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## **Child Maltreatment and Crime: New Evidence from a Sample of Twins**

### **Abstract**

Child maltreatment is a major social problem. This study measures the effects of child maltreatment on crime using data from the National Longitudinal Study of Adolescent Health (Add Health). We focus on crime because it is one of the most costly potential outcomes of maltreatment. Our work addresses many limitations of the existing literature. First, we use a large national sample, and investigate different types of abuse in a similar framework. Second, we pay careful attention to controlling for possible confounding factors by comparing male twins and by controlling for differences in genetic endowments that have been linked to aggression and risk taking behaviors. We find that maltreatment greatly increases the probability of engaging in crime and that programs to reduce maltreatment would be cost-effective.

## **Introduction**

Child maltreatment, which includes both child abuse and child neglect, is a major social problem. In the U.S., the death rate is 2.4 per 100,000 and 1,500 children die every year, making child maltreatment the leading cause of deaths from injuries in children over a year old (Institute of Medicine, 1999). Moreover, deaths are only the tip of the iceberg. According to the U.S. Department of Health and Human Services (1996), over a million children are victims of maltreatment annually. Paxson and Waldfogel (1999, 2002) show that abuse and neglect are more common in families of lower socioeconomic status, so that maltreatment may exacerbate differences in the life chances of rich and poor children.

Maltreatment may have many long-term consequences for survivors. This paper focuses on the effect of child maltreatment on crime using data from the National Longitudinal Study of Adolescent Health (Add Health). We focus on crime because it is one of the most socially costly potential outcomes of maltreatment, yet there is controversy about the extent to which a “cycle of violence” in which child maltreatment leads to future violence has been substantiated (c.f. Widom, 1989a).

Our work contributes to the existing literature in three ways. First, we use data from a national survey that includes a large “control” group of children who were neither maltreated nor committed crime. Second, in contrast to many studies that control for only a very limited number of background characteristics, we attack the problem of identifying the effects of maltreatment by comparing male twins. Since some twins are fraternal, we also control for genetic markers that have been associated with aggressive and risk-taking behaviors. Third, we examine the effects of sexual abuse, physical abuse, and neglect in a similar framework.

We show that the estimated effects of maltreatment on crime are large and remarkably robust to different estimation methods and specifications: Maltreatment approximately doubles the probability that a child will engage in crime in future. Moreover, while sexual abuse has the largest effects, neglect and (to a lesser extent) physical abuse are also important predictors of crime. The large size of the effects and the relatively modest cost of an intervention that has been shown to be effective in reducing childhood maltreatment suggest that further action to reduce the prevalence of child maltreatment is warranted.

## **Background**

Many studies have examined the long-term consequences of child maltreatment. The National Research Council (1993) offers a review and a critique. The main limitation of the studies they review is that most did not control adequately for potential confounders. It is possible that households in which children are maltreated have other characteristics that are associated with negative child outcomes and higher propensities to engage in crime. For example, in our data, children who were maltreated are more likely to have had a mother with less than a high school education, more likely to have had a father in jail at the beginning of the survey, more likely to have been in a family on welfare at the beginning of the survey, and more likely to have a mother who was a teenager at the time of her child's birth.

The sensitive nature of child maltreatment makes it difficult to use experimental designs. It would be unthinkable to divide study children into a control group and a treatment group that was maltreated. Hence, researchers must find another way to separate the effects of maltreatment from those of other confounders.

In this section, we attempt to briefly summarize some of the more recent work. A first group of studies establishes a cross-sectional relationship between past experiences of

maltreatment and other adverse events, and current risky behaviors/outcomes. For example, Felitti (1998) and Dube et al. (2003a) show that adverse childhood experiences (ACEs) increase the risk for depressed affect, suicide attempts, multiple sexual partners, sexually transmitted diseases, smoking, and alcoholism, while other studies show a relationship between ACEs, illicit drug use, and teen pregnancy (Dube et al., 2003b; Hillis et al., 2004).

While suggestive, these relationships do not necessarily imply that ACEs cause risky behaviors. If, for example, poverty is associated with ACEs then the fact that people with ACEs have higher rates of criminal activity could actually reflect a causal relationship between poverty and involvement in crime. Moreover, many ACE studies aggregate maltreatment with other forms of household dysfunction rather than trying to separately identify the effect of maltreatment.

A second group of studies is more closely related to the current study in that they control for family background factors such as poverty by using samples of twins in which one twin was maltreated and the other was not. Nelson et al. (2002), Kendler et al. (2000) and Dinwiddie et al. (2000) use this design to examine the effects of child sexual abuse on future psychiatric problems. The first two studies conclude that maltreated twins are more likely than their non-maltreated twins to suffer negative outcomes. However, Dinwiddie finds no differences between maltreated and non-maltreated twins. Our study examines neglect and physical abuse as well as sexual abuse, and focuses on effects on crime.

Widom (1989b) is one of the best known studies of the link between child maltreatment and crime. She matched a sample of 908 children with substantiated cases of maltreatment processed by the courts from 1967 to 1971 to controls who were selected to be similar in terms of age, sex, race, and socioeconomic status. She finds that being abused or neglected as a child

increases an individual's risk for an arrest as a juvenile by 53 percent and increases the probability of arrest as an adult by 38 percent.

Several other prospective longitudinal studies focus on groups of "at risk" children and follow them over time, comparing children who come to the attention of child welfare authorities to those who do not (see Stouthamer-Loeber et al., 2001 and Ireland, Smith, and Thornberry, 2006). Like Widom's, these studies deal only with substantiated cases. Administrative data on maltreatment and criminality capture only a fraction of all abuses and criminal behaviors because not all maltreatment or criminal activity are reported to or captured by government agencies.

Administrative data sets often contain only limited information on important mediating factors such as family income and socio-economic background. Matching on a small number of observable traits provides no guarantee that the controls are really similar to the "experimental" group in terms of unmeasured as well as measured characteristics. Furthermore, families about whom there are official records may be those more likely to come to the attention of official agencies, and thus may be an unrepresentative sample of families in which child abuse occurs (Smith and Thornberry, 1995). Lansdale et al. (2002) and (2007) address this problem by using maternal reports of maltreatment. But these reports may be suspect if the mother is the perpetrator, given that the researchers are mandated to report any ongoing abuse.

Our study is the first to examine the effects of child maltreatment on crime using a national sample of twins. The twin-comparison design offers a compelling way to control for unobserved family-level characteristics. In an effort to control for possible differences between fraternal twins that might be associated both with outcomes and how they are treated, we also include controls for genetic variations that have been associated with risky or aggressive

behaviors. A third strength of our study is that, like Widom, we examine the effects of physical abuse, neglect, and sexual abuse in a similar framework.

## **Data**

The Add Health survey was specifically designed to investigate adolescents' health and risk behaviors. It is considered the largest and most comprehensive survey of adolescents ever undertaken. It began with an in-school questionnaire administered to children in sampled schools between September 1994 and April 1995. A random sample of students from each school completed more detailed in-home interviews between April and December 1995. A second interview wave took place in 1996, and the third wave was administered between August 2001 and April 2002.<sup>1</sup>

The Add Health over-sampled twins, and in this study we focus only on male twins because it is well known that males are more likely than females to engage in serious crime (Lanctot and LeBlanc, 2002). Out of 484 twins, there are a total of 176 identical (monozygotic) twins. Sample sizes for some of our empirical analyses will be slightly less than these numbers, however, because of missing data in key variables for at least one twin in some twin pairs.

### *Measures of Maltreatment*

In Wave III, respondents answered questions about the way they were treated by their parents or other adults who took care of them before they were in the 6th grade. Specifically, they were asked whether and how often:

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<sup>1</sup> The Add Health is a program project designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris, and funded by a grant P01-HD31921 from the National Institute of Child Health and Human Development, with cooperative funding from 17 other agencies. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Persons interested in obtaining data files from Add Health should contact Add Health, Carolina Population Center, 123 W. Franklin Street, Chapel Hill, NC 27516-2524 (addhealth@unc.edu). More information on the design of Add Health can be found at <http://www.cpc.unc.edu/projects/addhealth/design>.

1. Parents (or other adult care-givers) had not taken care of their basic needs, such as keeping them clean or providing food or clothing.
2. Parents (or other adult care-givers) slapped, hit, or kicked them.
3. Parents (or other adult care-givers) had touched them in a sexual way, forced them to touch him or her in a sexual way, or forced them to have sexual relations.

The definitions of child maltreatment given at the Child Welfare Information Gateway website, which is a service of the Children's Bureau, Administration for Children and Families, U.S. Department of Health and Human Services (<http://www.childwelfare.gov/can/defining/>) are consistent with the abuse questions asked in the Add Health. It is important to emphasize that neglect is an important and very common form of child maltreatment, one that our results suggest can have long-term consequences.

Several researchers have studied the validity of self-reported data on child maltreatment and have concluded that, if collected properly, they are valid (Allen, Leadbeater, and, Aber, 1994; Dembo et al. 1991). In our data, the respondents listened to pre-recorded questions on sensitive topics through earphones and entered their answers directly on laptops in order to maintain confidentiality and to minimize the potential for interviewer or other third party influence. In order to obtain accurate responses about the timing of events, subjects were prompted with a calendar that gave the dates of many important events. Mocan and Tekin (2005, 2006) and Tekin and Markowitz (2008) provide evidence that rates of many of the risky behaviors reported in the Add Health are consistent with other sources. Widom and Shepard (1996) found good that official reports of physical abuse predict official reports of violent criminal behavior, just as self-reports of physical abuse predict self-reports of violent behavior.

A limitation our study shares with most others is that it is based on retrospective reports of maltreatment. It is possible that people tend to forget past abuse as they grow older. We have

investigated “forgetting” directly by examining whether the older people in the sample were less likely to report childhood abuse than those who were 18. We find no evidence that this is the case.

A potentially more serious problem is that people with negative outcomes may be more likely to report childhood maltreatment. For example, they may blame past maltreatment for their current problems. In this case, Ordinary Least Squares (OLS) estimates will tend to find “effects” of maltreatment that are too large. Measurement error of this type could also bias twin fixed effects models. Suppose that one twin is more likely to report bad things in general. Then this twin will be more likely to report both maltreatment and crime.

We investigated this problem by examining responses to a series of questions that should have been answered in the same way by both twins. These questions included whether or not the father was in jail at Wave I; how far the two twins lived away from each other; how often the twins saw each other; how often the twins talked to each other; and how often the twins fought with each other. We found few significant correlations between differences in the twins’ reports about maltreatment and differences in reports about these other variables. These findings provide some evidence against the hypothesis that one twin is just “more negative” than the other.

In the third wave of Add Health, respondents answered detailed questions about their relationships with their parents. Specifically, they answered questions on whether (1) they enjoyed spending time with parents, (2) parents were warm and loving toward them, (3) they felt close to their parents, and (4) they received money or any other significant payment from their parents within the past 12 months. We compared these measures to the reports of maltreatment as a way to both assess the internal validity of our data and to test the reliability of our

maltreatment measures. For all four measures of closeness to parents, respondents who reported maltreatment also reported that they had more distant relationships with their parents for all of our maltreatment variables.

Table 1 shows the fraction of respondents reporting various forms of maltreatment. The incidence of reports of particular types of maltreatment varies widely. Roughly fifteen percent of the sample report that their parents ever failed to meet their basic needs. Only 3.9% of the sample report any form of sexual abuse, while almost a third report that their parents ever hit them. These rates are broadly consistent with other studies. For example, Scher et al. (2004) use a sample of 967 adults from a community survey in Memphis Tennessee to determine the prevalence of retrospectively reported child maltreatment and find that 19% reported physical abuse, 18% reported neglect, and 5% reported sexual abuse. Still, in most of our work we will use a measure of whether the child was hit 10 or more times in order to indicate more severe or persistent physical maltreatment. Only 5.8% of respondents report physical abuse this severe. Note that the fraction of the twins sample reporting maltreatment is similar to those of the full Add Health male sample and the full male sibling sub-sample.

Column (2) of Table 1 shows the fraction of twins who have different reports of maltreatment. This column shows that discrepant reports are quite common, which is necessary if we are to identify effects of abuse using twin comparisons. As discussed above, it is not uncommon for some children in a household to be maltreated while others are unharmed. The question is whether this has anything to do with pre-existing characteristics of the child? By focusing on males, we eliminate gender as a potential explanation for why parents would maltreat one twin and not another. We control for birth weight (another characteristic that often varies between twins) directly in our models.

In the case of non-identical twins, we will also control for differences in genetic markers that have been associated with aggressive or risky behavior, as discussed further below. Note that in the case of identical twins, there are no genetic differences.

### *Genetic Measures*

In Wave III of the Add Health, DNA samples were collected from participants who were siblings using cheek swabs. Every person has two versions of each gene which are referred to as alleles. While most portions of most genes are the same across individuals, differences in the building blocks of the alleles may occur in some fragments and these differences are inherited by the children on a random basis. Alleles are often referred to by the length of the fragments involved. Variations in the coding of alleles are believed to be linked to some variations in human outcomes. There are many previous studies that associate certain types of individual behaviors with these variations (See Caspi et al., 2002; Rowe et al., 1998; Ding et al., 2006; Guo and Tong, 2006). These studies have guided us in incorporating genetic markers in our empirical analyses. We created control variables corresponding to different genetic patterns as described in Appendix 1.

### *Measures of Crime*

The crime questions in Add Health are similar to those found in other surveys and to official definitions of “crime” found in government sources such as the Bureau of Justice Statistics. We focus on whether the respondent committed any hard drug crime, or any non-drug crime in the past 12 months, and on three particular crimes that have relatively high incidence in our data: Whether the respondent damaged property, whether he assaulted someone, or whether he committed robbery. We created binary variables for these variables as follows: Any non-drug = 1 if committed any of the non-drug crimes in the past 12 months, and = 0 otherwise;

Damaged Property = 1 if deliberately damaged property that belonged to someone else in the past 12 months, and = 0 otherwise ; Assault = 1 if pulled a knife on someone, shot someone, or badly hurt someone in the past 12 months, and = 0 otherwise; Any Hard Drug = 1 if used any hard drugs (heroin, crystal meth, cocaine, LSD, ecstasy, inhalants, PCP, mushrooms, etc.) in the past 12 months, and = 0 otherwise; and Robbery = 1 if used or threatened to use a weapon to get something from someone else in the past 12 months, and = 0 otherwise.

The means of the crime variables are presented in Table 2 by whether or not respondents suffered various types of maltreatment. The table indicates that across almost every domain, children who suffered maltreatment are much more likely to have engaged in crime as those who did not. The differences for non-drug crimes are greatest for sexual abuse, but the incidence of crime is also high for those who report that their basic needs were not met (i.e. that they were neglected).

## Methods

We estimate models of the form:

$$(1) \text{Crime}_{ij} = \beta_0 + \beta_1 * \text{Maltreatment}_{ij} + \beta_2 * \text{Birthweight}_{ij} + \beta_3 * \text{SNP}_{ij} + \beta_4 * \text{PairID}_{ij} + \varepsilon_{ij},$$

where  $\text{Crime}_{ij}$  is one of the crime variables for male twin  $i$  in family  $j$ ,  $\text{Maltreatment}$  indicates one of the indicators for maltreatment,  $\text{Birthweight}$  is measured in grams,  $\text{SNP}$  is a vector of genetic markers as described above, and  $\text{PairID}$  is a unique identifier for each twin pair. These models control for all of the common elements of family background that are shared by the twins. Still, twin studies may underestimate the effects of abuse for two reasons. First, to the extent that there is random error in reports of abuse, estimates from twin models will be biased towards zero. Second, the occurrence of maltreatment in a household may traumatize all

children in the household. Hence, although the effects we find are large, there is some reason to believe that the true effects may be even larger.

In order to examine the hypothesis that the probability of engaging in crime increases with the experience or multiple forms of maltreatment, we created binary indicators for experiencing multiple types of maltreatment. About 11 percent of our twin sample experienced at least one type of maltreatment and another 5.2 percent experienced two types of maltreatment. We created three binary indicators for “no maltreatment”, “one type of maltreatment” and “two types of maltreatment” and used these as the measures of maltreatment. There is no one in the twin sample who experienced all three types of maltreatment.

Twin studies highlight an important question, which is whether it is common for parents to maltreat one twin and not the other, and whether maltreatment is related to characteristics of the child. Hamilton-Giachristis and Browne (2005) examine siblings in families in which police reports of maltreatment were filed for an index child. They found that in 37 percent of families, maltreatment was directed at all siblings, while in the remaining families, maltreatment was directed at some children but not others. They find little evidence that this phenomena was related in any consistent way to characteristics of the index child such as the presence of a disability or medical condition. Many authors have argued that in families with child maltreatment, it is common to have one child be singled out as a target or “scape-goat” (Young, 1976).

Jaffee et al. (2004) examine pairs of identical twins in which one was maltreated and the other was not. Again, they find little evidence that the maltreatment was related to observable characteristics of the index child. Campbell, Bogen, and Berger (2006) report on a survey of physicians with expertise in treating victims of abuse. When asked whether signs of abuse were

“often”, “occasionally”, or “almost never” likely to be present in the siblings of index children upon examination, these experts selected “occasionally” as the appropriate response.

In summary, there is considerable evidence that while siblings of abused children are at higher risk of maltreatment than other children, there are many families in which only some siblings are abused. And it is not easy to predict, on the basis of observable characteristics, which child will be maltreated. These findings lend support to the idea of using twin comparisons to identify the effects of maltreatment.

## **Results**

Our main results are shown in Table 3. This table shows quite different estimates of the effects of different forms of maltreatment. Having parents who ever failed to meet ones basic needs greatly increases the probability of committing both non-drug and drug crimes. Sexual abuse also has large effects (though not on hard drug use). In contrast, having a parent who struck, hit or kicked them increases the probability of hard drug use, but does not have a significant effect on the other categories of crime in these models. It is possible that the imprecise estimated effects for physical abuse reflect lack of consensus about what constitutes physical abuse (e.g. some may include punishments such as spanking while others may not).

We have also estimated these models using only identical twins. We have only 150 pairs of male MZ twins with complete data, and relatively few with differential maltreatment: For example 8 pairs have discordant reports for physical abuse (>10 times); 10 for sexual abuse; 16 for failing to meet basic needs; and 16 for any maltreatment. Therefore, it is remarkable that we still obtain significant effects of maltreatment on many types of crime even in these models, though we do not attach a lot of weight to the point estimates. In particular, estimates for any non-drug crime, assault, and robbery are robust to this change of samples.

Table 4 compares estimates from models in which we focus on whether the child suffered only one type of maltreatment, to estimates in which the child suffered two or more types of maltreatment. For example, if sexual abuse and neglect both cause crime separately, one might expect that a person who experienced both sexual abuse and neglect would be at a higher risk of committing crime than a person who had only one of these experiences.

Our data show that joint experiences of maltreatment are relatively common. For example, the percentage of individuals whose basic needs were not satisfied is 84 percent among those who experienced sexual abuse, while it is only 13 percent among the others. About 11 percent of our twin sample experienced at least one type of maltreatment and another 5.2 percent experienced two types of maltreatment. We created three binary indicators for “no maltreatment”, “one type of maltreatment” and “two types of maltreatment”. There is no one in the twin sample who experienced all three types of maltreatment. As shown in Table 4, the results provide evidence that the probability of engaging in crime increases if a person suffers multiple forms of maltreatment.

## **Discussion and Conclusions**

In order to determine the social cost of child maltreatment, we need to quantify its effects on important outcomes. This paper focuses on the effects on crime. We find that child maltreatment roughly doubles the probability that an individual engages in many types of crime. It is useful to put our results into perspective by comparing it to other estimates of the effects of factors related to crime. For example, using time series data from New York, Corman and Mocan (2005) find that a 1 percentage point decline in unemployment generates only a 2.2 percentage point decline in burglaries. They also find that a 10 percent increase in the minimum wage leads to about 3.5 percent decrease in robberies in New York City. Grogger and Willis

(2000) find that the introduction of crack cocaine in metropolitan areas was responsible for a 20 percent increase in murder rates, a fifteen percent increase in rapes, and a 27 percent increase in aggravated assault.

Using individual-level data from the first two waves of Add Health, Mocan and Tekin (2006) find that having access to a gun at home increases the propensity to commit a variety of crimes by about 30 percent among adolescents. Duggan (2001) calculates that the decreases in gun ownership over the 1990s can explain up to a third of the decline in crime over the same period. Finally, Bingenheimer et al. (2005) find that exposure to firearm violence approximately doubles the probability that an adolescent will engage in serious violence over the subsequent two years.

Hence, the effects of maltreatment are large relative to those of many environmental risk factors for crime, and are perhaps comparable to those of guns. The large size of these effects suggests that maltreatment may generate large costs to society in the form of crime.

Table 5 considers a crude translation of some of the effects measured in this paper into dollar terms, using estimates of the costs of crime from the literature. We use estimates of the baseline incidence of robbery and assault from the full male sample of the Add Health. Table 5 shows that these figures are quite similar to those shown for male twins in Table 2.

The estimated effects of maltreatment on the costs of crime are very sensitive to the estimated cost per crime, which varies widely between studies. Lochner and Moretti (2004) use estimates of the cost of crime that take account of the impacts on victims, as well as the costs of incarceration. Their estimates do not take account of other costs, such as the costs to society of avoiding crime, and thus should probably be regarded as lower bounds. Cohen (2004) derives estimates based on surveys of “willingness to pay” for crime reduction. These estimates may

well be upper bounds given that people are not required to pay anything when they fill in these surveys. The largest estimated costs of crime are for murder, which is such a rare crime that we cannot look at changes in its incidence using our data.

The Lochner and Moretti estimates suggest that the assault and robbery induced by abuse costs society about \$8.8 billion per year. The Cohen estimates suggest a much larger figure of \$68.6 billion. These figures must be compared to the costs of preventing maltreatment. Unfortunately, few intervention programs have been proven to be effective in rigorous studies. An exception is Olds et al. (1999) who report that home visits by nurses that start in the infancy and continue through two years can reduce the incidence of substantiated cases of maltreatment by 50 percent. At a cost of about \$4,000 per child, the steady-state cost of providing this service to all children would be about \$14 billion per year (assuming that there are roughly 3.5 children born each year). Given that the additional assaults and robberies induced by abuse are only one of the social costs of maltreatment, these estimates suggest that a home visiting program like Olds' could pay for itself in terms of reducing social costs, even using the most conservative estimates of the costs of crime. If we attach some benefit to improving the lives of children (beyond the value we attach to saving taxpayer money) then the cost-benefit analysis looks even more favorable.

Figures in Unicef (2003) suggest that there are very large variations in deaths due to maltreatment between European countries, with rates of only 0.1 to 0.3 per 100,000 in Spain, Greece, Italy, Ireland, and Norway. This suggests that there are other aspects of social organization which are protective for children, and that it might be worthwhile studying the large differences between countries to gain a better understanding of these factors.

In summary, we find that being maltreated greatly increases the probability of engaging in many types of crime and that the probability of engaging in crime increases with the experience of multiple forms of maltreatment, so that criminal behavior increases not only with the incidence of maltreatment but also with the severity of maltreatment. A rough cost-benefit calculation suggests that a home visiting program that prevented maltreatment would be cost effective, though there may well be other ways to reduce the appalling toll associated with child maltreatment.

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**Table 1**  
**Fraction of Add Health Sample Reporting Maltreatment**

<b>Type of Maltreatment</b>	<b>Male Twins Sample</b>	<b>Fraction Twins with Diff. reports</b>
Ever basic needs unsatisfied	0.151	0.119
Ever hit, spanked, kicked etc.	0.279	0.364
Hit etc. > 10 times	0.058	0.079
Ever sexual abuse	0.039	0.071
Ever any maltreatment	0.337	0.329
Any maltreatment using > 10 times cutoffs for physical abuse	0.205	0.164
Number of observations	484	

Source: Authors' calculations from the Add Health.

**Table 2: Means of Crime Variables by Type of Maltreatment**

<b>Variable Name</b>	<b>Full Sample</b>	<b>Never Any Maltreatment</b>	<b>Ever Fail to Meet Needs</b>	<b>Physical Abuse&gt;10X</b>	<b>Ever Sexual Abuse</b>
Any Non-Drug	0.234	0.180	0.444	0.429	0.684
Robbery	0.031	0.016	0.123	0.036	0.368
Assault	0.106	0.055	0.329	0.214	0.579
Damaged Property	0.135	0.114	0.208	0.179	0.421
Any Hard Drugs	0.151	0.132	0.178	0.357	0.211

Source: Authors' calculations from the Add Health.

**Table 3**  
**Effects of Different Types of Maltreatment on Outcomes**

<b>Outcome</b>	<b>Any Maltreatment <sup>a</sup></b>	<b>Basic needs unsatisfied</b>	<b>Physical abuse&gt;10X</b>	<b>Sexual Abuse</b>
<b>Any Non-drug</b>	0.538*** (0.124)	0.518*** (0.140)	0.079 (0.170)	0.503*** (0.191)
<b>Damaged Property</b>	0.288*** (0.101)	0.278** (0.114)	0.082 (0.133)	0.387** (0.150)
<b>Assault</b>	0.305*** (0.093)	0.285*** (0.104)	-0.098 (0.126)	0.328** (0.142)
<b>Any Hard drug</b>	0.383*** (0.094)	0.270** (0.110)	0.442*** (0.123)	0.057 (0.149)
<b>Robbery</b>	0.183*** (0.054)	0.249*** (0.059)	0.082 (0.071)	0.499*** (0.070)
<b>N</b>	292	302	302	308

<sup>a</sup> Using >10X cut off for physical abuse.

Notes: Each cell of the table shows the coefficient on the maltreatment indicator from a different regression. Standard errors are in parentheses. A \*, \*\*, \*\*\* indicates significance at 90%, 95%, 99% respectively.

Table 4

Effects of Multiple Experiences of Maltreatment<sup>a</sup> on Outcomes

	Any Non-drug	Damaged Property	Assault	Any Hard drug	Robbery
<b>Only one type of Maltreatment<sup>b</sup></b>	0.398*** (0.134)	0.140 (0.109)	0.214** (0.101)	0.435*** (0.099)	0.045 (0.050)
<b>Two types of Maltreatment</b>	0.583*** (0.173)	0.391*** (0.140)	0.291** (0.130)	0.367*** (0.127)	0.464*** (0.065)

<sup>a</sup> Using >10X cut off for physical abuse.

<sup>b</sup> Omitted category is "no-maltreatment"

Notes: Each cell of the table shows the coefficient on the maltreatment indicator from a different regression. Standard errors are in parentheses.

A \*, \*\*, \*\*\* indicates significance at 90%, 95%, 99% respectively.

**Table 5**  
**Estimated Annual Costs of Maltreatment in Terms of Increases in Costs of Crime**

a) *Costs from Lochner and Moretti (2004)*

<b>Crime</b>	<b>Cost Per Crime</b>	<b>Prevalence in Add Health</b>	<b>Estimated Effect Abuse Twin FE</b>	<b>Annual Per Person Cost of Abuse</b>	<b>Total Cost of Abuse (millions)</b>
Assault	\$13,884	.105	.294	\$429	\$7,715
Robbery	\$13,139	.028	.169	\$62	\$1111
				<b>Sum:</b>	<b>\$8,826</b>

b) *Costs from Cohen (2004)*

<b>Crime</b>	<b>Cost Per Crime</b>	<b>Prevalence in Add Health</b>	<b>Estimated Effect of Abuse - OLS</b>	<b>Annual Per Person Cost of Abuse</b>	<b>Total Cost of Abuse (millions)</b>
Assault	\$81,900	.105	.294	\$2528	\$45,509
Robbery	\$271,440	.028	.169	\$1284	\$23,120
				<b>Sum:</b>	<b>\$68,629</b>

Notes: Lochner and Moretti (2004) present estimates of the social costs of crime and include incarceration costs. Cohen (2004) derives estimates from a survey asking willingness to pay for crime prevention.

Estimated effects of abuse on probability of crime are from Table 3, column 6. Annual per person costs are obtained by multiplying the cost by the estimated effect, and then multiplying by the incidence of any abuse (.23). Total cost of abuse is estimated based on 39 million people aged 20-29 in 2000. Costs converted to millions \$2006.

## Appendix 1: Defining Genetic Variables

The Add Health Biomarker Team targeted the following genes that have been specifically hypothesized to be linked to risky behaviors in previous studies: the dopamine transporter (DAT1), the dopamine D4 receptor (DRD4), monoamine oxidase A promoter (MAOA), the serotonin transporter (SLC6A4), the dopamine D2 receptor (DRD2), and the Cytochrome P450 gene (CYP2A6). More detailed information on the procedures of DNA extraction and genotyping of the Add Health DNA sample can be found at <http://www.cpc.unc.edu/addhealth/.les/biomark.pdf/>

We created variables corresponding to different alleles of these genes. For example, the Dopamine Transporter gene (DAT1) has 7, 9, 10, 11 repeat alleles (in addition to some other much rarer patterns). The 10-repeat allele has a fragment size of 480, while the next most frequent, the 9-repeat allele has a fragment size of 440. We looked at all the combinations of fragment lengths in our data, and included an indicator for all combinations with over 30 observations. A few people had missing genetic information (a maximum of 11, depending on the measure) and so we also created dummy variables for missing data. Our results are not sensitive to the way the genetic information is coded.

The Table shows the categories we created for each of the six genes:

GENE	Description	Number of Cases
<b>DRD4</b>		
<b>(Dopamine Receptor)</b>		
DRD4_475	=1 if both alleles are 475, =0 otherwise	468
DRD4_619	=1 if both alleles are 619, =0 otherwise	47
DRD4_475_619	=1 if allele A is 475 and allele B is 619, =0 otherwise	260
DRD4_427	=1 if either allele is 427, =0 otherwise	72
DRD4_379_475	=1 if allele A is 379 and allele B is 475, =0 otherwise	123
DRD4_379_619	=1 if allele A is 379 and allele B is 619, =0 otherwise	39
DRD4_475_OTHERS	=1 if allele A is 475 and allele B is not 475 or 619, =0 otherwise	63
DRD4_ALL_OTHERS <sup>a</sup>	=1 if none of the above, =0 otherwise	34
DRD4_MISSING	=1 if both alleles are missing, =0 otherwise	11

	Total number of cases	1117
<b>DAT1</b>		
<b>(Dopamine Transporter)</b>		
DAT1_440	=1 if both alleles are 440, =0 otherwise	57
DAT1_480	=1 if both alleles are 480, =0 otherwise	639
DAT1_440_480	=1 if allele A is 440 and allele B is 480, =0 otherwise	374
DAT1_ALL_OTHERS <sup>a</sup>	=1 all the others, =0 otherwise	42
DAT1_MISSING	=1 if both allele are missing, =0 otherwise	5
	Total number of cases	1117
<b>MAOA_V</b>		
<b>(Monoamine Oxidase)</b>		
MAOA351	=1 if both alleles are 351, =0 otherwise	609
MAOA321	=1 if both alleles are 321, =0 otherwise	459
MAOA_ALL_OTHERS <sup>a</sup>	=1 both alleles are either 291, 336, or 381, =0 otherwise	34
MAOA_MISSING	=1 if both alleles are missing , =0 otherwise	15
	Total number of cases	1117
<b>DRD2</b>		
<b>(Dopamine D2 Receptor)</b>		
DRD2_178	=1 if both alleles are 178, =0 otherwise	601
DRD2_304	=1 if both alleles are 304, =0 otherwise	90
DRD2_178_304 <sup>a</sup>	=1 if allele A is 178 and allele B is 304	414
DRD2_MISSING	=1 if both alleles are missing, =0 otherwise	12
	Total number of cases	1117
<b>CYP2A</b>		
<b>(Cytochrome P450 2A6)</b>		
CYP_1	=1 if both alleles are 1, =0 otherwise	1056
CYP_1_2 <sup>a</sup>	=1 if allele A is 1 and allele B is 2, =0 otherwise	51
CYP_MISSING	=1 if both alleles are missing, =0 otherwise	10
	Total number of cases	1117
<b>SLC6A</b>		
<b>(Setotonin Transporter)</b>		
SLC484	=1 if both alleles are 484, =0 otherwise	229
SLC528	=1 if both alleles are 528, =0 otherwise	359
SLC484_528 <sup>a</sup>	=1 if allele A is 484 and allele B is 528	521
SLC_MISSING	=1 both alleles are missing, =0 otherwise	8
	Total number of cases	1117

<sup>a</sup> Omitted category in the regressions.