Revenue (15% marginal tax rate)
12,657-46,290	$723,300	1.76%	$161m-$289m	$24m-$88m

The number of children requiring special education is estimated at 20% of children over 25 µg/dl. According to national averages, 362 children in Philadelphia had levels of 25µg/dl or higher. If the Philadelphia number is estimated using the higher average incidence rates in Pennsylvania, the number of children in Philadelphia with 25µg/dl or higher could be as many as 1,305 children.

Table 13. Special Education Costs in Philadelphia

Average cost per year	Children with 25µg/dl or more	20% of these need special ed	Years of special ed required	Total cost of special education
$12,833 per child	362-1,305	72-261	3 on average	$2.7m-$9.8m

Multiplying out these factors with the average cost per child for three years of special education, we reach a wide range of estimates. The most conservative is $2.8 million and the upper bound cost estimate is $10 million.

Table 14. Summary Lead Analysis for Philadelphia

Lead Abatement	Health Care Costs	Earnings Lost	Special Educ
$75m-$675m	$734,864-$2.4m	$161m-$289m	$2.7m-$9.8m

Totals	Conservative Estimate	Optimistic Estimate
Total Benefits From Lead Reduction	$165 million	$601 million
Total Cost of Lead Abatement	$675 million	$75 million
Total Net Benefit	-$510 million	$526 million
Cost/Benefit Ratio	1:¼	1:8

Long Term Effects

While the costs of lead abatement are solely incurred in the first year, the benefits from better health, lower crime, and higher earnings will accrue over a longer term. To get a better picture of the true costs and benefits, therefore, we calculate benefits for a five year and ten year horizon. (Refer to discussion of long term calculations in the national estimates).

Table 15. Long Term Effects

Present value of benefits and costs of lead abatement			
Present Value	Health Care Costs	Earnings Lost	Special Education
Conservative Estimate			
5 years	$3.5m	$759.5m	$12.7m
10 years	$6.5m	$1,414.6m	$23.7m
Optimistic Estimate			
5 years	$11.3m	$1,363.2m	$46.2m
10 years	$21.1m	$2,539.2m	$86.1m

5 year benefit-cost analysis		
Totals	**Conservative Estimate**	**Optimistic Estimate**
Total Benefits From Lead Reduction	$775.7 million	$1,420.7 million
Total Cost of Lead Abatement	$675 million	$75 million
Total Net Benefit	$100.7 million	$1345.7 million
Cost/Benefit Ratio	1:1.1	1:19

10 year benefit-cost analysis		
Totals	**Conservative Estimate**	**Optimistic Estimate**
Total Benefits From Lead Reduction	$1,444.8 million	$2,646.6 million
Total Cost of Lead Abatement	$675 million	$75 million
Total Net Benefit	$769.8 million	$2,571.6 million
Cost/Benefit Ratio	1:2.1	1:35

Over the longer term, therefore, the investment in lead abatement appears to be even more attractive. Even the conservative estimate for the five year horizon will yield $100 million in net benefits. Give a set of more optimistic assumptions, the program could return $19 per dollar of cost over 5 years and $35 over ten.

Los Angeles

California ranks first or second among all states for number of housing units with a high risk of lead hazards (230,000), number of housing units build before 1950 (2 million), number of housing units with low income residents (1.4 million), and number of children under 5 living below poverty (680,000).

Los Angeles County is not only the worst county for lead hazards in California, but it almost ranks the worst in the United States. Nearly ½ million housing units are low income, 790,000 housing units were built before 1950, and 120,000 housing units have a high risk of lead hazards. Also, a quarter million children under 5 in Los Angeles are living below poverty.

The housing stock in Los Angeles County is 81% pre-1980, 47% pre-1960, and 25% pre-1950. The older the housing stock, the greater the likelihood of lead exposure in children. Based on state level statistics, over 9% of children under 6 have blood lead levels over 10 µg/dl. In 2001, the number of children with elevated blood lead levels is estimated to be over 32,000.

As in the lead paint abatement estimate for Philadelphia, here we estimate the cost for the number of housing units which have a high risk of lead hazards. Multiplying the range of $1,000 to $9,000 per unit cost by 120,000 units, we arrive at a total abatement cost of $120 million to $1.08 billion for Los Angeles.

Table 16. Lead Abatement in Los Angeles

	Per Unit Costs	Number of Units	Total Abatement Cost
Lead Paint Abatement	$1,000-$9,000	120,000	$120m-1.08b

As with the national figures, here we estimate the costs of medical treatment for the current cohort of children. The range of children affected allows for measurement error in the assessment and identification of children with lead poisoning. Because testing is not random, we provide a range of numbers and are confident that the truth lies in between.

Table 17. Medical Costs in Los Angeles

Blood lead level	Cost of recommended medical action	Number of children affected	Total cost for each group
10 – 20 µg/dl	$55.95	8668-17,672	$484,975-$988,749
20 – 45 µg/dl	$782.60	1905-13,852	$1.5m-$10.8m
45 - 70 µg/dl	$1017.60	109-621	$110,918-$632,216

Over 70 µg/dl	$2625.60	17-115	$44,635-$302,081
			$2.1m-$12.8m

Effect of Lead on IQ.

Table 18. Effect of Lead on IQ in Los Angeles

Average Lead Level	Number of Children with Lead > 10µg/dL	Average IQ Loss per µg/dL	Total IQ Loss from Elevated Lead Levels
18-22µg/dl	10,699-32,261	.245	47,83-173,887

In this section, we examine the effects of IQ loss on lifetime earnings. The greatest costs to the individual and to society are the losses of earnings due to permanent brain damage and learning disabilities brought on by repeated exposure to lead paint.

Table 19. Lifetime Earnings Lost in Los Angeles

Total IQ Loss from Elevated Lead Levels	Pres Discounted Value (3%) of Lifetime Earnings	Earnings Loss Due to a 1 pt IQ Loss	Total Earnings Lost (3% discount rate)	Tax Revenue (15% marginal tax rate)
47,83-173,887	$723,300	1.76%	$600m-2.2b	$90m-$332m

The number of children requiring special education is estimated at 20% of children over 25 µg/dl. Given the range of children in Los Angeles who fit these levels, we estimate costs of providing special education for the current cohort of children with elevated lead levels.

Table 20. Special Education Costs in Los Angeles

Average cost per year	Children with 25µg/dl or more	20% of these need special ed	Years of special ed required	Total cost of special education
$12,833 per child	1049-8,123	210-1625	3 on average	$7.9m-$60.8m

Multiplying out these factors with the average cost per child for three years of special education, we reach a wide range of estimates. The most conservative is $8 million and the upper bound cost estimate is $62.5 million.

Table 21. Summary Lead Analysis for Los Angeles

Lead Abatement	Health Care Costs	Earnings Lost	Special Educ
$120m-1.08b	$2.1m-$12.8m	$600m-2.2b	$7.9m-$60.8m

Totals	Conservative Estimate	Optimistic Estimate
Total Benefits From Lead Reduction	$610 million	$2.275 billion
Total Cost of Lead Abatement	$ 1.08 billion	$120 million
Total Net Benefit	-$470 million	$2.155 billion
Cost/Benefit Ratio	1:3/5	1:19

In the most conservative case, the costs to lead abatement outweigh the benefits of abatement. It is important to remember that these are the total costs of lead abatement – this removes the lead hazard from all homes in Los Angeles at high risk of lead poisoning. While lead abatement will help today's children from the hazards of lead paint, it will also aid future children who live in these homes. In addition, this assessment has removed the benefits to crime reduction as the focus groups did not find that information compelling or truthful.

It is important to note that the optimistic estimate finds a return of 19 dollars for every dollar spent in lead abatement programs. The truth most definitely lies in between both of these estimates and therefore probably we would find that every dollar spent brings returns greater than a dollar to the children, families, and society as a whole.

Long Term Effects

While the costs of lead abatement are solely incurred in the first year, the benefits from better health, lower crime, and higher earnings will accrue over a longer term. To get a better picture of the true costs and benefits, therefore, we calculate benefits for a five year and ten year horizon. (Refer to discussion of long term calculations in the national estimates).

Table 22. Long Term Effects

Present value of benefits and costs of lead abatement			
Present Value	Health Care Costs	Earnings Lost	Special Education
Conservative Estimate			
5 years	$9.9m	$2.8b	$37.3m
10 years	$18.5m	$5.3b	$69.4m
Optimistic Estimate			
5 years	$60.4m	$10.4b	$286.8m
10 years	$112.5m	$19.3b	$534.2m

5 year benefit-cost analysis		
Totals	**Conservative Estimate**	**Optimistic Estimate**
Total Benefits From Lead Reduction	$2.85 billion	$10.7 billion
Total Cost of Lead Abatement	$1.08 billion	$120 million
Total Net Benefit	$1.77 billion	$10.6 billion
Cost/Benefit Ratio	1:2.7	1:89

10 year benefit-cost analysis		
Totals	**Conservative Estimate**	**Optimistic Estimate**
Total Benefits From Lead Reduction	$5.4 billion	$19.9 billion
Total Cost of Lead Abatement	$1.08 billion	$120 million
Total Net Benefit	$4.3 billion	$19.8 billion
Cost/Benefit Ratio	1:5	1:166

Over the longer term, therefore, the investment in lead abatement appears to be even more attractive. Even the conservative estimate for the five year horizon will yield $1.77 billion in net benefits. Give a set of more optimistic assumptions, the program could return $5 per dollar of cost over 5 years and $166 over ten.

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Children and Asthma

In this report, we explore the growing trend of asthma amongst the youth in the United States. In the last 20 years, the prevalence of asthma has increased nearly three-fold. The effects of this increase are critical for both children and families and for society as a whole. Asthma is very expensive to control and can have detrimental effects on parent's work and children's school readiness. In this report, we attempt to uncover important facts about asthma and the growing prevalence among American youth.

In the first section, we explore the incidence of asthma among US children. In the second section, we briefly discuss the economic burden of asthma to individuals and families with a focus on direct medical expenditures and indirect costs. In the third section, we review a series of articles on children with asthma to uncover significant relationships between second hand smoke and asthma, cockroaches and asthma, the importance of asthma management, and the effect of childhood asthma on lost school days, school achievement, and parental work loss. In the final section, we provide case examples of two cities disproportionately affected by asthma. Philadelphia and Los Angeles have poverty rates far above average for the US and the incidence of asthma is higher as well.

I. Asthma Incidence

Asthma is a problem for Americans of all ages. 11.4% of Americans have been told by a health professional that they had asthma (CDC, 2001). While asthma affects both the young and old, the prevalence among children is significantly higher than among adults: 12.6% versus 10.9%. African-Americans are also disproportionately prone to lifetime asthma. 12.1% of non-Hispanic Blacks and 11.6% of non-Hispanic whites have been diagnosed at some point in there lives. Hispanics have a low rate of diagnoses (9.2%).

The current rates of prevalence, or people who have been diagnosed and still have asthma, follow the same pattern. 7.3% of Americans currently have asthma, including 8.7% of children and 6.9% of adults. Another measure of asthma incidence is the prevalence of an attack in the previous year. The asthma attack prevalence is considered a crude indicator of uncontrolled asthma and a rte of people who are at risk for hospitalization or other emergency care. In 2001, 4.3% of Americans had an asthma attack in the past year. This includes 5.7% of youth and 3.8% of adults.

Nearly 12.6% of children under 18, or nine million kids, have ever been told they have asthma. Almost 6% of children had an asthma attack in the previous 12 months. Incidence of asthma is much greater for boys than girls (14.5% vs. 10.7%). Children older than 5 are much more likely to have asthma than younger children (14.4% vs. 7.9%). White and Asian children have much lower incidence rates than African Americans or Latino's. Family income is also related to asthma in children. The incidence rate in children from families with less than $20,000 in family income is 16% compared with 12% of children in families with more than $20,000 in family income. Children on Medicaid are more likely to have asthma and children in poverty are more likely to have asthma. (CDC, 2003).

II. Cost of Asthma

Several studies outline the direct and indirect costs of asthma (Weiss et al, 1992; Weiss and Sullivan, 2001). Total costs of asthma (for both adults and children) were estimated to be 12.7 billion dollars in 1998. These costs are divided into 58% to direct medical expenditures and 42% to indirect costs.

Direct medical expenditures were split between hospital care and physician's services. Hospital care includes hospital inpatient care at about 2 billion, emergency room care at 546 million, and hospital outpatient care at 723 million dollars. Physician services are broken down into physician inpatient care at 97 million, physician office visits at 647 million, and prescription drugs at 2.5 billion dollars. Of the direct medical expenditures, hospital inpatient care and prescription drugs compose the vast majority of medical costs at 28% and 43% respectively.

While these data are for the entire population, a disproportionate share of health expenditures are borne by children and their families (CDC, 2001). In the US in 2000, there were 10.4 outpatient visits to private physician offices and hospital clinic. While this equates to 3.79% of the US population, youth had nearly twice that prevalence rate. 6.49% of children and only 2.85% of the adult population had asthma related outpatient visits. Similarly, there were 1.8 million visits to emergency rooms in 2000, which included 1.04% of children and .54% of adults. While the age differences are striking in emergency room use for asthma, the racial differences are even more extreme. About .59% of whites and 1.33% of blacks visited the emergency room for asthma emergencies. Asthma hospitalizations follow the same pattern: .3% of children, .12% of adults, .10% of whites, and .32% of blacks.

The indirect costs of asthma include loss of school days and work days, housekeeping costs, and mortality. Weiss and Sullivan (2001) estimate the costs for school days lost to be 1.1 billion, for men's loss of work to be 415 million, and women's loss of work to be 1.1 billion. The effects of asthma on school and work days lost will be discussed further in the next section. Housekeeping costs and mortality costs were estimated at 842 million and 1.8 billion respectively. Mortality related to asthma disproportionately affects adults over children (a rate about seven times the rate of children). In addition, Blacks are three times as likely to die from asthma than whites.

III. Asthma: Some Causes and Effects

Second Hand Smoke

There is a long-standing body of research that demonstrated the relationship between environmental tobacco smoke and respiratory problems. Asthma is one of the serious consequences of second hand smoke, and particularly the aggravation of asthma. High levels of environmental tobacco smoke (ETS) is associated with nearly a three-fold increase in asthma symptoms (Morkjaroenpong, 2002).

Parental smoking has an important impact on asthma in infants and children; the detrimental effects of parental smoking on lung growth will have an impact on respiratory health throughout life (Landau, 2001). Gergen (2001) stresses that ETS is a completely preventable form of environmental pollution and thus interventions to reduce or eliminate the exposure of children to ETS should be explored.

<u>Cockroaches, etc.</u>

Cockroach allergens constitute another important cause of respiratory allergies and “may trigger asthma exacerbations in sensitized individuals” (Liccardi et al, 2000). Eggleston (2001) goes so far as to say that cockroach infestation is a major contributor to asthma throughout the world. While cockroach allergen is known to be prevalent in inner-city homes, a recent study (Matusi et al, 2003) suggests that cockroach allergen exposure might be more common in suburban middle-class homes of asthmatic children than previously thought.

Other studies indicated that house-dusk-mite allergies are correlated with asthma development (Bukowski, 2002). And, pets, particularly cats, carry particles of allergen, which can be easily dispersed by clothing of cat owners to homes without cats and can be easily prevented by washing (Liccardi et al, 2000)

<u>Asthma Management</u>

While the previously cited studies suggest the importance of second hand smoke and environmental factors in predicting asthma prevalence and severity, other research points to the importance of asthma management in controlling asthma and preventing otherwise unnecessary hospitalizations and avoidable deaths.

Research indicates that ETS exposure did not correlate with asthma morbidity, rather significantly related to family asthma management (Budhiraja, 2004). Factors that define the child’s experienced asthma pattern, such as activity limitations, number of allergens, and school absenteeism, were associated with the parent’s work of asthma management (Horner, 2002). “A multifaceted asthma intervention program reduced symptoms days and was cost-effective for inner-city children with asthma (Sullivan, 2002).

Asthma disease management programs are not only the most suggested methods of treating asthma, but also they are cost effective. A pilot program in Colorado found substantial cost savings for participants in a disease management program. Monthly care costs for participants were $351.97 on average before the program intervention. The program itself cost $41.67 per person and the costs of care outside the program totalled $179.17. The cost savings of diverted medical care (e.g. less emergency room visits) totaled $172.80 per person. This translates into substantial savings: every dollar spent on the program yielded over four dollars in savings.

Lost School Days, School Achievement, and Parental Work Loss

Asthma has a substantial effect on the lives of children including lost school and on adult caretakers in terms of missed work (Mellinger-Birdsong, 2003). Children with asthma were found to have on average two excess days of absenteeism, however, school performance evaluated by grade point average, grade promotion, or class rank was not significantly different from children without asthma (Silverstein, 2001). Weiss and Sullivan (2003) estimate the costs of school days lost to be on the order of a billion dollars.

Research indicates a strong relationship between childhood asthma and the workforce participation of single mothers. “The presence of a child disabled by asthma poses unique barriers to the labor market activity of single mothers, because the symptoms are episodic and particularly disruptive and children’s routine activities” (Feng and Reagan, 2003). Weiss and Sullivan (2003) estimate the costs of lost work to be approximately 1.5 billion dollars.

IV. Case Studies

Over nine million children (or nearly 13% of kids) in the United States have ever been told they have asthma and over four million had an asthma attack in the past 12 months (5.7% of kids). Children in poor, urban communities have been most severely affected by the recent rise in incidence of asthma. Philadelphia and Los Angeles are two cities particularly affected by the recent rise. In this section, we briefly discuss the incidence rates for these cities and stress the importance of allergen free environments and managed care for the children in these communities.

Philadelphia

According to the Census, median income in 1999 (dollars) for families in Philadelphia was $37,036, compared to $50,046 median family income in the US. 18.4% of families and 31.3% of children in Philadelphia were living below the poverty level as compared to 9.2% of families and 16.1% of children in the US as a whole. At the same time, 44.3% of Philadelphians are African American (or some combination thereof) compared to 12.9% of the US.

Since income, poverty, and race are strong indicators of asthma prevalence and high use of medical services for treating asthma, Philadelphia are consistently shown to have higher prevalence rates than the US as a percentage of its population. While the national average of children with asthma is 12.7%, children in Philadelphia County face a 13.7% incidence rate (Philadelphia Citizens, 2004). Currently, approximately 51,900 children in Philadelphia have asthma.

Data from 1998 indicate that one out of three Philadelphia-area children with asthma had to go to an emergency room because of an asthma attack sometime during the year (Asthma in America, 1998). The same study revealed that 27% of residents are awakened by asthma symptoms at least once a week. Nocturnal asthma in children has been proven to affect school attendance and school performance (Diette et al, 2000). Even before children begin school, children with asthma have poorer parent-reported school readiness skills and a greater need for extra help with learning compared with children without asthma (Halterman et al, 2001). In Philadelphia, 31% of asthma patients have missed school or work because of asthma and 46% say asthma limits their ability to take part in sports and recreation. Nationwide, over 10 million school days are missed each year by school children experiencing asthma-related problems (NIH, 1997).

While asthma is generally considered a controllable disease, Philadelphia residents are not getting the information or adequate health care to treat the disease and its symptoms. While three out of four asthma patient acknowledge there is a "strong need" for education, the gap in information is great. The Asthma in America Survey found serious disparities between doctors' view of best practices in asthma management and patients' experience. 70% of Philadelphia doctors say they use spirometry to measure lung functioning on an ongoing basis while only 35% of patients report have this test in the past year. Strikingly, 92% of doctors say anti-inflammatory drugs are either "essential" or "very important" in the long-term management of persistent asthma, but only 18% of asthma patients report using these medications in the past four weeks.

Studies have shown that asthma morbidity is significantly related to family asthma management (Budhiraja, 2004). While 70% of Philadelphia doctors say they prepare a written plan for all, most or some of their patients, only 27% of patients say their doctor has development such a plan for them.

While the health care received by asthma patients appears less than adequate, the education and information asthma patients have is even worse. Only 9% of patients could name the underlying cause of asthma without being prompted. And, half of asthma patients believe it is only possible to treat asthma symptoms and not their underlying cause. This misinformation translates into insufficient care. The National Heart, Lung, and Blood Institute (NHLBI) guidelines indicate that inhaled corticosteroids, anti-inflammatory drugs are the most effective for long-term control of asthma. While quick-relief inhalers are short term solutions for basic asthma symptoms, long-term control medications actually reduce the airway inflammation that underlies asthma symptoms. The Asthma in America Survey finds that only 19% with persistent asthma take the recommended drugs for their asthma.

The NHLBI guidelines suggest several ways to address this problem. First, it is important to reduce exposure to allergens and other asthma triggers (smoke, pollen, mold, pets). Second, when necessary for persistent asthma, they encourage the use of long-term medications like inhaled corticosteroids. Three is the development of an asthma management system including regular symptom monitoring, the development of an action plan for use during asthma attacks, and regular visits to the doctor.

The growth of asthma among children and adults in the Philadelphia area requires substantial medical care. In 1998, the annual cost of treating asthma in Philadelphia was estimated to be $161 million. As incident rates and hospitalizations have only increased, the costs are also undoubtedly much greater today. Asthma remains the most common chronic disease of childhood and the leading cause of hospitalizations among children.

Los Angeles

According to the Census, the median income in 1999 (dollars) for families in Los Angeles was $39,942. Over 18% of families and 30% of children in Los Angeles were living below the poverty level. As with Philadelphia, these higher poverty rates are suggestive of higher asthma prevalence rates in Los Angeles than in the US as a whole. The evidence supports this theory.

Thirteen percent of parents in a Los Angeles survey reported that their children have been diagnosed with asthma or wheezy bronchitis (Los Angeles County Department of Health Services, 2002). Of these asthmatic children, 34% visited the emergency room in the past year for asthma treatment and 13% received inpatient treatment for their asthma.

Although asthma management has been demonstrated to be an effective control mechanism for treating asthma patients, such treatment is rare. Even at the most basic levels of treatment, parents are not informed about what they can and should do for their children. Only 48% of the parents surveyed said their child's doctor discussed what to do if their child has an asthma attack, 53% discussed when it's necessary to get medical care right away, 52% discussed removal of environmental triggers, 43% discussed limiting activity in smog, and 62% discussed the effects of secondary smoke on their children (LAC-DHS, 2002).

The *Asthma in America* study supported these findings. The information families have is insufficient to adequately treat chidlren's asthma. In this 1998 survey, 80% of asthma patients in Los Angeles believe there is a "strong need" for patient education. Only 14% could name inflammation as the underlying cause of asthma symptoms and more than half thought it was possible to treat only asthma attacks and their symptoms, but not their underlying cause.

This lack of information coincides with less than the recommended "Best Practices" for asthma treatment. While the recommended treatment for people with persistent asthma is inhaled corticosteroids, only 16% of asthmatics in Los Angeles were on this treatment plan. While doctors state they are using these best treatment methods, there is clearly a disconnect between what they are saying and what their patients are saying. While 70% of doctors say they use spirometry to measure patient airflow on an ongoing basis, only 39% of patients report having this test in the last year. While 92% of doctors say that anti-inflammatory drugs are either "essential" or "very important" in the long-term managment of persistent asthma, only 18% of asthma patients report using these medications in the past four weeks.

Although an asthma managment plan is one of the best medical practices and cost-effective methods of controlling asthma, only 27% of asthma patients in Los Angeles say their doctor has developed such a plan for them. The effect of uncontrolled and unmanaged asthma are far reaching. 32% of asthma patients are awakened by breathing problems at least once a week. 44% of asthma patients have missed school or work because of asthma in the past year. Nearly half of children with asthma went to the emergency room for asthma attacks in the past year and nearly 50% were hospitalized, treated in emergency rooms, or required to have urgent care for their asthma in the past year.

Los Angeles is one of the worst places in the United States when it comes to air pollution. Several studies have examined the effect of air quality on asthma in children. Ostro et al (2001) focus their research on African Americans in Los Angeles as the recent increases among America's youth have been in this population. They find that for this population in central Los Angeles, air pollutants have effects that may be clinically significant, citing associations between respiratory symptom occurence and several environmental factors.

Another study focused on the high levels of traffic in Los Angeles. Diaz-Sanchez et al (1996) simulated the experience of a day's exposure to city traffic by instilling diesel exhaust particles into volunteer's nostrils. This exposure was found to exacerbate allergic respiratory disease. Delfino et al (2002) also found that the pro-inflammatory and irritant nature of traffic-related pollutants can lead to adverse health effects in asthmatic children.

While asthma is a the most common chronic illness among children throughout the United States, children in Los Angeles are particularly at risk. Higher levels of poverty and higher rates of pollutants make the city's children especially susceptible to asthma. Without substantial investment in children's health, the numbers of asthmatics is only expected to rise. An action plan for the city should include education to limit the dangerous triggers that lead to severe asthma attacks such as second hand smoke, molds, pets, and other environmental pollutants and access to chronic disease managment for all children with asthma to better control and manage the disease and prevent expensive and unnecessary emergency room visits and hospital stays.

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