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Paternal incarceration and trajectories of marijuana and other illegal drug use from adolescence into young adulthood: evidence from longitudinal panels of males and females in the United States

Michael E. Roettger¹, Raymond R. Swisher^{1,2}, Danielle C. Kuhl², and Jorge Chavez²

¹National Center for Family and Marriage Research, Bowling Green State University, Bowling Green, OH, USA

²Department of Sociology, Bowling Green State University, Bowling Green, OH, USA

Abstract

Aims—One-eighth of young adults in the United States report that their biological father has ever been incarcerated (FEI). This study is the first to examine associations between FEI and trajectories of substance use during the transition from adolescence into young adulthood for the US population.

Design—Using multi-level modeling techniques, trajectories of marijuana and other illegal drug use are examined, with FEI as the primary independent variable.

Setting—Data are from the first three waves of the National Longitudinal Study of Adolescent Health, a nationally representative sample of US adolescents beginning in 1995.

Participants—Panels of 7157 males and 7997 females followed from adolescence (7th–12th grades) into early adulthood (ages 18–27 years).

Measurements—Dependent variables included an ordinal measure of marijuana frequency of use in last thirty days, and a dichotomous measure for whether respondent had any use in the last thirty days of illegal drugs such crystal meth, cocaine, heroin, hallucinogens, PCP, LSD, speed, and ecstasy.

Findings—Among males and females, respectively, FEI is associated with an increased frequency of marijuana use, and increased odds of any other illegal drug use. Interactions between FEI and age further reveal that FEI is associated with an accentuated trajectory (i.e. a steeper slope) of marijuana use, and an elevated risk (i.e. higher mean level) of other illegal drug use.

Conclusions—Analysis provides some of the first evidence that paternal incarceration is significantly associated with drug use among U.S. males and females, even after controlling for a number of family background, parental, and individual characteristics.

Keywords

Adolescence; collateral consequences of incarceration; drug use trajectories; father incarceration; illegal drug use; marijuana use; young adulthood

INTRODUCTION

With the onset of the ‘War on Drugs’ and ‘War on Crime’, the US incarcerated population increased from 250 000 in 1975 to 2.25 million in 2006 [1,2].

Coinciding with this rise, the number of children with an incarcerated father has increased dramatically. In 2006, nearly 7.5 million children were estimated to have a parent either incarcerated or on probation/parole [3]. Wildeman [4] estimates that by age 14, 4% of white children and 25% of African American children will have had a parent in prison; moreover, 13% of young adults in the United States report that their father had spent time in jail or prison [5,6].

Given these trends, researchers are increasingly examining the ‘collateral consequences’ of paternal incarceration for children and families [7–9]. Research has demonstrated associations between parental incarceration and increased levels of delinquency [10–12], mental health problems [13–15], homelessness, decreased civic participation [5] and internalizing and externalizing symptoms [13–16]. Similar outcomes for children have also been observed in studies focusing upon parental criminality [9]. Given the wide range of these associations, it is surprising that few studies have examined the link between paternal incarceration and youth substance use (see review by Murray & Farrington [9]). To the extent that substance use represents a form of delinquency, or reflects internalizing and externalizing behavior, such an association would be consistent with previous studies.

Using national panels of US male and female respondents, we examine associations between biological father’s incarceration and trajectories of marijuana use and other illegal drug use during the transition to adulthood. To be as conservative as possible, we test if these associations are robust in response to controls for a wide range of individual, family and neighborhood characteristics.

THEORETICAL FRAME

In a review of the literature on the consequences of parental incarceration, Murray & Farrington [9] reported only one previous study with a control group linking paternal incarceration with alcohol and drug use, and no studies examining the issue within a large sample of the general population. Using a matched sample of 258 juveniles institutionalized for mental health treatment, Phillips *et al.* [14] found that respondents whose parents had been incarcerated were more likely to engage in alcohol and marijuana use. More recently, in a study of 2400 Australian youth, Kinner *et al.* [17] observed that both maternal and paternal incarceration correlated significantly with alcohol and tobacco use, but that these associations disappeared when controls for socio-economic status, parental and family characteristics were introduced. In a prior study using the same data, Kinner *et al.* [18] found father’s arrest, but not incarceration, to be correlated with marijuana use in young adulthood [18]. Both studies suggest paternal incarceration may not be associated directly with substance abuse. Perhaps the best quantitative evidence of an association between paternal incarceration and substance abuse comes from the Cambridge Study of Delinquent Development. Murray & Farrington ([9], p. 161) observed that parental imprisonment increased the odds of drug use by a factor of 3.7 between ages 32 and 48 years, suggesting that parental incarceration is associated with use of drugs across the life-course.

As results by Kinner *et al.* [17] above indicate, it is important to consider the potential role of other variables that might alternatively explain the association between paternal incarceration and youth outcomes. The present study follows the conceptual framework of Murray & Farrington [9], which identifies background factors that place individuals at a greater risk for experiencing parental incarceration, such as low socio-economic status and other disadvantages. Murray & Farrington [9] also describe a variety of processes through which parental incarceration might be associated with negative outcomes: parental separation, behavioral modeling, economic strain, poor parenting and stigma. Due to uncertainty regarding the timing of father's incarceration, the present study is unable to strictly differentiate the temporal ordering of background factors, father's incarceration and potential mediators. Instead, it seeks to produce as conservative an estimate as possible of the association between father's incarceration and substance abuse by controlling for a wide array of covariates. Thus, we include measures for race and ethnicity, indicators of parental substance use [20–25], family socio-economic status [26], family structure [9,17], parental involvement and monitoring [17,27], history of abuse by a caretaker [24,28], peer drug use [29,30] and low self-control [5,31].

Finally, we will consider the degree to which the association between paternal incarceration and substance use is moderated by age and gender [9]. The association between age and problem behavior in adolescence and young adulthood is well established [26,32–34]. Thus, this study uses panel data to examine how age trajectories of substance use vary for youth with and without an incarcerated father. The consequences of paternal incarceration may also vary by gender; however, the findings of previous studies have been mixed in this regard. For example, Murray *et al.* [35] observed a stronger association between parental incarceration and criminal behavior for females, whereas Gabel & Shindledecker [13] reported stronger associations between parental incarceration and male antisocial behavior.

DATA AND METHODS

Data

Data were obtained from the National Longitudinal Study of Adolescent Health (Add Health). The Add Health in-home sample consists of approximately 20 000 respondents enrolled in grades 7–12 during wave I interviews in 1995. Follow-up interviews were conducted 1 year later (wave II) and again as young adults (ages 18–27) in 2001–02 (wave III), with approximately 15 000 respondents completing interviews at each wave. Data used in this analysis are from self-reports of respondents and parent reports. Answers to sensitive questions, such as regarding paternal incarceration and substance use, were obtained using computer and Audio-CASI interview methods [36], techniques which typically increase reliability. Respondents who completed surveys at both waves I and III are included in the analysis (72% response rate at wave III). All models use the Add Health longitudinal sampling weights, which are designed to compensate for differential probabilities of sampling and attrition. After removing ~75 cases with substantial missing data, our analysis includes 99.5% of the 15 197 respondents who completed surveys at both waves I and III. Incorporating up to three waves of data for each respondent, we analyze panels containing 19 774 observations based on 7157 males and 22 142 observations from 7997 females.

Data were missing for some variables on a small percentage of observations. In such instances, multiple imputation replicates the error structure, makes optimal use of non-missing data (relative to case-wise deletion or use of dummy variables) and produces unbiased point estimates and standard errors when cases are missing at random [37]. The STATA 'ice' procedure was used to estimate missing values, assuming that the data were missing at random [38,39]. To increase randomness in the imputation process, median values for cases with observations were taken from 21 randomly imputed data sets. In

supplemental analyses, results based on a subset of respondents with complete data were found to be similar to those reported below based on the imputed data.

Explanatory variables

Paternal incarceration—Paternal incarceration is measured by answers to the wave III question: ‘Has your biological father ever served time in jail or prison?’. Data are unavailable regarding the timing of father’s incarceration. However, given that most males experience first incarcerations by their mid-30s, and that incarceration rates decline rapidly thereafter, most children in Add Health would have experienced father’s incarceration prior to wave I [40,41]. The stigma associated with criminal histories [42,43] and general findings of reliability for self-reports of delinquency and arrest [44,45] probably minimize false reports. Respondents ($n = 517$ males, 542 females) who refused to answer the question or indicated no knowledge of their father’s incarceration were coded as ‘missing’. Consistent with treatment of other missing data described above, multiple imputation was used for these missing cases, as it did not alter the pattern of findings when compared with case-wise deletion and use of dummy variables.

Controls—A number of additional variables were utilized to control for individual and family characteristics likely to be associated with both father’s incarceration and youth substance use. These include: age at interview; self-reported race/ethnicity; residing with both biological parents; family socio-economic status based on mother and father’s education and occupation [46]; neighborhood poverty; low self-control; mother’s binge drinking; prior arrest as a juvenile; peer substance use; prior physical abuse; the respondent’s closeness and involvement to the biological father; parental supervision; and school attachment.

Dependent variables

Frequency of marijuana use—Frequency of marijuana use is measured by respondent’s answer to the question: ‘During the past 30 days, how many times have you used marijuana?’. Responses range from 0 to 120 times. To reduce the influence of outliers, approximately 30 observations with improbably high reports were top-coded to 120. In supplemental analyses, deletion of these cases yielded a similar pattern of results.

Other illegal drug use—A measure of more serious drug use is adapted from Cleveland & Weibe [47], which accounts for slight variations in the measurement of other illegal drug use across waves. At wave I, respondents were asked if they had ever (i) used inhalants, such as glue or solvents; (ii) used cocaine (defined in lead-in question as ‘including powder, freebase, or crack cocaine’); (iii) used lysergic acid diethylamide (LSD), phencyclidine (PCP), ecstasy, mushrooms, speed, ice, heroin or pills, without a doctor’s prescription; or (iv) ever injected any illegal drug, such as heroin or cocaine. At wave III, they were asked if during the past year they had used: (i) crystal methamphetamine; (ii) any form of cocaine, ‘including powder, freebase, or crack’; or (iii) drugs listed in wave I categories (iii–iv). A dichotomous indicator variable denotes any other illegal drug use at each wave.

STATISTICAL MODELS

Frequency of marijuana use

Frequency of marijuana use is modeled with a Poisson regression for panel data. The distribution for frequency of marijuana use is non-normal, with 80% of males and 85% of females indicating no use. Poisson regression addresses this problem [48]. Additionally, to control for clustering resulting from multiple observations per respondent and a high number of zero-counts (i.e. a ‘zero-inflated Poisson model’), a multi-level model with an individual-

level random slope is used [49]. With this modeling approach, the resulting observations are assumed to be distributed identically and characterized as:

$$\ln(y_{it}) = \beta_0 + \beta \text{Age}_{it} + \beta \mathbf{X}_{it} + \nu_{i1} \quad (\text{equation 1})$$

where y_{it} represents the number of times individual i at wave t reports using marijuana; β_0 represents the intercept; βAge_{it} represents a row vector of estimated coefficients and the respondent age at wave t ; $\beta \mathbf{X}_{it}$ represents a vector of control variables and estimated coefficients; and ν_{i1} is an individual-level random error component that is constant across waves. As a random intercept, ν_{i1} is assumed to vary across individuals with a distribution of $\nu_{i1} \sim \Gamma(1, \alpha)$. As Rabe-Hesketh & Skrondal [49] note, the measure alpha indicates the degree to which the individual-level intercept corrects for zero-inflated counts where individuals deviate from the restrictive assumption of a Poisson distribution.

Other illegal drug use

To model other illegal drug usage, we adopt a multi-level logistic regression with an individual-level random effect to control for the repeated measurements of respondents [49]. The probability of other illegal drug use by individual i at wave t , p_{it} is predicted by:

$$p_{it} = \frac{1}{1 + e^{-y_{it}}} \quad (\text{equation 2})$$

such that $y_{it} = \beta_0 + \beta \text{Age}_{it} + \beta \mathbf{X}_{it} + \nu_i + e_{ij}$, where β_0 represents the estimated slope; βAge_{it} represents the row vector of estimated coefficients and the respondent's age at wave t ; $\beta \mathbf{X}_{it}$ represents the vector of control vectors and estimated coefficients; ν_i is the individual-level intercept $\nu_i | \mathbf{x}_{ij} \sim \mathcal{N}(0, \psi)$; and $e_{ij} | \mathbf{x}_{ij} \sim \text{logit}(\psi)$ fits a standard logistic distribution.

RESULTS

Table 1 presents means and standard deviations for all variables by sex and father ever incarcerated (FEI) status. Both males and females with an incarcerated father report higher levels of substance use. Mean marijuana frequencies and mean percentage reporting any usage are higher at all three waves for respondents with an incarcerated father. Cumulatively across the three waves, 51.3% of males and 39.3% of females with FEI reported using marijuana, compared to 37.7% and 28.3% of males and females, respectively, without FEI. Similarly, mean levels of other illegal drug use are higher for respondents with a FEI, although differences are smaller for females than males. Cumulatively, 39.4% (versus 27.8%) of males and 28.9% (versus 22.2%) of females with FEI ever report illicit drug usage.

Table 1 also demonstrates that FEI is associated with numerous other negative individual, family and neighborhood circumstances. In particular, respondents with a history of father's incarceration are more likely to report having mothers with a history of binge drinking; arrests as juveniles; friends who engaged in substance use; lower family and neighborhood socio-economic status; and lower levels of father involvement.

Frequency of marijuana use

Associations between FEI and frequency of marijuana use are provided in Table 2 stratified by sex. Model 1 includes controls for age and race. Model 2 adds a test for the interaction of FEI and age. To test the robustness of these associations, controls are introduced in model 3 for a variety of individual, family and neighborhood factors.

In Fig 1, mean frequencies are predicted using regression coefficients in model 2 of Table 2, for males and females, respectively. Models are fitted using the 'xtpoisson' command in STATA version 10.1. The presented mean frequencies are estimated using only the subset of observations in each age by FEI status subgroup.

Males—Among males, having an FEI is associated strongly with increased marijuana use, controlling for age and race. FEI increases the frequency of marijuana use by a factor of $e(0.57) = 1.77$ ($P < 0.001$). In model 2, the interaction of FEI with age is highly significant, and suggests that father's incarceration is associated with an altered trajectory (i.e. a higher mean and varying slope associated with age and age-squared) of marijuana use relative to those whose father has not been incarcerated (Fig. 1a). For respondents without an incarcerated father, marijuana use peaks around age 21 at slightly more than five times per month and steadily declines. In contrast, for respondents who had a FEI, marijuana use begins at a higher initial frequency, and then increases to a plateau of approximately six times per month. These results suggest that marijuana use follows a typical age-deviance curve among youth without an incarcerated father, with increasing prevalence during adolescence followed by decline in the early 20s. However, those with an incarcerated father display continued elevated frequency of usage into young adulthood; those who had a FEI use marijuana at age 24 at a level equivalent to the peak for those without FEI (age 21). In model 3, despite additional controls, the FEI–marijuana association and FEI–age interactions observed in model 2 remain significant and largely unchanged.

Females—Among females (Table 2), FEI is associated strongly with increased marijuana use. In model 1, FEI increases the frequency of marijuana use by a factor of $e(0.56) = 1.75$ ($P < 0.001$) controlling for age and race. The interaction of FEI with age in model 2 is highly significant, suggesting that FEI is again associated with a varying trajectory of marijuana use for females. Plotting the predicted probabilities in Fig 1b shows that among females without an incarcerated father marijuana use peaks around age 20, at a frequency just over two times per month before steadily declining. In contrast, those with an incarcerated father start at an initially higher frequency of use and plateau at an even higher frequency of almost three times per month. Importantly, females with a FEI continue to use marijuana at age 24 at a level higher than the peak level for females without FEI. In model 3, despite additional controls, the association between FEI and marijuana use and the interaction of FEI with age remain significant and largely unchanged. These results suggest that both males and females with an incarcerated father are at risk for greater marijuana use and follow a different trajectory of use with age.

Other illegal drug use

Results for models examining the association between having an incarcerated father and other illegal drug use are presented in Table 3, again stratified by sex. Variables are entered in the same sequence of models as before.

In Fig 2, mean probabilities are predicted using regression coefficients from model 1 of Table 3. Predicted probabilities are estimated using only the subset of panel observations with the corresponding age and FEI status.

Males—Among males, paternal incarceration is strongly associated with increased probability of other illegal drug use, increasing the risk of other illegal drug use in young adulthood by a factor of $e(0.78) = 2.20$ ($P < 0.001$), controlling for age and race (model 1). However, the interaction of FEI with age in model 2 is non-significant, suggesting that FEI is not associated with an altered trajectory of other illegal drug use. Plotting the predicted probabilities in Fig 2a shows that, among respondents without an incarcerated father, other

illegal drug use rises exponentially and plateaus at a rate of about 14% between ages 21–24. Following a similar curve, risk of other illegal drug use among those with an incarcerated father rises and then stabilizes at a higher rate of about 21–25% at ages 21–24. In model 3, the association of FEI with other illegal drug use remains highly significant ($P < 0.001$), despite controlling for other factors.

Females—Among females, FEI is associated strongly with increased risk of other illegal drug use. In model 1, father's incarceration increases risk of other illegal drug use over time by a factor of $e(1.93) = 6.89$ ($P < 0.001$), controlling for age and race. The interaction of FEI with age in model 2 is non-significant, suggesting that father's incarceration is not associated with an altered age trajectory for female other illegal drug use. Figure 2b shows the predicted probabilities from model 2 by FEI and age for females. Between the ages of 19 and 24, the percentage of females using other illegal drugs plateaus at approximately 6–7% among those without an incarcerated father, compared to between 8 and 10% among those with a FEI. As was the case for males, the direct association of FEI with other illegal drug use remains statistically significant ($P < 0.01$) when controlling for a wide range of individual and family characteristics.

DISCUSSION

In this paper, we have investigated associations of paternal incarceration with substance use during the transition to adulthood, uncovering two notable findings. First, having a father ever incarcerated (FEI) is associated with increased marijuana use and increased risk of other illegal drug use among both males and females. Secondly, in the case of marijuana use, father's incarceration is associated with altered age-marijuana use trajectories, for both males and females. Furthermore, these associations are robust in response to controls for background factors and other covariates including parental substance abuse, low self-control, juvenile delinquency, family structure and socioeconomic status, peer drug use, prior physical abuse, school attachment and father closeness and attachment. Thus this paper provides some of the first evidence of an association between father's incarceration and drug use within a large, nationally representative (i.e. non-clinical) sample.

These findings suggest that paternal incarceration is associated with drug use during the transition to adulthood in the United States. Despite the inability of this study to establish causality, it suggests a number of tentative policy implications. Given that paternal incarceration is an increasingly common life-course event [4] and that 13% of young adults in the United States report a biological father having been incarcerated [5], this study's findings suggest that a substantial population in the United States is at risk for heightened drug use. Increased drug use associated with paternal incarceration may also lead to substantial economic and social costs, including illegal drug market activity, increased crime and incarceration rates, lost work productivity and substance abuse treatment [51]. In a society where drug users make up one-fourth of incarcerated prisoners [52] and 60% of inmates report regular drug use prior to incarceration [53], the early onset and heightened risk of drug use also increases the likelihood of an intergenerational transmission of incarceration between fathers and their children.

This study is not without limitations. The school-based sampling design of Add Health may exclude youth who have dropped out of the school system and are most likely to be caught up in the criminal justice system. Further, Add Health has limited information regarding the biological father's other characteristics, including histories of substance use and criminality. While mother's history of binge drinking or alcoholism helps to capture intergenerational effects from the mother, the intergenerational influence of father's substance use and criminality remains a potential source of unobserved heterogeneity.

While the measure of other illegal drug use, adapted from Cleveland & Weibe [47], captures a broad range of more serious drugs across three waves of data collection, it does not allow detailing patterns of use for specific drugs, such as heroin, crystal methamphetamine or cocaine. Recent research suggests that long-term use patterns vary by type of drug [50].

Future research examining type of drug may yield additional insights into influences of paternal incarceration on substance use among youth.

Finally, while this study substantially expands the existing literature linking paternal incarceration with substance use among youth, causal inference is limited by a lack of information regarding the timing of paternal incarceration and concurrent criminality. Future research incorporating these measures would help to establish (i) whether paternal incarceration is linked causally to youth substance abuse and (ii) how mediating mechanisms related to paternal incarceration, such as family instability, poverty and stress, influence adolescents' future drug use.

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Figure 1.
Trajectories of marijuana use among males and females, by age and whether respondent's father was ever incarcerated. FEI: father ever incarcerated

Figure 2.

Trajectories for probability of other illegal drug use among males and females, by age and whether respondent's father was ever incarcerated. FEI: father ever incarcerated

Table 1

Mean and standard deviations for respondents by sex and father's incarceration.

Variable	Male respondents		Female respondents	
	No report that father ever incarcerated	Report that father ever incarcerated	No report that father ever incarcerated	Report that father ever incarcerated
Dependent variables				
Marijuana usage				
Wave I frequency of use	1.93 (7.34)	3.45 (13.52)	0.930 (4.80)	1.74 (7.28)
Wave I proportion using	0.159 (0.366)	0.244 (0.429)	0.124 (0.329)	0.190 (0.392)
Wave II frequency of use	2.21 (9.67)	3.06 (10.49)	0.997 (4.40)	2.03 (8.18)
Wave II proportion using	0.176 (0.381)	0.258 (0.437)	0.141 (0.348)	0.210 (0.407)
Wave III frequency of use	4.32 (13.29)	7.25 (18.17)	1.85 (7.96)	2.52 (6.49)
Wave III proportion using	0.252 (0.434)	0.348 (0.476)	0.161 (0.367)	0.220 (0.414)
Other illegal drug usage				
Wave I	0.114 (0.318)	0.18 (0.289)	0.106 (0.236)	0.153 (0.360)
Wave II	0.071 (0.257)	0.11 (0.304)	0.075 (0.249)	0.088 (0.283)
Wave III	0.199 (0.400)	0.291 (0.454)	0.141 (0.343)	0.169 (0.376)
Independent predictors				
Age				
Wave I	15.66 (1.69)	15.52 (1.72)	15.53 (1.72)	15.33 (1.69)
Wave II	16.30 (1.59)	16.23 (1.63)	16.11 (1.63)	15.98 (1.61)
Wave III	22.07 (1.73)	21.92 (1.73)	21.89 (1.73)	21.68 (1.70)
Race				
White [reference]	0.527 (0.499)	0.460 (0.498)	0.531 (0.499)	0.459 (0.498)
Black	0.194 (0.39)	0.264 (0.440)	0.220 (0.414)	0.301 (0.458)
Hispanic	0.164 (0.362)	0.196 (0.397)	0.151 (0.357)	0.177 (0.381)
Asian	0.088 (0.294)	0.028 (0.166)	0.074 (0.262)	0.029 (0.178)
Native American	0.016 (0.120)	0.044 (0.204)	.0154 (0.123)	0.028 (0.165)
Other	0.0105 (0.103)	0.007 (0.084)	0.009 (0.097)	0.006 (0.078)
Lives with two biological parents ^a	0.581 (0.493)	0.307 (0.461)	0.562 (0.496)	0.260 (0.439)
Family SES ^b	6.43 (2.55)	5.46 (2.51)	6.28 (2.62)	5.29 (2.53)
Neighborhood poverty ^c	0.110 (0.121)	0.144 (0.142)	0.117 (0.130)	0.152 (0.146)
Low self-control ^d	0.271 (0.444)	0.321 (0.461)	0.277 (0.477)	0.345 (0.476)
Mother's binge drinking ^e	0.091 (0.288)	0.133 (0.335)	0.094 (0.291)	0.153 (0.360)
Respondent arrested as juvenile ^f	0.067 (0.250)	0.144 (0.351)	0.012 (0.124)	0.025 (0.156)
Peer marijuana use ^g	0.612 (1.00)	0.831 (1.13)	0.540 (0.917)	0.749 (1.04)
Prior physical abuse ^h	0.074 (0.271)	0.168 (0.374)	0.073 (0.257)	0.133 (0.340)
Closeness to biological father ⁱ	4.10 (1.11)	3.49 (1.41)	3.74 (1.24)	3.03 (1.37)
Father involvement ^j	1.30 (1.31)	0.934 (1.24)	1.07 (1.20)	0.694 (1.11)
Parental supervision ^k	1.44 (1.21)	1.41 (1.23)	1.46 (1.18)	1.51 (1.20)
School attachment ^l	3.96 (0.627)	3.79 (0.720)	3.90 (0.692)	3.76 (0.77)

Variable	Male respondents		Female respondents	
	No report that father ever incarcerated	Report that father ever incarcerated	No report that father ever incarcerated	Report that father ever incarcerated
Number of observations	16 964	2744	18 897	3210
Number of respondents	6 146	982	6 830	1152

^a Respondent resided with both biological parents at Wave I.

^b Family socioeconomic status at wave I. Developed by Ford, Bearman & Moody [54] for use in Add Health.

^c Parent indicates respondent has temperament issues. Used by Hagan & Foster [31] as a measure of low self control.

^d Proportion of families in census tract below poverty level at wave I.

^e Indicator variable from parent interviews for: (i) biological mother's self-report of binge drinking; (ii) mother/caregiver's report that biological brother had history of alcoholism.

^f Respondent's self-report of being arrested prior to age 18.

^g Number of closest three friends who used marijuana monthly at wave I.

^h Indicator variable for self-report of physical abuse by parent or caregiver before age 12.

ⁱ Respondent's reported closeness to biological father.

^j Scale measuring respondent's wave I activities with father during the past month for the following activities: (i) gone shopping; (ii) played a sport; (iii) attended church service or activity; (iv) talked about relationship issues; and (v) attended concert, sporting event, movie, play or museum. Coded as: '1' = yes, '0' = no.

^k Wave I summary score of whether or not a respondent's parents set weekend curfews, controlled/limited contact with social circle, set bedtime, set limits on TV viewing and set limits on clothes worn.

^l Wave I school attachment scale used by Hagan & Foster [31], averaging responses to questions regarding agreement with the following statements: (i) you feel close to others at school; (ii) you are happy at school; and (iii) you feel like you are part of your school. Coded responses were: '1' = strongly disagree, '2' = disagree, '3' = neither agree nor disagree, '4' = agree, '5' = strongly agree. SES: socio-economic status.

Table 2
Poisson regression of frequency of marijuana use on predictors, by sex (regression coefficients with standard errors in parentheses).

Variables	Males			Females		
	(1)	(2)	(3)	(1)	(2)	(3)
Focal IVs and basic controls						
Father ever incarcerated (FEI)	0.57 *** (0.10)	5.47 *** (0.41)	5.31 *** (0.41)	0.56 *** (0.10)	4.99 *** (0.55)	4.86 *** (0.55)
Age	1.31 *** (0.02)	1.43 *** (0.02)	1.43 *** (0.02)	1.11 *** (0.02)	1.21 *** (0.03)	1.21 *** (0.03)
Age squared	-0.03 *** (0.00)	-0.03 *** (0.00)	-0.03 *** (0.00)	-0.03 *** (0.00)	-0.03 *** (0.00)	-0.03 *** (0.00)
Black	-0.22 * (0.09)	-0.22 * (0.09)	-0.12 (0.09)	-0.31 *** (0.09)	-0.31 *** (0.09)	-0.59 *** (0.10)
Hispanic	-0.12 (0.10)	-0.12 (0.10)	-0.32 *** (0.09)	-0.35 *** (0.11)	-0.35 *** (0.11)	-0.53 *** (0.10)
Asian	-0.64 *** (0.13)	-0.64 *** (0.13)	-0.75 *** (0.12)	-0.69 *** (0.15)	-0.69 *** (0.15)	-0.47 *** (0.14)
Native American	0.15 (0.25)	0.15 (0.25)	0.10 (0.23)	0.55 * (0.28)	0.54 *** (0.28)	0.08 (0.26)
Other	0.07 (0.35)	0.08 (0.35)	0.54 *** (0.32)	-0.02 (0.39)	-0.01 (0.39)	-0.60 *** (0.36)
Interactions						
FEI × age	-	-0.50 *** (0.04)	-0.50 *** (0.04)	-	-0.42 *** (0.06)	-0.43 *** (0.06)
FEI × age squared	-	0.01 *** (0.00)	0.01 *** (0.00)	-	0.01 *** (0.00)	0.01 *** (0.00)
Additional controls						
Two biological parents			-0.35 *** (0.08)			-0.26 ** (0.08)
Family SES			0.05 *** (0.01)			0.04 ** (0.01)
Neighborhood poverty			-1.03 *** (0.27)			-0.26 (0.28)
Low self-control			0.31 *** (0.07)			0.28 *** (0.08)
Mother's binge drinking			0.37 *** (0.11)			0.38 *** (0.11)
Respondent arrest as juvenile			0.85 *** (0.12)			1.28 *** (0.28)
Friend marijuana use			0.58 *** (0.03)			0.71 *** (0.04)
Repeated physical abuse						
Father closeness			0.00 (0.03)			-0.04 (0.03)
Father involvement			0.02 (0.03)			-0.05 (0.03)
Parental supervision			-0.02 (0.03)			0.02 (0.03)

Variables	Males			Females		
	(1)	(2)	(3)	(1)	(2)	(3)
School attachment						
Intercept	-12.28*** (0.18)	-13.48*** (0.20)	-0.35*** (0.05)	-10.68*** (0.23)	-11.75*** (0.26)	-0.18*** (0.05)
Alpha	2.12*** (0.02)	2.12*** (0.02)	1.94*** (0.02)	2.34*** (0.02)	2.34*** (0.02)	-11.83*** (0.35)
Log-likelihood	-49 991.6	-49 934.2	-49 582.7	-32 138.59	-32 030.9	2.14*** (0.03)
Number of observations	19 774	19 774	19 774	22 142	22 142	-31 694.5
Number of respondents	7 157	7 157	7 157	7 997	7 997	22 142
						7 997

* $P < 0.05$ (two-tailed test);

** $P < 0.01$;

*** $P < 0.001$;

**** $P < 0.05$ (one-tailed test). SES: socio-economic status.

Table 3
Logistic regression of other illegal drug use on predictors, by sex (regression coefficients with standard errors in parentheses).

Variables	Males			Females		
	(1)	(2)	(3)	(1)	(2)	(3)
Focal IVs and basic controls						
Father ever incarcerated (FEI)	0.79 *** (0.09)	0.30(2.24)	0.47 *** (0.08)	0.66 *** (0.15)	2.95(3.01)	0.25 ** (0.09)
Age	0.84 *** (0.09)	0.83 *** (0.10)	0.78 *** (0.09)	0.75 *** (0.12)	0.79 *** (0.13)	0.54 *** (0.09)
Age squared	-0.02 *** (0.00)	-0.02 *** (0.00)	-0.02 *** (0.00)	-0.01 *** (0.00)	-0.02 *** (0.00)	-0.01 *** (0.00)
Black	-1.94 *** (0.11)	-1.94 *** (0.11)	-1.87 *** (0.11)	-3.44 *** (0.23)	-3.44 *** (0.23)	-2.00 *** (0.12)
Hispanic	-0.37 *** (0.09)	-0.37 *** (0.09)	-0.31 *** (0.08)	-0.62 *** (0.15)	-0.62 *** (0.15)	-0.26 ** (0.09)
Asian	-0.83 *** (0.13)	-0.83 *** (0.13)	-0.76 *** (0.12)	-1.34 *** (0.24)	-1.34 *** (0.24)	-0.72 *** (0.14)
Native American	0.29(0.21)	0.28(0.21)	0.11(0.19)	0.95 ** (0.36)	0.95 ** (0.36)	0.20(0.21)
Other	-0.43(0.33)	-0.43(0.33)	-0.46(0.29)	-0.36(0.55)	-0.36(0.55)	
Interactions						
FEI × age	-	0.07(0.24)	-	-	-0.26(0.33)	-
FEI × age squared	-	-0.00(0.01)	-	-	0.01(0.01)	-
Additional controls						
Two biological parents			-0.14 * (0.07)			-0.21(0.32)
Family SES			0.09 *** (0.01)			0.08 *** (0.01)
Neighborhood poverty			-0.46(0.28)			-1.31 *** (0.32)
Low self-control			0.16 * (0.06)			
Mother's binge drinking			0.06(0.09)			0.18 **** (0.10)
Respondent arrest as juvenile			1.05 *** (0.09)			1.36 *** (0.22)
Friend marijuana use			0.66 *** (0.03)			0.66 *** (0.03)
Repeated physical abuse			0.42 *** (0.10)			0.44 *** (0.11)
Father closeness			0.03(0.03)			-0.06 * (0.03)
Father involvement			-0.02(0.03)			-0.01(0.03)
Parental supervision			0.01(0.02)			-0.06 * (0.03)

Variables	Males			Females		
	(1)	(2)	(3)	(1)	(2)	(3)
School attachment			−0.36*** (0.04)			−0.49*** (0.05)
Intercept	−11.61*** (0.89)	−11.55*** (0.98)	−10.50*** (0.91)	−9.46*** (0.87)	−9.68*** (0.95)	−6.55*** (0.90)
Individual-level standard error	0.1.58*** (0.056)	1.58*** (0.056)	1.13*** (0.06)	1.84*** (0.06)	1.84*** (0.06)	1.22*** (0.06)
Log-likelihood	−7 205.5	−7 205.2	−6 668.3	−7 042.8	−7 042.4	−6 569.6
Number of observations	19 774	19 774	19 774	22 142	22 142	22 142
Number of respondents	7 157	7 157	7 157	7 997	7 997	7 997

* $P < 0.05$ (two-tailed test);

** $P < 0.01$;

*** $P < 0.001$;

**** $P < 0.05$ (one-tailed test). SES: socio-economic status.