Impacts of Age of Onset of Substance Use Disorders on Risk of Adult Incarceration among Disadvantaged Urban Youth: A Propensity Score Matching Approach

Eric P. Slade[a][*], **Elizabeth A. Stuart**[b], **David S. Salkever**[b,c], **Mustafa Karakus**[d], **Kerry M. Green**[b], and **Nicholas Ialongo**[b]

a*University of Maryland School of Medicine, 737 W. Lombard St., Baltimore, Maryland, 21201, United States*

b*Johns Hopkins University Bloomberg School of Public Health, 624 N. Broadway, Baltimore, Maryland, 21205, United States*

c*University of Maryland, Baltimore County, Department of Public Policy, 1000 Hilltop Circle, Baltimore, MD 21250, United States*

d*WESTAT 1650 Research Blvd., Rockville, MD 20850, United States*

Abstract

Background—Age of onset of substance use disorders in adolescence and early adulthood could be associated with higher rates of adult criminal incarceration in the U.S., but evidence of these associations is scarce.

Methods—Propensity score matching was used to estimate the association between adolescent-onset substance use disorders and the rate of incarceration, as well as incarceration costs and self-reported criminal arrests and convictions, of young men predominantly from African American, lower income, urban households. Age of onset was differentiated by whether onset of the first disorder occurred by age 16.

Results—Onset of a substance use disorder by age 16, but not later onset, was associated with a fourfold greater risk of adult incarceration for substance related offenses as compared to no disorder (0.35 vs. 0.09, *P*=0.044). Onset by age 16 and later onset were both positively associated with incarceration costs and risk of arrest and conviction, though associations with crime outcomes were more consistent with respect to onset by age 16. Results were robust to propensity score adjustment for observable predictors of substance use in adolescence and involvement in crime as an adult.

Conclusion—Among young men in this high risk minority sample, having a substance use disorder by age 16 was associated with higher risk of incarceration for substance related offenses in early adulthood and with more extensive criminal justice system involvement as compared to having no disorder or having a disorder beginning at a later age.

Keywords

Incarceration; substance use disorder; adolescence; longitudinal; African American

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*Corresponding author. Address: 737 W. Lombard St., Rm. 526, Baltimore, MD 21201; Tel.: 410-706-2490; Fax.: 410-706-0022; E-mail: eslade@psych.umaryland.edu.

1. Introduction

Over the past two decades, the costs of criminal incarceration of persons involved in substance related crimes have increased substantially in the U.S. Inflation adjusted annual state prison costs more than doubled between 1986 and 2001, from $49 per resident in 1986 to $104 per resident in 2001 (Stephan, 2004). This increase in costs has been driven largely by increases in the number of persons incarcerated for substance offenses, crimes relating to the possession and distribution of illicit substances. Substance offenders now comprise the fastest increasing category of offenders in the U.S. state prison system (Harrison and Beck, 2005). Between 1980 and 2002, the number of persons in U.S. state prisons for substance offenses increased from 19,000 to 265,000. The rapid increase in public expenditures devoted to incarceration of persons who may have persistent substance use disorders implies there is an increasing economic opportunity to finance interventions aimed at preventing later incarceration of such persons. Information about the onset of substance use disorders and its relationship to later incarceration may consequently be useful to policymakers as they consider how best to allocate scarce public resources.

The onset of substance use disorders could be related to increased risk for criminal arrest, conviction, and eventual incarceration, especially for offenses related to the possession or distribution of illegal substances. However, evidence on the association of onset and course of substance use disorders with the risk of involvement with criminal justice systems (i.e., contact with law enforcement, judicial, and corrections systems that is related to one's own alleged or established violations of law) is scarce. Many research studies provide evidence that substance use and involvement in crime frequently co-occur in adolescence and early adulthood (Nurco, 1998; Hays and Ellickson, 1996; White and Gorman, 2000; McBride et al., 2003; Gordon et al., 2004). Recent studies of longitudinal data from a non-U.S. cohort provide evidence that heavy use of alcohol and marijuana in adolescence is positively related to later criminal justice system involvement (Fergusson and Horwood, 2000; Fergusson, Horwood, and Swain-Campbell, 2002; Fergusson, Swain-Campbell, and Horwood, 2002). Although these relationships suggest that onset of disorders might influence later risk of incarceration in the U.S., empirical evidence from at least some studies (Dobkin et al., 1995; Fergusson and Horwood, 1997; White and Gorman, 2000) suggests that correlations between substance use and adult criminal outcomes could be spurious, insofar as delinquent behaviors and serious behavioral problems usually precede initiation of substance use and later involvement in crime.

The present study explores the association of timing of onset of substance use disorders with the risk of criminal incarceration in early adulthood among a cohort of young men (ages 18 to 24) who are predominantly from lower income, urban, African American households. Using propensity score matching techniques (Dehejia and Wahba, 2002; Rosenbaum and Rubin, 1983a), analyses controlled for numerous observable characteristics that are related to initiation of substance use and incarceration risk. Young men who met Diagnostic and Statistical Manual Version 4 (DSM-IV) criteria for a substance abuse or dependence disorder were propensity score matched to a comparison group of young men who did not meet these criteria but had a similar propensity for having a substance use disorder. We hypothesize that young men with substance use disorders are at increased risk for criminal incarceration for substance related offenses in early adulthood. Epidemiological evidence that early initiation of heavy use of marijuana and alcohol is associated with higher rates of criminal justice system contacts (Fergusson and Horwood, 1997; Fergusson, Horwood, and Swain-Campbell, 2002; Fergusson, Swain-Campbell, and Horwood, 2003; Ellickson et al., 2003 and 2004) and with greater involvement in drug distribution (Inciardi and Poettinger, 1998) led us to also hypothesize that an early age of onset of a disorder (onset by age 16) indicates greater incarceration risk, higher incarceration costs, and greater risk of criminal arrest and prosecution.

1.1. Substance Use Disorders and Incarceration Risk

Conceptually, onset of substance abuse or dependence (a substance use disorder) has been hypothesized to increase an individual's vulnerability to impairments in executive function (e.g., decisionmaking and forethought) and impulse control, and consequently to increase an individual's propensity to participate in criminal acts (Anthony and Forman, 2003). Data from research studies of the correlates of substance use disorders are consistent with this concept (Fagan, 1990). Specifically, the onset of a substance use disorder is associated with a higher propensity for more severe forms of substance use, including polydrug use (American Psychiatric Association, 2000; Ellickson et al., 2004; Newcomb et al., 2001) and use of "hard drugs" (e.g., cocaine and heroin) (Chaiken and Chaiken, 1990; Ellickson et al., 2004; Morral et al., 2002). Severe forms of substance use, in turn, are associated with impulse control problems (Cunningham, 2004), and may motivate participation in drug selling and other crimes in order to obtain drugs or money to purchase drugs (Fagan, 1990; Nurco, 1998).

1.2. Early Onset

Compared with individuals whose disorders begin later, individuals with disorders appearing during the early and middle phases of adolescence, up to the ages of 16 or 17 years old, could have a higher risk of incarceration by early adulthood (Anthony and Forman, 2003; Fergusson and Horwood, 1997; Fergusson, Horwood, and Swain-Campbell, 2002; Fergusson, Swain-Campbell, and Horwood, 2003; Ellickson et al., 2003 and 2004). An early onset indicates greater liability to more severe forms of substance use and to chronic relapse (Ellickson et al., 2003; Kandel et al., 1992; Reiss et al., 2005; Riala et al., 2004; Tolan, 1987). Early onset also indicates impaired executive function and impulse control problems (Chambers et al., 2003; Cunningham, 2004; Tomas et al., 1990), which may predispose individuals to participation in crime. Although these cognitive and behavioral problems could predate initiation of substance use, it has also been proposed that heavy use of addictive substances during the sensitive developmental phase of early adolescence may impair maturation of neurological systems that influence executive function and impulse control (Chambers et al., 2003; Hyman, 2005). Finally, early initiation indicates greater involvement in drug selling and distribution early in adulthood, which could increase the risk of incarceration (Inciardi and Pottieger, 1998).

1.3. Potential Confounders and Propensity Score Matching

Despite several decades of research, there is no consensus among researchers as to whether there is a unique contribution of substance use to participation in criminal activity and, therefore, to risk of incarceration in adulthood. Substance use tends to co-occur with several other behavioral risk factors for criminal activity, especially deviant or delinquent behaviors, affiliation with delinquent peers, and academic problems (Derzon and Lipsey, 1999; Ellickson et al., 2003 and 2004; Elliott et al., 1989; Fergusson, Swain-Campbell, and Horwood,, 2002; Gordon et al., 2004; Hays and Ellickson, 1996; McBride et al., 2003; Tomas et al., 1990; White and Gorman, 2000). Moreover, initiation of substance use during adolescence is often preceded by behavioral problems and adverse family circumstances earlier in childhood (Dobkin et al., 1995; Fergusson and Horwood, 1997; Nurco et al., 1998; White and Gorman, 2000; Fergusson et al., 2005), complicating the interpretation of empirical correlation between initiation of substance use and later criminal activity or incarceration outcomes. As a result, empirical separation of a marginal impact of substance use on risk of incarceration from the impacts of other adverse circumstances is generally problematic.

Here, we use a common version of propensity score matching (Dehejia and Wahba, 2002; Rosenbaum and Rubin, 1983a), one-to-one matching, to guard against the influence of factors that could confound the association between substance use disorders and incarceration risk. Mechanistically, propensity score matching generates treated and untreated comparison samples that closely resemble one another, or are "balanced," with respect to their observed

characteristics and estimated propensity for exposure to the "treatment" (Dehejia and Wahba, 2002). Once matched, the outcomes of individuals in the comparison sample and those of individuals in the treatment sample–in this case having a substance use disorder–are compared, using mean comparisons or multivariable regression to estimate the marginal influence of exposure to the treatment.

The internal validity of propensity score analyses depends critically on the available covariate measures. Even if the matched samples have similar observed characteristics, other unobserved characteristics could be correlated with both exposure to the treatment and with the outcome of interest. The propensity score analysis of the present study is enhanced by an unusually rich set of covariate predictors of participation in crime and substance use. Consequently, the resulting estimates of the association of substance use disorders to incarceration risk may be more robust to residual unobserved differences between the substance use disordered and comparison groups than is normally the case in studies based on observational data.

2. Methods

2.1. Sample Selection

The data used in this study are from a sample of young men, ages 18 to 24 years old, who originally were participants in the Preventive Intervention Research Center (PIRC) randomized trials of two school-based, preventive interventions, which targeted early learning and aggression in first and second grades in 19 schools in Baltimore, Maryland (Dolan et al., 1993). Child participants began the study in two consecutive cohorts, which were recruited during the 1985–86 and 1986–87 school years.

The PIRC sample (n=2,311) was designed to be representative of 1st grade students enrolled in the Baltimore City Public School System and living in five socio-demographically distinct areas in eastern Baltimore. The five geographic areas in which the participating schools are located were defined by census tract data and vital statistics from the Baltimore City Planning Office. These areas were varied by ethnicity, type of housing, family structure, income, unemployment, violent crime, suicide and school drop out rates. The resulting sample included a substantial minority of students from middle-income households. With regard to demographics, 49 percent were male, 65 percent were African-American, 32 percent were Euro-American, and the remaining 3 percent were Native American, Hispanic, or of unknown race or ethnicity. Further details of the prevention study design can be found elsewhere (Chilcoat et al., 1995; Kellam et al., 1994; Kellam and Anthony, 1998; Storr et al., 2002 and 2004; Wilcox and Anthony, 2004).

The sample in the present study included male PIRC participants. Although females also participated in the PIRC, they were not included in the present study. Incarceration among females was too rare an event, preventing us from comparing incarceration rates among females with and without substance disorders.

We included individuals whether or not they had been in PIRC 1st grade intervention classrooms. Exposure to the PIRC 1st grade intervention could, in principle, introduce interaction effects with substance use disorders and incarceration outcomes. However, intervention group assignment was not associated with substance use disorders in adolescence, and is therefore unlikely to be a confounder of the association between substance use disorders and incarceration risk.

Attrition from the PIRC sample, from the study baseline in the fall of first grade to the follow-up interviews at ages 20 to 21, when information on history of substance use was collected, resulted in a loss of 596 of the original 2,311 PIRC sample of first graders. Thirty-four of the

participants died, as confirmed by a search of the National Death Index or by an immediate family member, 112 could not be located, 100 refused to be interviewed, and the remainder were not interviewed for other reasons (e.g., scheduling difficulties or failure to respond to repeated requests for an interview). Of the 1,151 males from the original sample, 780 (67.8 percent) who had data collected at the follow-up in early adulthood make up the sample for this study prior to matching. Compared with others, the 780 young adults who completed follow-up interviews were absent from school a lower proportion days in 7th grade (0.139 vs. 0.164, P=0.045), had slightly more disciplinary removals from school from kindergarten through 8th grade (0.515 vs. 0.369, P=0.045), and were less likely to be white race (0.312 vs. 0.442, P<0.001). Completers did not differ significantly from non-completers on measures of incarceration in adulthood, involvement in the juvenile justice system, peer use of alcohol and marijuana, peer delinquency, academic performance, poverty status, or conduct disorder symptoms.[1]

We used data collected at two follow-ups of the participants as well as data resulting from a search, conducted in early adulthood, of a statewide prison information system. The first of the participant follow-ups took place at 7th grade (1993–94), when most of the participants were ages 12 or 13 and prior to typical ages of onset of substance use disorders. Data on potential predictors of later substance use disorders, such as measures of conduct problems, were collected in interviews with parents, teachers, and participants and in reviews of school attendance and disciplinary records and juvenile justice system court records. A second follow-up took place in 2000–2002, when most of the individuals were ages 20 or 21. At that time, participants completed structured clinical interviews. Data from these structured clinical interviews were used to ascertain whether participants met DSM-IV criteria for lifetime substance dependence or abuse disorders, and if so, the age of onset.

Incarceration records were obtained in 2004 from the Maryland Department of Corrections adult prison database. At the time when the database was accessed, most of the participants were 24 or 25 years old. Consequently, criminal incarcerations that occurred by the age of 24 or 25 were measured in our analyses. The Department of Corrections database included information on any incarceration in an adult prison in Maryland and incarcerations resulting from transfers to out-of-state prisons and to federal penitentiaries. The Maryland database probably captures most incarcerations, as more than 90 percent of the follow-up sample was residing in Maryland at the time of the age 20 or 21 follow-up interviews. However, some incarcerations in other states may not be counted. Information relating to contacts with local jail systems, criminal arrests, and juvenile incarcerations also was not included in the adult prison database. A self-reported history of arrests, which was collected at the age 20 to 21 follow-up interviews, provided additional information about contacts with law enforcement in the prior 12-months and age of first arrest.

2.2. Measures

2.2.1. Dependent Variables—Three binary indicators of lifetime adult incarceration were created from prison records: any lifetime incarceration, incarceration for substance related offenses, and incarceration for non-substance related offenses. Substance related offenses were

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[1]While sample completers and non-completers had similar incarceration rates overall (0.173 vs. 0.167, *P*=0.802), this overall similarity masked an interaction by race that might affect the interpretation of results. White completers had nominally higher incarceration rates than white non-completers (0.082 vs. 0.037, *P*=0.065), whereas non-white completers had nominally lower incarceration rates than non-white non-completers (0.214 vs. 0.271, *P*=0.102), especially for substance related offenses (0.140 vs. 0.213, *P*=0.015). Consequently, the sample of completers probably under-represents African-American males who were incarcerated for substance related offenses, and over-represents whites who were incarcerated for both substance-related and non-substance related offenses. Overall, this selection could have resulted in an underestimation of the true correlation between substance use disorders and incarceration for substance related offenses in Baltimore, especially among African Americans.

defined as drug possession, distribution, or conspiracy. Non-substance related offenses included robbery, car theft, assault, weapons violations, homicide, and other crimes.

Several other dependent variables were added to provide additional information about respondents' criminal behaviors and contacts with law enforcement. Only a fraction of individuals who have contact with criminal justice systems are ever incarcerated. Consequently, results for the additional dependent variable measures provide a broader basis for inference regarding differences in criminal justice system contacts than criminal incarcerations alone. We used self-reported data on criminal arrests and convictions, which were recorded at the age 20 to 21 follow-up interviews, to create binary indicators of any arrests for drugs or assaults in the 12 months prior to interview as well as measures of lifetime number of arrests, whether the individual had ever been arrested as of age 16 years old, and whether the individual had ever been convicted of a crime. Self-reported arrests and criminal convictions are subject to greater underreporting than administrative records, yet may capture a broader range of encounters with law enforcement.

Using the administrative data on incarcerations, we also created a measure of total incarceration costs. We interpret total incarceration costs as a crude measure of intensity of involvement with the criminal justice system, as longer prison stays and higher costs per day both correspond to greater intensity of use of criminal justice resources. Incarceration costs were estimated as the product of total prison days served and average prison costs per day (in 2005). Estimates of average prison costs per day were provided by administrators at the Maryland Department of Corrections, and differed by prison facility (e.g., daily costs at a maximum security facility differed from daily costs at a minimum security facility). For individuals who had been released from prison, we used the dates of incarceration to construct total days incarcerated. For persons who were currently incarcerated, total expected days of incarceration was estimated using information on the expected remaining days in prison, given the original sentence length and the number of days served. We used published Maryland data on the average ratio of time served to sentence length by type of offense (Wellford and Souryal, 1998) to adjust the number of days remaining for the fact that prisoners tend to be released before they serve 100 percent of their sentence duration.

2.2.2. Substance Use Disorder Indicators—The primary independent variable in the analysis was presence of a substance use disorder at any age (a lifetime disorder), as assessed using the Composite International Diagnostic Interview-University of Michigan Version (CIDI-UM) (Kessler et al., 1994). The CIDI-UM is a fully structured psychiatric interview based on the Diagnostic Interview Survey (Robins et al., 1989). The highly structured format is intended to minimize clinical judgment in eliciting diagnostic information and recording responses. The CIDI-UM was administered by lay interviewers, trained to follow precisely the interview schedule.

In some of the analyses we disaggregated the substance use disorder group into two subgroups depending on whether onset was by age 16 or after age 16. Previous empirical evidence (Kessler et al., 2005) suggests that age 16 approximately delineates an atypically early period of onset from a more normative period of onset of substance use disorders. Whereas 50 percent of all adults with substance use disorders have at least one disorder by age 20, only 10 percent of adults with a substance use disorder have onset by age 16. The age 16 cutoff also theoretically delineates the period of late adolescence, which begins somewhere around age 17, from the potentially more vulnerable period of early and middle adolescence, which begins around age 11 or 12 and ends around age 16. In sensitivity analyses, we re-ran all the results using age cutoffs of 15 and 14. We found similar results using an age 15 cutoff. Using a cutoff of age 14, the number of subjects in the substance use disorder group was much lower, and consequently the results were less stable.

2.2.3. Covariates/Matching Variables

Conduct disorder symptoms: Symptoms of conduct problems from the DSM-IV conduct disorder checklist were obtained during 7th grade interviews with participants. Conduct disorder symptoms include fire-setting, property destruction, fighting, sexual assaults, running away from home, stealing, lying, cruelty toward animals, and other aggressive, violent, or delinquent behaviors. Only symptoms that persisted for at least six months were counted. We used an index of the aggregate number of symptoms reported.

Performance in school: Teacher ratings of the youth's performance in school were obtained in the spring of 7th grade using the Teacher Observation of Classroom Adaptation-Revised (TOCA-R) (Werthamer-Larsson et al., 1991). The TOCA-R is a brief measure of each child's adequacy of performance on core tasks in the classroom as defined by the teacher. Teachers rated their students' performance relative to expected grade-level norms on a 6-point Likert scale. TOCA-R scores in this sample are associated with higher rates of adjudication for violent crimes in middle-to late-adolescence (Petras et al., 2004); other evidence indicates that school-aged children with below average academic performance are at higher risk for substance use problems in adolescence (Ellickson et al., 2004).

School absences and disciplinary removals: Percentage of school days missed during 7th grade and the total number of school disciplinary removals–in-school and out-of-school suspensions and expulsions–from kindergarten through the end of 7th grade (range of 0 to 8) were constructed from schools' administrative records. Suspensions and expulsions are the result of a wide variety of rules infractions, including aggressive or violent behaviors but also including non-violent disruptive or inappropriate behaviors.

Juvenile court appearances: Some of the young adults had contact with the juvenile justice system prior to typical ages of onset of substance use disorders. Juvenile justice system contacts beginning at a young age could indicate high propensity for substance use disorders and for incarceration in adulthood. By including covariates for early contact with the juvenile justice system, we guarded against bias that could have resulted from differences in serious delinquent behaviors that preceded onset of substance use. Using administrative data on juvenile court appearances, we created two binary indicators. The two indicators were for any juvenile court appearance before age 14 for any non-violent offense and for any violent offense, respectively. Violent juvenile offenders may be at especially high risk for later incarceration. We did not create a measure of juvenile court appearances that occurred at age 14 or later, because appearances at these later ages may have been related to onset of a substance use disorder. Contacts at younger ages are far less likely to be related to onset of a substance use disorder, because approximately 90 percent of young adults with substance use disorders reported onset at age 14 or later. By comparison, 50 percent of individuals with juvenile court appearances had their first appearance before age 14.

Free lunch eligibility: Eligibility for a free school lunch upon entry into first grade, as determined by a review of school records, was used as a proxy for low family income.

Family characteristics: Young adults were asked to describe retrospectively their parents' or other primary caregivers' level of education, marital status, employment status. They also reported whether their biological father and mother were present in the household when the respondent was in 7th grade. These variables served as proxies for 7th grade family and neighborhood socio-demographic influences on young adults' later substance use and criminal outcomes.

Family member substance use: Young adults were also asked to recall how many of their primary caregivers used illegal drugs such as marijuana, cocaine, or heroin. The answer to this question provided a measure of family history of illegal substance use.

Exposure to peer effects: Delinquency and drug and alcohol use of peers could explain a positive association between substance use disorder and incarceration risk (Dobkin et al., 1995). Measures of the young adults' "closest" friends' use of alcohol, use of marijuana, and participation in delinquent activities were included as covariates. All three measures were from items coded on a 5-point Likert scale representing the prevalence of the behavior among the respondents' closest friends, as reported in the 7th grade interview. The peer alcohol and marijuana measures were binary indicators equal to 1 if the individual reported that "most" or "all" of his closest friends used alcohol or marijuana. The delinquency measure was an average of responses for five types of behavior: cheating on school tests, property damage, stealing, threatening someone, and encouraging the respondent to engage in illegal behavior.

2.3. Multiple Imputation

To impute missing values in the data, multiple imputation using chained equations was implemented using "ice" in STATA 9.0 (Schafer, 1999; Royston, 2005). As a result of the multiple imputation procedure, we were able to use data from all 780 young men who completed follow-up interviews. The ice procedure uses Bayesian methods to impute observations from the posterior distribution of all covariates for all individuals given the distribution of the observed data. In estimating imputed values, all dependent and independent variables used in the main analyses were included in the imputation model. We also took full advantage of the richness of the data by including in the imputation model behavioral and academic performance measures from multiple rounds of data collected during the early grades of elementary school, prior to our period of analysis. Because behavior problems that begin early in childhood tend to persist throughout childhood, measures from earlier grades were highly predictive of measures of behavioral outcomes in 7th grade, which had the largest number of missing values. The multiple imputation procedure produced five samples, each of which contained imputed values. Estimates from analyses of each of these imputed samples were combined using formulas provided by (Schafer 1999).

2.4. Propensity Score Matching

Each of the 279 young men who met DSM-IV criteria for a lifetime substance use disorder (American Psychiatric Association, 2000) was matched one-to-one with a young man who did not meet lifetime criteria but had similar propensity for these disorders. Data from the resulting matched sample (n=558) were used in the analyses. Results for these 558 individuals may not generalize to the entire PIRC sample of 780 males, as they represent a non-random minority selected for their high propensity for substance use disorders. To describe the potential impact on generalizability, we report comparisons of the characteristics of those who were matched to those who were excluded from the analysis. In our discussion of results, we also discuss the results of sensitivity analyses using data from all 780 individuals and using an alternative matching technique.

Propensity scores were estimated in a multivariable logistic regression model in which the dependent variable was a binary indicator for any lifetime substance use disorder. Propensity scores were used to identify from among potential comparison sample subjects the individual with the most similar characteristics, measured by absolute propensity score distance (Dehejia and Wahba, 2002). To allow the nearest match possible for each individual with a disorder, we allowed individuals with no disorder to be matched multiple times. The resulting matched samples (treatment and comparison) were then compared and tested for balance on covariates.

Covariates in the logistic regression model for substance use disorder were chosen in three steps. First, we selected covariates in our database that previous studies suggested might have an association with substance use disorders and with incarceration (McBride et al., 2003; White and Gorman, 2000). These covariates included family background and demographic characteristics and the scale and school records measures of behavioral and emotional problems and school performance. Second, we estimated bivariate logistic regressions, using each potential covariate as the sole predictor of a disorder. Any variable that had a *P*-value less than 0.30 in the bivariate model was included in the full multivariable logistic regression model that was used to estimate propensity scores. Third, following procedures used in (Dehejia and Wahba 2002), we iteratively added to the logistic regression specification higher order polynomials of covariates that did not perfectly balance in the previous specification, and again matched the sample. After an iteration of the propensity score matching, covariate values in the treatment and comparison samples were tested for balance across samples using t-tests.

As a result of matching, individuals in the matched no-substance-use-disorder sample resembled (t-test values less than 1.96) those in the substance-use-disorder sample with respect to all covariates (shown in Table 1), including school performance, conduct disorder symptoms, proportion of school days missed in 7th grade, total disciplinary removals from school, juvenile court appearances, delinquency of peers, peer alcohol and marijuana use, age, employment status of childhood caregiver, caregiver substance use, race, and free lunch status.

Within particular strata of the propensity scores, minor differences between treatment and matched comparison sample covariate means were identified. Mean sample differences within each quintile of the estimated propensity scores were tested for each variable, using t-tests. Differences at the five percent level were considered significant. Within the highest and lowest propensity score quintiles, significant mean differences could not be eliminated for age, the number of conduct disorder symptoms, and teacher-rated school performance measures. We therefore included linear and quadratic measures of these variables in the subsequent incarceration outcome regressions to adjust for residual imbalances in the extremes of their distributions.

2.5. Analysis of Criminal Incarceration Outcomes

Using the propensity score matched sample, we estimated the marginal association of substance use disorders with incarceration outcomes. Most of these outcomes were binary valued. Binary outcomes were estimated using probit regression models. Continuous outcomes (number of lifetime arrests and incarceration costs) were estimated using ordinary least squares regression. For each dependent variable, we estimated two regression models, both of which included all the covariates that were included in the propensity score logistic regression equation plus quadratic terms for age, teacher rated school performance, and number of conduct disorder symptoms. The first model included the indicator of substance use disorder. In the second model, instead of a single binary indicator of a substance use disorder, we included two binary indicators, one for onset by age 16 and another for onset after age 16.

In sensitivity analyses (results not shown here), the models were estimated again using a dual-matched sample, in which the age-of-onset subgroups (by age 16 and after age 16) were each matched separately to a comparison sample of persons with no history of a substance use disorder. Matching separately could reduce bias in matches that may result from differences in the characteristics of the two age-of-onset subgroups. Point estimates from the resulting analysis were similar to those resulting from analysis of the single-matched sample but less precise. The greater imprecision could have been due to smaller samples sizes. The sample size in each of these sensitivity analyses was approximately one third smaller than the sample size of the main analyses; that is, persons with onset after age 16 were excluded from the

propensity score analysis of onset by age 16, and persons with onset by age 16 were excluded from the propensity score analysis of onset after age 16.

To estimate variances of all parameters, the entire propensity score matching and regression procedure was bootstrapped. The rationale for using bootstrapping is that the propensity score value in the regression equation is an estimate of the true propensity for exposure to treatment, and therefore should not be treated as though it were known (Dehejia and Wahba, 2002). Bootstrapping simulated the empirical variability of the propensity score estimate. T-statistics and *P*-values for two-sided tests were constructed using the empirical bootstrapped parameter distribution. We did not use probability sampling weights in the analyses, because the matched sample was a non-randomly selected subset of the overall PIRC study sample.

2.6. Sensitivity Analysis for Potential Confounding

Propensity score matching estimates of the "average treatment effect" depend critically on the so-called "conditional independence assumption" (Rosenbaum and Rubin, 1983a). Conditional independence means that, conditional on the observed covariates, the "treatment," which in the present analysis is having a substance use disorder, is assigned independently of the outcome of interest. If the conditional independence assumption is violated, propensity score estimates of the average treatment effect may be biased and inconsistent. Although this assumption is not directly testable, methods for assessing the sensitivity of propensity score matching estimates to violations of the conditional independence assumption have been proposed (Rosenbaum and Rubin. 1983b; Rosenbaum, 1987), and more recently have been developed for applications (Ichino, Mealli, and Nannicini, 2007; Nannicini, 2007). These methods can be used to quantify the potential magnitude of bias in the propensity score matching estimate of the average treatment effect. In the present study we use this approach to assess the plausibility of the notion that one or more unmeasured confounders could fully explain the estimated marginal association of onset of substance use disorders with incarceration outcomes.

3. Results

3.1. Substance Use Disorder Prevalence

Table 2 shows the lifetime prevalence of substance use disorders among the 279 young men who reported onset of a substance use disorder by age 20 or 21, and compares individuals who reported initial onset by age 16 to those who reported initial onset was after age 16. Although alcohol and marijuana use disorders are prevalent among a majority in both onset groups, the earlier onset group reported a higher prevalence of marijuana, cocaine, heroin, and other drug disorders, and also reported a higher prevalence of more than 1 disorder (*P*<0.05).

3.2. Binary Comparisons

Table 3 shows binary comparisons of the mean values of all dependent variables by substance use disorder onset, using the matched sample. The first two columns show differences by substance use disorder status (any disorder vs. none). Individuals with at least 1 substance use disorder were approximately twice as likely to be incarcerated for any offense (29.7 percent vs. 14.7 percent, *P*<0.05). Incarceration rates for substance related and non-substance related offenses indicated similarly large and significant differences by substance use disorder status. Results for all of the other dependent variables indicated a similar pattern. On every measure, individuals with at least 1 substance use disorder had significantly greater criminal justice system involvement, including greater incarceration costs, than individuals with no disorder.

The third and fourth columns of Table 3 show incarceration rates and other outcomes among the 279 young men who reported any substance use disorder, with comparisons by age of onset.

Individuals who reported onset by age 16 had significantly higher rates of incarceration ($P<0.05$) for any offense (34.3% vs. 23.3%), and were nearly twice as likely to have been incarcerated for substance related offenses (20.2% vs. 11.2%). Differences by age of onset in rates of incarceration for non-substance related offenses were not statistically significant. Compared to individuals with later onset, individuals with onset by age 16 also reported higher numbers of arrests in their lifetime and were more likely to report having ever been arrested by age 16 and having been convicted of a crime, arrested for drugs, and arrested for assault during the past 12 months.

There were also a few significant differences in criminal justice system involvement among individuals with onset after age 16 as compared to individuals with no onset of a disorder. Compared to individuals with no onset of a disorder, individuals with initial onset of a disorder after age 16 were more likely to have been incarcerated for any offense (23.3% vs. 14.7%) and for non-substance related offenses (13.8% vs. 9.7%). They also reported a higher lifetime number of arrests (3.1 vs. 1.4), and were more likely to report that by age 16 they had ever been arrested (43.1% vs. 31.1%).

3.3. Regression Models

Table 4 shows the probit and ordinary least squares regression model findings for marginal associations with substance use disorders. The first set of results is for the comparison of individuals with at least 1 substance use disorder to individuals with no substance use disorder. Probit estimates are reported as marginal effects (MEs), the change in probability of the outcome associated with having a substance use disorder. Having a disorder was positively and statistically significantly associated with the probability of incarceration for any offense (ME=0.17, t=3.23, P=0.001) and with the probability of incarceration for non-substance related offenses (ME=0.07, t=2.33, P=0.020). At conventional levels of significance, onset of a disorder was not significantly associated with the probability of incarceration for substance related offenses. However, the coefficient value was positive in sign and nearly significant (ME=0.06, t=1.90, P=0.057). Results for other dependent variables indicated significant positive associations between onset of a substance use disorder and incarceration costs, number of arrests, arrested by age 16, being convicted of a crime, being arrested for drugs in the past year, and being arrested for assault in the past year.

The second and third sets of results in Table 4 shows associations of onset by age 16 and onset after age 16 with the probability of criminal justice system contacts. Onset by age 16 was positively and significantly associated with all measures of criminal justice system contacts. Results included a predicted 0.20 probability of incarceration for substance related offenses versus 0.09 probability for the no disorder reference group (ME=0.11, t=2.02, P=0.044), and a 0.21 probability of incarceration for non-substance related offenses versus 0.10 probability for the no disorder reference group (ME=0.11, t=2.33, P=0.020).

Onset after age 16 was not significantly associated with higher rates of incarceration. However, in analyses of incarceration for non-substance related offenses, the coefficient point estimate for onset after age 16 was similar in value to the coefficient point estimate for onset by age 16 (0.09 and 0.11, respectively), suggesting estimated incarceration rates for non-substance related offenses were similar across onset groups. For other dependent variables, coefficient point estimates for onset after age 16 were positive but smaller in magnitude than coefficients for onset by age 16. Only two were statistically significant: total number of arrests (ME=1.7, t=2.84, P=0.005) and having been arrested by age 16 (ME=0.22, t=2.37, P=0.018).

3.4. Potential Confounders

In sensitivity analyses, we repeatedly simulated the effect of a potential confounder variable on our main results, each time varying the simulated degree of confounding. We found that the estimated association of onset of a substance use disorder by age 16 with incarceration for a substance related offense would still be positive in value at plausible degrees of confounding, but a larger sample size would likely be required to detect a significant effect. For example, in one round of simulation, we assumed that an unmeasured confounder had an Odds Ratio of 5.1 for selection into the onset-by-age-16 group and an Odds Ratio of 5.0 for incarceration for a substance related offense. Even with this level of confounding, onset by age 16 would still be positively associated with incarceration for a substance related offense. The simulation results suggested that the marginal effect estimate for onset by age 16 would still be 0.05 (compared to 0.11 in column 2 of Table 4); however, the standard deviation of this estimate would increase in value by more than 60%. As a result, in that scenario, the marginal effect estimate would probably not be statistically significant.

4. Discussion

In this study we used data on a cohort of predominantly urban, low income, African American males followed through early adulthood to assess the association between onset of substance use disorders and risk of criminal incarceration and other criminal justice system outcomes in early adulthood. The main finding of this study is that young men with substance use disorders beginning by age 16 have an approximately fourfold greater probability (0.35 vs. 0.09) of incarceration for substance related offenses by early adulthood than similar young men with no lifetime substance use disorder. Young men with onset by age 16 were also more likely to have been convicted of non-substance related offenses (21 percent vs. 10 percent), had higher incarceration costs, and had greater rates of criminal justice system contact as measured by arrests and conviction. Onset of a disorder after age 16 was not significantly associated with higher rates of incarceration for substance or non-substance related crimes. However, it was significantly and positively associated with criminal arrests, and was positively though not significantly associated with all measures of criminal justice system contacts.

A similar pattern of results was previously reported in the Christchurch Health and Development Study (Fergusson, Swain-Campbell, and Horwood, 2003), one of only a few studies of child cohorts with follow-up data from early adulthood. In that study, more frequent lifetime marijuana use was associated with greater risk for marijuana related court convictions. However, frequent marijuana use in early adulthood (ages 21 to 25) had a more modest level of association with criminal outcomes than frequent use at younger ages (Fergusson, Swain-Campbell, and Horwood, 2002), suggesting that individuals with early onset substance use disorders have a higher level of risk for criminal incarceration.

The results of the present study provide some of the strongest evidence to date that among males from disadvantaged households, onset of alcohol and illicit substance use disorders at a relatively early age may independently increase the risk of future criminal justice system involvement and incarceration. This study's comparisons were adjusted for several potential confounders, including conduct problems, school absences and disciplinary actions, teacher-rated academic performance, family-member substance use, and peer variables, and yet associations with substance use disorders remained significant and substantial in magnitude. A sensitivity analysis further suggested that unmeasured confounders are unlikely to fully explain the positive association of onset of disorders with risk of incarceration. The inference that onset of substance use disorders may increase incarceration risk is also bolstered by the results from previous research studies of longitudinal data from the Christchurch sample (Fergusson and Horwood, 2000; Fergusson, Horwood, and Swain-Campbell, 2002). In those studies, associations of heavy substance use with criminal outcomes were adjusted for observed

as well as unobserved persistent individual differences, using individual "fixed effects." Results from those studies indicate strong, robust associations of initiation of heavy use of alcohol and other substances beginning early in adolescence with criminal outcomes in early adulthood.

Nevertheless, the marginal associations between onset of substance use disorders and risk of incarceration reported in this study do not provide direct evidence of an effect of substance use. Therefore, alternative interpretations should not be ruled out. Reverse causation (i.e., involvement in crime increases risk of substance use) is one possible explanation for the correlation between onset of substance use disorders and later incarceration. Adolescents who become involved in criminal activity at an early age could have greater access and exposure to alcohol and illicit substances, and consequently could be more likely to develop substance use disorders. Multiple adjustments made in this study for conduct problems and peers' behaviors may serve to minimize the likelihood that this interpretation could account for our findings.

Correlation between individuals' propensity for use of substances at young ages and for participation in criminal activity could also explain the correlation between onset of disorders and later incarceration. For instance, early initiation of use of alcohol and marijuana before age 16 is predicted by greater severity of emotional and behavioral problems and more aversive family circumstances earlier in childhood (Dobkin et al., 1995; Nurco et al., 1998; Fergusson et al., 2005; Ellickson et al., 2003 and 2004), factors that are also related to later involvement in crime. Propensity score adjustment for childhood measures of behavior problems and for peer and family variables was designed to adjust for differences propensity for crime. However, some differences, especially those which may emerge only in middle or late adolescence, may not have been well controlled in this study.

Another plausible interpretation of the main findings is that duration of substance use or addiction, rather than age of onset, is what matters most. Because criminal incarcerations were measured through age 24 or 25 only, individuals in the earlier onset group experienced use and addiction over a longer time period than individuals in the later onset group. Consequently, if duration of use or addiction is positively related to risk of incarceration, the earlier onset group would be expected to have higher risk of incarceration. This interpretation implies that over time, risk of incarceration may increase among individuals in the later onset group. Tests of this hypothesis provide an interesting avenue for future research studies.

The results of this study also indicate that in this propensity score matched sample having a substance use disorder is associated with a relatively high risk of incarceration for non-substance related offenses and with greater criminal justice system involvement and costs across a range of measures. Whether or not these results are generalizable to other similarly composed samples is unclear, because of the lack of other similar studies. The rates of incarceration in this study's sample—14.7 percent for persons with no disorder and 29.7 percent for persons with at least one disorder—substantially exceed national averages, suggesting the sample has an unusually high level of incarceration risk. For comparison, the lifetime rate of incarceration among U.S. males between the ages of 18 and 24 years old was 2.7 percent in 2001, and the rate among African American males in the same age group was 8.5 percent in 2001 (Bonczar, 2003). The high average risk level of this sample may reflect its socioeconomic and geographic origins. Study participants were predominantly from low-income urban minority households and lived in Baltimore, a city known to have an epidemic problem with drug related crime during the 1980's and 1990's. Analysis of high risk samples from other geographic areas may provide more generalizable information about the association of substance use disorders with risk of criminal justice system involvement in high risk youth.

4.1. Implications for Intervention Cost Effectiveness

The recent growth in public resources devoted to arrest, prosecution, and incarceration of persons who have committed substance related offenses suggests the need for careful assessment of the cost-effectiveness of public investment in substance abuse treatment strategies for individuals who are at high risk for incarceration. Results from the present study suggest that reduced costs of substance related incarcerations and other criminal justice system contacts could offset at least some of the costs of substance abuse treatment services, and also suggest that early intervention targeting younger adolescents who are at high risk for later incarceration could improve the cost-effectiveness of investments in substance abuse treatment.

Substance abuse treatment costs may represent only a small fraction of the excess public sector costs attributable to substance use disorders among high-risk urban youths. Roebuck, French, and McLellan (2003) review mean economic costs in 13 outpatient substance abuse treatment programs for adolescents. Those programs' mean costs varied between $793 and $11,422 per treatment episode per individual in 2001 dollars, and the median program cost was $1,642 per individual per treatment episode. Moreover, evidence on rates of treatment suggests that most adolescents with substance use disorders receive no treatment whatsoever (Wang et al., 2005), and therefore currently have zero treatment costs. Meanwhile, by early adulthood, young men in our sample who had a substance use disorder by age 16 had incurred incarceration costs estimated to be $52,478 per young man, as compared with $20,443 per young man with a later onset of disorder, and $10,699 per young man with no onset of a disorder, adjusting for other differences. Further, the cost consequences of substance use disorders among adolescents and young adults may stretch across multiple agencies within the public sector. Individuals with substance use disorders may intensively utilize other criminal justice system resources (e.g., courts and law enforcement) as well as other public services and programs, including public mental health and general medical care services, unemployment insurance, and public disability programs (Cartwright, 1999; Green and Ensminger, 2006; Toumbourou et al., 2007).

However, it is unclear whether current substance abuse treatment interventions, if made accessible to high-risk adolescents, would significantly reduce rates of incarceration or other public-sector costs in early adulthood. Rigorous effectiveness studies of interventions for adolescents with substance use disorders are scarce (Gilvarry, 2000). In addition, very few substance abuse treatment studies have included economic evaluations (McCollister and French, 2003). Initial findings from the few available studies have been limited to short-term follow-ups, and have been mixed with respect to the net economic benefits from treatment or prevention (French et al., 2003). Therefore, additional evaluations of the outcomes of substance abuse treatment, particularly in programs targeted to disadvantaged adolescents and young adults, are crucial in order to assess the economic value of investments in treatment programs.

4.2. Limitations

Several limitations of the data and study design are relevant to the interpretation of the findings of this study. First, this study uses a geographically limited sample of individuals from low income, urban-dwelling families. As a result, the results of this study may not generalize well to other urban populations or to populations that have a lower level of risk for criminal incarceration. On the other hand, our results could be more applicable to other high risk, minority, urban populations, which are often the focus of public programs and interventions. Second, the incarceration rates may have been underestimated, in that our database does not include incarcerations that resulted from a conviction in another U.S. state's judicial system. Third, age of onset of the substance use disorder is recalled retrospectively and may be subject to recall bias and underreporting (Johnston and O'Malley, 1997). The substantive impact of

this bias on our results is unclear, as all respondents were relatively young and therefore not very far removed from their initial experiences with substances. In addition, young adults who use illicit substance might have greater recollection of family members' and peers' use of illicit substances. Recall biases in these covariates could lead to errors in matching and estimation bias, though this bias would probably be in the direction of underestimation of the association between substance use disorders and incarceration.

Finally, the results might be sensitive to the exclusion of many individuals who were not selected into the matched sample, imputation of missing information, and the particular propensity score procedures used. We also conducted probit analyses of the full unmatched sample using model specifications that included all covariates included in the initial logistic regression used to estimate propensity scores. These analyses produced nearly identical findings except that treatment effect estimates were more precise using the unmatched sample. The application of multiple imputation procedures changed the coefficient point estimates very little as compared with case-wise deletion, yet resulted in higher standard errors. We also completed additional sensitivity analyses using the method of "full matching," which retains all cases instead of deleting those that do not enter a one-to-one match. All the results were robust to this alternative propensity score procedure.

4.3. Conclusions

In summary, onset of a substance use disorder by age 16 is associated with a higher rate of criminal incarceration for substance related offenses, with higher incarceration costs in early adulthood, and with greater involvement with the criminal justice system than either no onset of a disorder or later onset, even after adjusting for numerous correlates of substance use and risk of incarceration. Analyses of other high risk samples are needed to confirm or reject the generalizability of these findings. Further evidence on the economic consequences of intervention programs for disadvantaged young persons with substance use disorders is needed.

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Table 1

Means of matching variables by whether has ever had a substance use disorder (SUD)

| | Unmatched sample (N=780) | | | Matched sample (N=558) | | |
	No SUD	≥1 SUD	abs(t)[§]	No SUD	≥1 SUD	abs(t)[§]
Teacher rating of child's performance in school, fall 7th grade	3.0	3.1*	2.84	3.1	3.1	0.06
Child conduct disorder symptoms, fall 7th grade	1.9	2.9*	6.55	2.8	2.9	0.42
School days missed in 7th grade (%)	12.2	15.8*	3.08	16.1	15.8	0.19
Total disciplinary removals, K–8th grade	0.4	0.7*	3.22	0.7	0.7	0.29
Ever had a juvenile court appearance for a nonviolent offense before age 14 (%)	6.6	11.5*	2.37	11.5	11.5	<0.01
Ever had a juvenile court appearance for a violent offense before age 14 (%)	5.4	10.4*	2.60	10.4	10.4	<0.01
Average delinquency of peers in 7th grade (Likert scale)	2.25	2.32*	1.25	2.28	2.33	0.71
Many or all closest friends drink alcohol heavily (%)	0.41	0.61*	5.35	0.56	0.61	1.03
Many or all closest friends use marijuana (%)	0.12	0.20*	3.10	0.17	0.20	1.09
Age at follow-up (years)	19.9	20.2*	3.92	20.3	20.2	0.62
Main caregiver employed (%)	54.7	44.4*	2.75	38.7	44.4	1.37
Fraction of childhood caregivers that used illegal drugs (Likert scale)	1.4	2.0*	6.93	1.9	2.0	1.28
Participant is white race (%)	28.1	36.6*	2.43	34.7	36.5	0.44
Student participates in a free lunch program, 7th grade (%)	49.1	44.4	1.25	40.0	44.4	1.03

*
P<.05 based on *t*-test.

§
Absolute value of t-test statistic, defined as standardized difference between No SUD and SUD means.

Table 2

Lifetime substance use disorders, by onset of first disorder[†]

	≥1 SUD (N=279)	Onset ≤16 years (N=163)	Onset >16 years (N=116)
Alcohol (%)	71.2	72.5	69.3
Marijuana (%)	69.3	82.4	51.3[*]
Cocaine (%)	4.7	7.4	1.0[*]
Heroin (%)	4.3	6.8	1.0[*]
Other (%)[§]	11.2	16.7	3.4[*]
>1 Disorder (%)	42.7	57.1	22.4[*]

[†]Young men with substance use disorders, N=279

[*]Different from Onset≤16 years at $P<.05$

[§]Includes amphetamines/stimulants, analgesics, tranquilizers, inhalants, and hallucinogens.

Table 3

Crime outcomes of young men, by onset of first substance use disorder [matched sample, N=558]

	No SUD (N=279)	≥1 SUD (N=279)	Onset ≤16 (N=163)	Onset >16 (N=116)
Incarceration rate (%)[§]				
Any offense	14.7	29.7[‡]	34.3[‡]	23.3,[‡¶]
Substance related offenses[†]	9.0	16.5[‡]	20.2[‡]	11.2[¶]
Non-substance related offenses	9.7	17.9[‡]	20.9[‡]	13.8[‡]
Other				
Incarceration costs per young adult ($)	10,699	42,763[‡]	57,625[‡]	21,879
Number of arrests in lifetime	1.4	4.6[‡]	5.6[‡]	3.1,[‡¶]
Ever arrested by age 16 (%)	31.1	52.3[‡]	58.9[‡]	43.1,[‡¶]
Ever convicted in lifetime (%)	36.5	51.6[‡]	57.7[‡]	43.1[¶]
Arrested for drugs in past 12 months (%)	12.5	26.5[‡]	33.7[‡]	16.4[¶]
Arrested for assault in past 12 months (%)	17.2	27.9[‡]	33.1[‡]	20.7[¶]

[§]124 young men in the sample had been incarcerated as of Fall, 2004. This number includes 47 incarcerated for substance related offenses only, 53 incarcerated for non-substance related offenses, and 24 incarcerated for both types of offenses.

[†]Substance related offenses included drug conspiracy, drug possession, and drug distribution.

[‡]Different from None at *P*<.05

[¶]Different from Onset≤16 at *P*<.05

Table 4

Estimates of marginal effects (ME's) of substance use disorder on crime outcomes [matched sample, N=558]§

Dependent Variable	≥1 SUD			Onset≤16 years			Onset >16 years		
	ME	t	P	ME	t	P	ME	t	P
Incarceration rate									
Any offense	0.17	3.23	0.001**	0.26	3.20	0.001**	0.19	1.93	0.054
Substance related offenses	0.06	1.90	0.057	0.11	2.02	0.044*	0.04	0.64	0.525
Non-substance related offenses	0.07	2.33	0.020*	0.11	2.33	0.020*	0.09	1.53	0.125
Other									
Incarceration costs per young adult ($)	27,549	2.55	0.011*	41,779	2.64	0.008**	9,744	0.84	0.400
Number of arrests in lifetime	3.0	5.37	0.000***	3.8	5.59	0.000***	1.7	2.84	0.005**
Ever arrested by age 16	0.28	3.52	0.000***	0.35	3.67	0.000***	0.22	2.37	0.018*
Ever convicted in lifetime	0.23	2.79	0.005**	0.30	3.14	0.002**	0.17	1.70	0.089
Arrested for drugs past 12 months	0.15	3.69	0.000***	0.23	3.66	0.000***	0.09	1.43	0.153
Arrested for assault past 12 months	0.12	2.33	0.020*	0.18	2.60	0.009**	0.11	1.43	0.154

§Most results were estimated using ML probit on a propensity score matched sample. Results for number of arrests and incarceration costs were estimated using ordinary least squares regression. All variance estimates were generated using bootstrapping methods.

†Additional covariates were linear and quadratic terms for number of conduct disorder symptoms, teacher rating of child performance in 7th grade, and age in years, and linear terms for 7th grade measured average delinquency of peers, indicator for whether many or all closest friends heavily drink alcohol, indicator for whether many or all closest friends use marijuana, percent days absent from 7th grade, total disciplinary removals through 8th grade, 1st grade free-lunch program participation, indicator of white race, indicator that main childhood caregiver was employed as of 7th grade, fraction of childhood caregivers who used illicit drugs, ever had a juvenile court appearance for a nonviolent offense before age 14, and ever had a juvenile court appearance for a violent offense before age 14.

¶The reference group is no lifetime substance use disorder. The reference-group probabilities of incarceration were 0.15 for any offense, 0.09 for a substance-related offense, and 0.10 for all other offenses. The reference-group values for other dependent variables were $10,699 in incarceration costs per young adult, 1.4 arrests lifetime, 0.31 ever arrested by age 16, 0.36 ever convicted of a crime, 0.12 arrested for drugs in the past 12 months, and 0.17 arrested for assault in the past 12 months.

* P<0.05

** P<0.01

*** P<0.001