Research Links Childhood Lead Exposure to Changes in Violent Crime Rates Throughout the 20th Century

A recent peer-reviewed study (*Environmental Research,* May 2000) shows that variations in childhood gasoline lead exposure from 1941 to 1986 explain about 90% of the variation in violent crime rates from 1960 to 1998. Furthermore, variations in childhood paint lead exposure from 1879 to 1940 explain about 70% of the variation in murder rates from 1900 to 1960.

Rick Nevin, the author of this study, reviewed extensive research demonstrating that childhood lead exposure reduces IQ levels later in life, and he examined other research showing a strong association between low IQ and criminal behavior. He then conducted a statistical analysis of United States crime rate data and lead consumption data to determine whether changes in population lead exposure could explain subsequent trends in violent crime.

Figure 1 shows the relationship between population exposure to gasoline lead from 1941 to 1986 and the resulting trend in violent crime rates from 1964 to 1999. The 23-year time lag is consistent with a typical age of about 23 for violent crime offenders, and research showing that a child's brain is most vulnerable to lead poisoning in the first few years after birth.

With the elimination of lead in gasoline, paint lead is now the main source of childhood lead poisoning in the United States. The use of lead in residential paint rose throughout the late 1800s, peaked around 1914, and declined after World War II until it was finally banned in 1978. Although lead paint in older housing poses a serious risk of childhood lead poisoning today, the risk was obviously much greater during the early 1900s when deteriorated paint with high lead content was routinely scraped away and covered with more lead paint. Figure 2 shows the resulting relationship between population exposure to paint lead from 1879 to 1939 and the murder rate from 1900 to 1960. The 21-year lag is consistent with the typical age of those arrested for murder and the impact of lead on a child's early cognitive development.

Figure 1: **US Violent Crime versus Gasoline Lead**

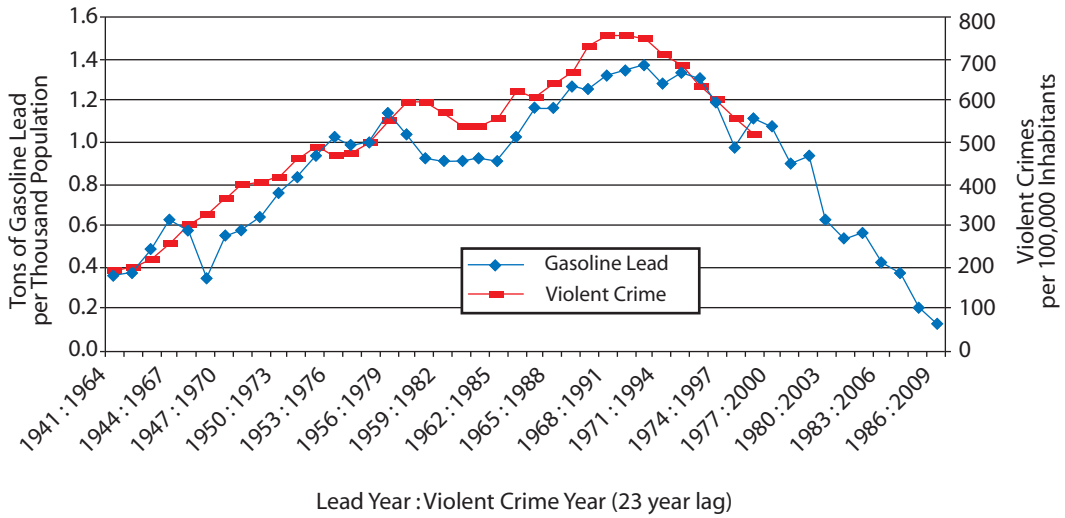
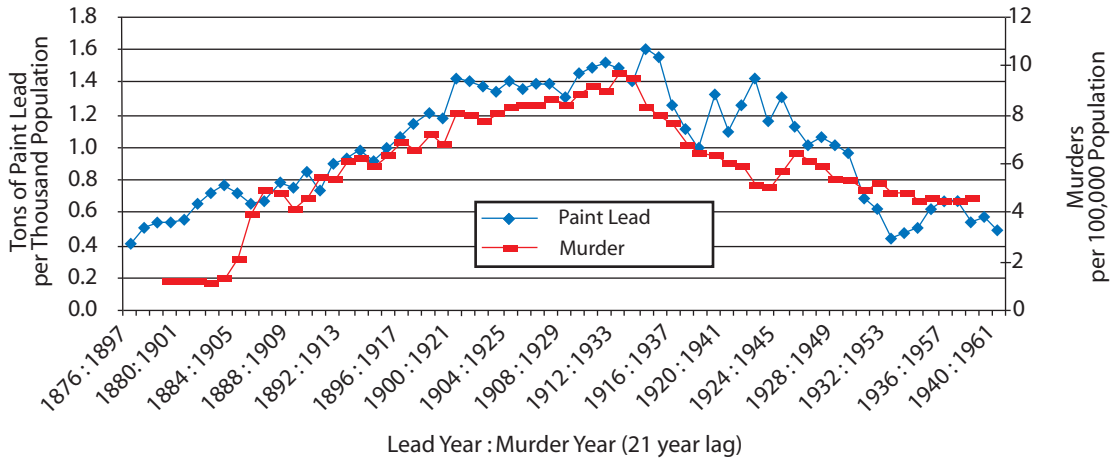


Figure 2: **Murder, 1900–1959, versus Paint Lead**



The Nevin study also examined the individual components of violent crime since 1960: aggravated assault, robbery, rape, and murder. For each of these components, and for the overall violent crime rate, Nevin tested the effect of childhood lead exposure and the effect of teen unemployment, the overall unemployment rate, and the proportion of the population in age brackets associated with higher crime rates (ages 15 to 25). Nevin's statistical analysis found that childhood lead exposure explained 88% of the variation in the overall violent crime rate, while teen unemployment explained just 2%. The effect of overall unemployment and the proportion of the population in younger age brackets were found to be insignificant.

Only childhood lead exposure was found to have any significant effect on changes in the rate of aggravated assault, which accounts for about 60% of all violent crime. Figure 3 shows the relationship between population exposure to gasoline lead from 1941 to 1986 and the resulting trend in aggravated assault rates from 1964 to 1999. Over this time period, childhood lead exposure explained 90% of the variation in aggravated assault.

Figure 3: **Aggravated Assault versus Gasoline Lead**

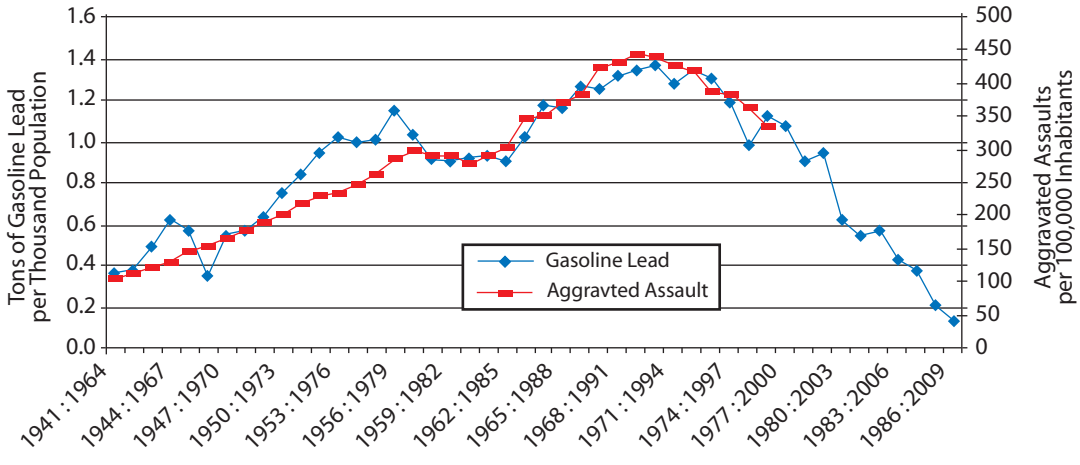
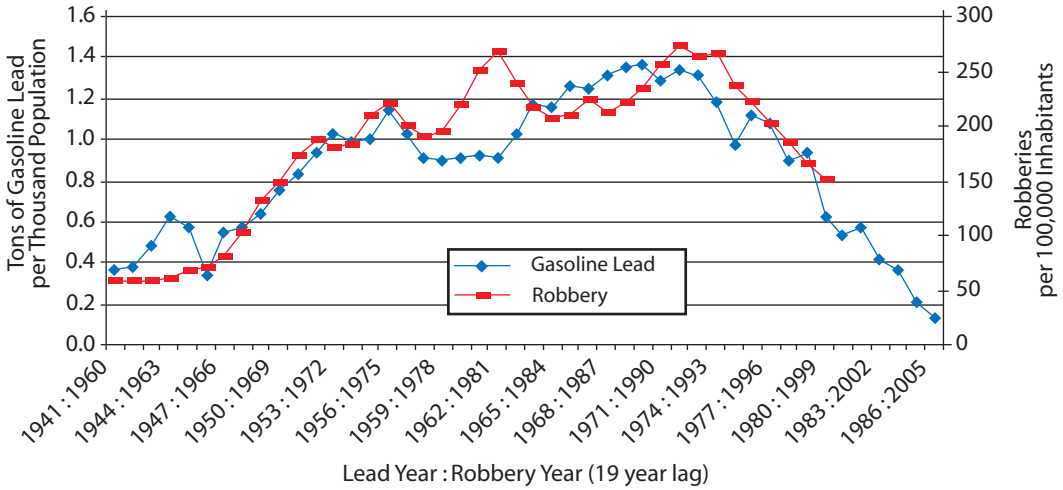


Figure 4: **Robbery versus Gasoline Lead**



Childhood lead exposure explains about 76% of the variation in robbery (which accounts for about one-third of all violent crime) and teen unemployment explains about 3%. Figure 3 shows the relationship between population exposure to gasoline lead from 1941 to 1986 and the resulting trend in robbery from 1960 to 1999. The 19-year time lag is consistent with a typical age of about 19 for robbery offenders. The effect of teen unemployment is apparent in the peak robbery rates during the recession years of 1981 and 1991, but the long-term trend is primarily related to childhood lead exposure.

Nevin also presented available data on two other variables often associated with crime: family demographics and economic status. Figure 5 shows that the percent of children living with mothers only, the percent born to single mothers, and the percent living in poverty all increased from 1970 to 1990, and there was no significant change in the percent of children living below 200 percent of the poverty level.

Figure 5: **Potential Crime Rate Covariates**

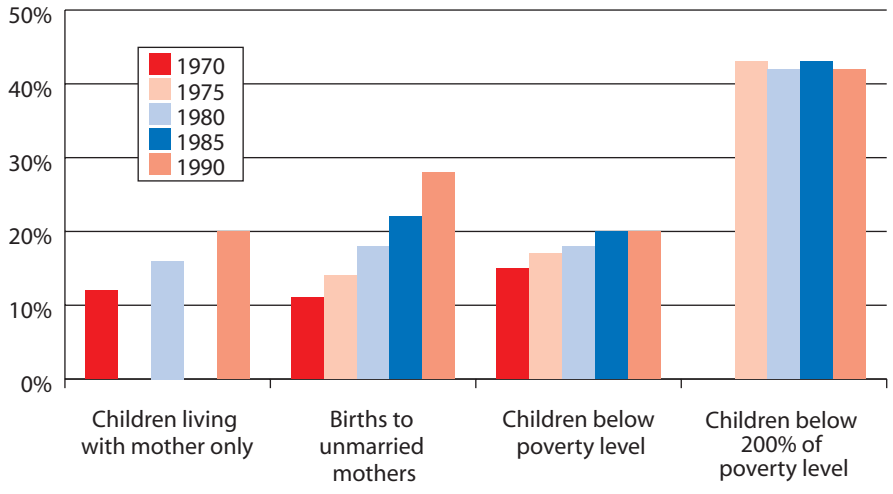


Table 1: **Comparison of Best-Fit Lags with Age Brackets for Violent Offenders**

Dependent Variable	Best-Fit Time-Lag	Age at Time of Arrest*	
		Mode	Median
Murder (1960-98)	18	18 – 23	23 – 29
Murder (1900-60)	21	18 – 23	23 – 29
Assault (1960-98)	23	18 – 24	25 – 28
Rape (1960-98)	21	18 – 21	22 – 27
Robbery (1960-98)	19	17 – 18	19 – 22
All Violent Crime (1960-98)	23	18 – 21	22 – 26

*Ranges shown for arrests reflect medians and modes in 1965, 70, 75, 80, 85, 90, and 1995.

An association between crime and economic status or family demographics could partially explain the rise in United States crime rates from 1960 through the 1980s. The family demographic and economic status trends in Figure 5, however, are completely inconsistent with the decline in crime rates during the 1990s.

Although other social and economic trends and government policies are often cited to explain the rise and fall of crime rates over time, the role of childhood lead exposure is especially apparent in the "best-fit" time lags reported in the Nevin study. Nevin tested time lags of 12 to 25 years for six categories of violent crime. The best-fit lag for each category is the one that explains the largest percentage of variation in crime, and shows the highest statistical significance for the effect of lead exposure. Table 1 shows that the best-fit time lag for each category of crime reflects the typical age of offenders for that category.

The time-lag effect of lead exposure explains why the robbery rate has declined much more than the rate for aggravated assault over recent years—because the younger age of robbery offenders reflects more of the decline in gasoline lead exposure since the mid-1970s. In the case of paint lead exposure, the time lag should include another few years because the effect of paint lead on childhood blood lead levels is greatest when the paint begins to deteriorate some years after it is applied. This is reflected in a best-fit lag for paint lead versus murder rates that is three years longer than the best-fit lag for gasoline lead versus murder.

Abortion and Crime: Cause and Effect?

Although there has been little media coverage of the peer-reviewed Nevin study, there was widespread reporting of an earlier, unpublished theory suggested that the decline in United States crime rates in the 1990s might be explained by the legalization of abortion in 1973. Like the lead exposure analysis of the Nevin study, this theory about abortion and crime emphasizes the time lag between birth and the typical age of criminal offenders. Unlike the lead exposure analysis, however, the theory about abortion and crime could only explain the decline in crime rates in the 1990s and not the long rise in crime rates from 1960 to 1990 or the variation in murder rates from 1900 to 1960.

The theoretical basis for linking abortion with subsequent crime rates is that unwanted pregnancies are aborted and unwanted children are more likely to become criminal offenders. There is no direct basis, however, for measuring the likelihood of "unwanted" children becoming criminals, and no data on the percentage of births that are "unwanted" children. This theory appears to rely on proxy variables to indicate the likelihood of "unwanted" children becoming criminals, noting that poor children and those raised by single parents are more likely to become criminal offenders and that women who obtain abortions are more likely to be unmarried and poor. The trend data in Figure 5, however, completely undermines this theory because the percentages of children living in poverty, living with mothers only, and born to unwed mothers all rose from 1970 to 1990. If these variables, as indicators of "unwanted" children, were key determinants of crime rates, then crime in the United States would have risen throughout the 1990s.

If legalized abortion has had any effect at all on crime rates, it is likely the result of higher abortion rates among poor and minority women who were also more likely to have raised their children in low-income urban areas with disproportionate risks of gasoline and paint lead exposure.

Lead Exposure and Unwed Pregnancy

Ironically, the Nevin study also cites research that shows an association between IQ and unwed births, and presents analysis showing that trends in unwed pregnancy—including abortions—can also be explained by temporal trends in childhood lead exposure. Figure 6 shows the relationship between gasoline lead exposure from 1941 to 1986 and unwed pregnancy rates for women ages 18 or 19 from 1961 to 1997. The 20-year time lag is consistent with the age bracket examined and the impact of lead on the brain's early development.

Figure 6: **Gasoline Lead versus Unwed Pregnancies: Ages 18–19**

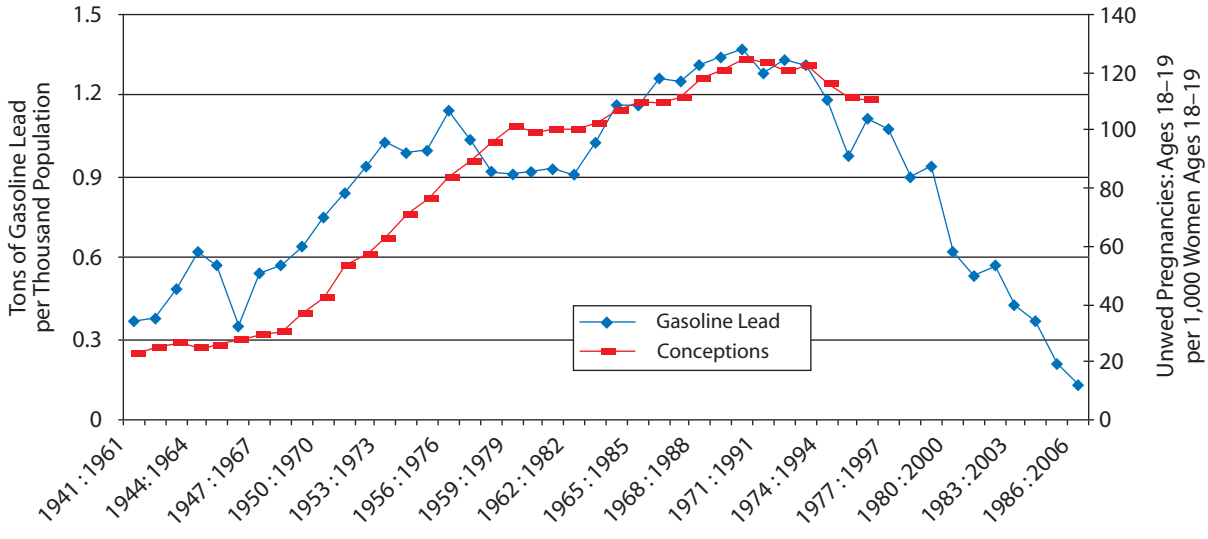


Figure 7: **Gasoline Lead versus Unwed Pregnancies: Ages 15–17**

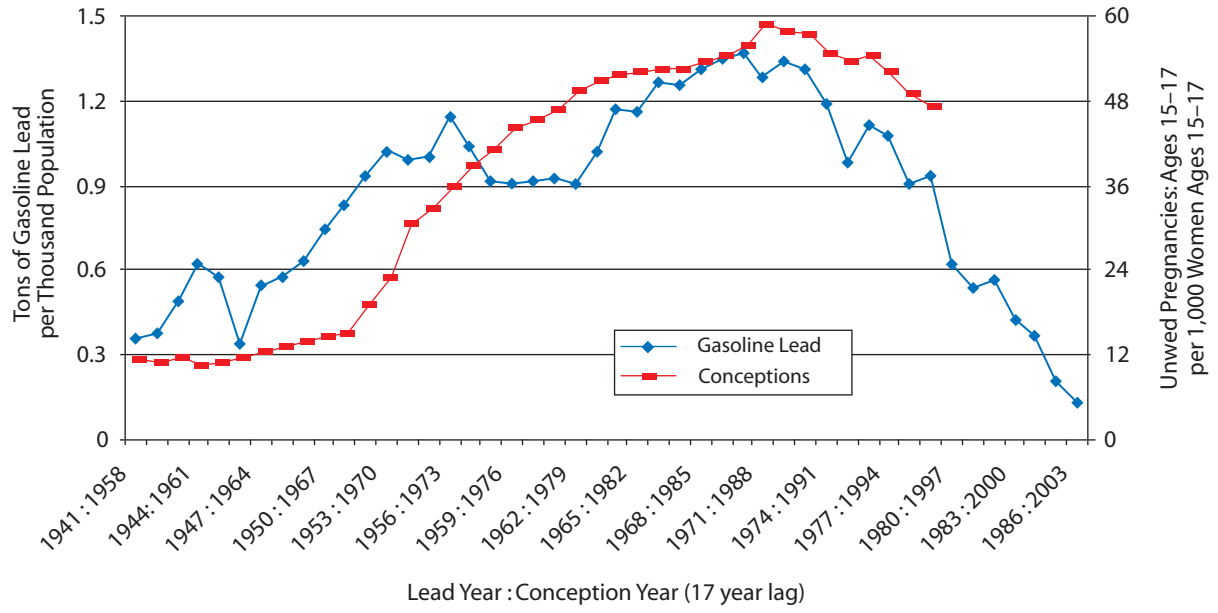


Figure 7 shows the corresponding relationship between gasoline lead exposure from 1941 to 1986 and unwed pregnancy rates for women ages 15 to 17 from 1958 to 1997. The 17-year best-fit time lag is again consistent with the age bracket examined and the impact of lead on the brain's early development.

In addition to examining the effects of childhood lead exposure on unwed pregnancy, the Nevin study also considered the effect of the Supreme Court decision legalizing abortion. Nevin's statistical analysis found that Roe v Wade explained about 5% of the long-term variation in unwed pregnancy rates for women ages 15 to 19, whereas childhood lead exposure explained almost 90%.

As in the case of violent crime, the effect of childhood lead exposure was especially apparent in the "best-fit" time lags for unwed pregnancy. Table 2 shows that the best-fit time lag for each of four age brackets examined is entirely consistent with the effects of childhood lead exposure in the first few years of life.

An Answer for Senator Moynihan

In a recent *ABC News* interview (September 24, 2000), Senator Daniel Patrick Moynihan was asked about the biggest change he'd seen in his 40-year political career. Rather than mentioning the collapse of the Soviet Union, Senator Moynihan stated that the biggest change—in his judgement—was that family structure had "come apart all over the North Atlantic world." He then explained:

> *"If you look at 1960, the—we'll just take the illegitimacy ratio as a—a good surrogate for it all—in United States it was about 6 percent, in Canada about 5, in Britain about 7, France around 4. Boom. Forty years. It's 32, 33, 36, 37. Like that. Boom. In an historical instant, something that was not imaginable 40 years ago has happened. Once you recognize that something like that has happened, … you have to believe that we can figure it out, I would say by about 2075."*

Table 2: **Comparison of Best-Fit Lags with Age Brackets for Unwed Pregnancy**

Dependent Variable	Best-Fit Time-Lag	Age at Time of Conception*	
		Mode	Median
Pregnancy under Age 15	15	14	14
Unwed Pregnancy Ages 15 – 17	17	17	17
Unwed Pregnancy Ages 18 – 19	20	19	19
Unwed Pregnancy Ages 20 – 24	24	21 – 23	21 – 23

* Nevin explains that the time lag effect of gasoline lead includes about one year from the purchase of lead by refineries to the time when childhood blood lead is most affected (due to storage, processing, and shipment time). On average, reported ages for unwed pregnancy also reflect data for each age category plus six months. For example, unwed pregnancies for women age 19 include a distribution of women from one day after their 19th birthday to one day before their 20th birthday. Therefore, a best-fit lag of 20 years for unwed pregnancies to women age 19 is consistent with lead exposure during the first year of life.

The Nevin study suggests that Senator Moynihan does not need to wait until the year 2075 to find an explanation for this international phenomenon. Gasoline lead exposure increased across the industrialized world with the expanding use of automobiles after World War II and it is not surprising that its association with subsequent trends in unwed pregnancy in the United States is also reflected in unwed pregnancy trends in other nations.

The crime rates in other industrialized countries have also risen steadily throughout the last 40 years, and many of those nations have not witnessed the decline in crime rates that the United States has enjoyed over the last decade. The reason for this divergence is because gasoline lead exposure began to decline in the mid-1970s in the United States and fell sharply after 1980. By contrast, Britain and many other industrialized countries did not begin to reduce their population exposure to gasoline lead until 1986. The result is that Britain now has a violent crime rate that is higher than the violent crime rate in the United States.

An Explanation for the Flynn Effect

A few years ago, the news media widely reported evidence of rising IQ scores in twenty nations over most of the 1900s—a phenomenon documented by political scientist James Flynn, and now known as the Flynn Effect. A number of researchers have examined whether the Flynn effect can be explained by advances in education and improved nutrition, but Flynn concludes that no single theory adequately explains all of the data on IQ gains:

> *"Some day sufficient data may allow us to see why some tests show higher gains than others, why some countries show higher gains than others [resulting in] a better theory of intelligence and better vehicles for measuring it." (Flynn, 1987).*

Nevin argues that the decline in childhood paint lead exposure over the first half of the 1900s can substantially explain rising adult IQ scores recorded through the early 1970s. The rise in gasoline lead exposure that began to more than offset the decline in paint lead during the 1950s

can also explain why the Flynn Effect appeared to slow or stop in many nations in the 1980s and 1990s.

The Nevin study also presents evidence that the decline in gasoline lead now appears to be creating a new acceleration of rising IQ scores, based on a comparison of scores on the Cognitive Abilities Test (CogAT) reported for representative national samples of grade-school children in 1984 and in 1992. Nevin compared the change in CogAT scores with two representative national surveys showing the decline in children's blood lead from the late 1970s to the late 1980s, and showed that the significant rise in CogAT scores could be entirely explained by the decline in childhood blood lead levels.

The Nevin analysis of CogAT scores also appears to confirm recent research indicating that cognitive development can be harmed by relatively low childhood blood lead levels. Although the Centers for Disease Control have specified a childhood blood lead level of 10 (micrograms per deciliter) as the level of concern, Nevin reviewed research indicating that IQ scores are also affected by blood lead levels below 10. In fact, this research suggests that children lose about one-quarter IQ point for every 1-unit (microgram/deciliter) increase in blood lead above 15, but they lose about one-half IQ point for every 1-unit increase in blood lead below 10. (Higher blood lead levels are definitely more harmful to children—and can lead to seizures, mental retardation, and even death at very high levels—but a "saturation effect" appears to make a child's IQ relatively less sensitive to each additional 1-unit change at higher blood lead levels.) Nevin used this research to calculate predicted gains in the 25th, 50th, and 75th percentiles of IQ for school age children, based on prior declines in the 25th, 50th, and 75th percentiles of childhood blood lead levels. The predicted increase in IQ proved to be remarkably similar to the actual increase for each quartile of CogAT IQ scores.

Children at Risk

The most recent data show that almost 1 million American children under age 5 still have blood lead levels above 10 (micrograms per deciliter). Children living in pre-1978 housing account for about 90% of these lead-poisoned children, and children living in pre-1940 housing account for about 70% of all children with blood lead levels above 15 (micrograms/deciliter). Furthermore, the evidence of cognitive impairment at blood lead levels below 10 suggests that lead exposure is still diminishing the intellectual potential of millions of American children. The conclusion of the Nevin study addresses the fate of these children as follows:

> *"The association between lead exposure and undesirable social behavior is a sobering new indication of the potential consequences of failing to address the remaining lead exposure hazards for young children. In particular, lead paint remains a hazard in more than 57 million pre-1980 homes, including more than 18 million pre-1940 homes that are likely to have high concentrations of lead in paint on a wide variety of surfaces.*
>
> *The number and percent of children exposed to lead paint hazards will certainly decline over time without any new public policy initiatives, due to the natural rates of demolition and renovation for older housing. In the absence of new policy initiatives to address lead paint hazards, however, a continuing temporal association between lead exposure and crime and unwed pregnancy suggests that lead exposure could still have life-altering consequences for countless Americans born over the next several decades."*

Rick Nevin is a Vice-President with ICF Consulting, Housing and Community Development Group. Comments and questions on the Nevin Lead Exposure Study can be directed to ricknevin@icfconsulting.com. The complete text of the Nevin Study is available at www.icfconsulting.com/publications.