Paternal Incarceration and Altered Trajectories of Marijuana and Hard Drug Use From Adolescence into Adulthood: Evidence From National Panels of U.S. Males and Females

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1

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Abstract

National estimates find approximately 13% of young adults ages 18-24 report that their biological father has served time in jail or prison (Foster and Hagan, 2009). Yet a recent review of existing literature by Murray and Farrington (2008) found no existing studies examining a possible link between paternal incarceration and substance abuse. Using panel data from the National Longitudinal Survey of Adolescent Health, we examine trajectories of marijuana and hard drug use from adolescence into young adulthood. Results indicate that having a father ever incarcerated (FEI) is significantly associated with increased marijuana and hard drug use among both males and females. We find that father's incarceration is also associated with differences in trajectories of marijuana and hard drug use, with variations occurring by both sex and drug type. These findings are robust to controls for a wide range of background characteristics, including childhood abuse, family structure, mother's history of alcoholism or heavy drinking, low self-control, peer drug use, race, neighborhood poverty, and being arrested as a juvenile. Accordingly, this paper provides some of the first direct evidence that paternal incarceration is associated with increased marijuana and hard drug use as young males and females transition into adulthood.

Introduction

With the onset of the United States' "War on Drugs" and "War on Crime," the U.S. jail and prison population increased from 250,000 in 1975 to 2.25 million in 2006 (West & Sabol, 2009; Western & Wildeman, 2009). Coinciding with this rise, the number of children with a biological father who has been incarcerated has increased dramatically. In 2006, nearly 7.5 million children were estimated to have a parent either incarcerated or on probation or parole (Herman-Stahl, Kan, & McKay, 2008). In terms of cumulative exposure to incarceration, Wildeman (2009) estimates that 5% of white children and 25% of African American children born in 1990 experienced a father being incarcerated for one year or more by the age of fourteen. Among U.S. adults ages 18-24, 13% reported that a biological father had served time in jail or prison (Foster & Hagan, 2007, 2009).

With millions of individuals impacted by incarceration, researchers have increasingly begun studying the "collateral consequences" of paternal incarceration on children and families (Hagan & Danovitzer, 1999; Johnson & Waldfogel, 2004; Murray & Farrington, 2008). Research demonstrates links between parental incarceration and increased levels of delinquency (Murray, Janson, & Farrington, 2007; Gottfredson & Hirschi, 1990; Thornberry, Freeman-Gallant, Lizotte, Krohn, & Smith, 2003), mental health issues (Gabel & Schindledecker, 1993; Phillips, Burns, Wagner, Kramer, & Robbins, 2002; Wilbur et al., 2007), decreased civic participation (Foster & Hagan, 2007), and numerous symptoms of internalizing and externalizing behaviors in children and adults (Gabel & Schindledecker, 1993; Phillips et al., 2002; Robins, 1966; Wilbur et al., 2007).

Surprisingly, few studies have focused on the association between paternal incarceration and youth substance abuse (see review by Murray & Farrington, 2008). In this paper, we thus expand the existing literature by examining the relationship between paternal incarceration and child drug use during adolescence and young adulthood. Using national panels of male and female respondents in the U.S., we examine how father's incarceration may be associated with varying age trajectories of marijuana and hard drug use. We also introduce controls for parental substance abuse, household characteristics, peer influences, and low self-control/deviance, examining potential mediating mechanisms of father's incarceration and drug use. Results help establish how paternal incarceration impacts patterns of adolescent and young adult drug use in contemporary U.S. society.

Theoretical Framework

In a review of the existing literature on the consequences of parental incarceration, Murray and Farrington (2008) reported only one previous study with a control group linking paternal incarceration with alcohol and drug use and zero studies examining the issue using a large sample of the general population. Using a small matched sample of 258 adolescents seeking mental health treatment, Phillips et al. (2002) found that respondents whose parents had been incarcerated were more likely to engage in alcohol and marijuana use. In another study, Kinner, Alati, Najman, and Williams (2007) observed that parental incarceration (both mothers and fathers) was significantly correlated with alcohol and tobacco use among 2400 Australian adolescents; however, these bivariate correlations became insignificant in multivariate models using socioeconomic status, mother's characteristics, and family characteristics. These results

led the authors to conclude parental incarceration and substance abuse were explained by other causal mechanisms. Perhaps the best quantitative evidence to date comes from the Cambridge Study of Delinquent Development, with Murray and Farrington (2008, pg. 161) observing that paternal imprisonment increased the odds of drug use by a factor of 3.7 at ages 32 and 48. This study suggests a potentially powerful influence of paternal incarceration on substance use, with long lasting effects across the life course.

In empirical research among incarcerated populations, drug use has been observed within the context of intergenerational incarceration. In interviews of 25 incarcerated adolescent females, Lopez, Katsulis, and Robillard (2009) observed that a large percentage used drugs with a formerly incarcerated parent as means of social bonding. Following a sample of young delinquents in the Ohio Life Course Survey, Giordano, Manning, Longmore, and Seffrin (2006) found statistical evidence linking paternal incarceration and child drug use; in interviews, formerly incarcerated fathers were found to directly involve their children in selling and using illegal drugs. Additionally, using a national survey of prisoners, Dallaire (2007) found that mother's regular drug use was a predictor of an adult child being incarcerated. While sample size and lack of control groups limit inference with these studies, they nonetheless suggest that paternal incarceration and children's drug use may be linked.

Accordingly, while research is suggestive, it remains an open question, particularly within the United States, whether paternal incarceration increases a youth's risk for substance abuse. The present study examines this question and considers the role of background factors and potential mediators that might account for the relationship. We build on the conceptual framework advanced by Murray and Farrington (2008) linking parental incarceration and youth outcomes. Their framework begins with pre-existing

6

background factors, such as parental behavioral and mental health, family poverty or socioeconomic status, and other disadvantages that place individuals at a greater risk of experiencing a parental incarceration. In the United States particularly, minority status places individuals at heightened risk of incarceration (Petit & Western, 2004; Wildeman, 2009). This study, therefore, controls for race and ethnicity, as well as indicators of parental substance use and depression (Chassin, Curran, Hussong, & Colder, 1996; Dallaire, 2007; Duncan, Tildesley, Duncan, Hops, 1996; Johnson & Leff, 1999; Merikangas et al., 1998; Moss, Clark, & Kirisci, 1997), family socioeconomic status (Daniel, et al., 2009), family instability, and history of abuse (Sheridan, 1995; Merikangas et al., 1998). We also include a measure of the child's own predisposition for problem behavior – difficult temperament.

Murray and Farrington (2008) identify a wide variety of mediators that may serve as potential mechanisms through which parental incarceration is associated with child outcomes, including separation caused by incarceration, behavioral modeling, economic strain, poor parenting, and the stigma associated with incarceration. This study will focus on several of these and other potential mediators, including family structure, parental involvement and monitoring, and peer drug use (Fergusson & Horwood, 1997; Dishion, et al., 1995).

Finally, we will consider the degree to which the association between paternal incarceration and substance use is moderated by several factors. Of the many potential moderators identified by Murray and Farrington (2008), this analysis will focus on age and gender. The association between age and problem behavior in adolescence and young adulthood is well-established in research (Ezell & Cohen, 2005; Gottfredson & Hirashi, 1990; Moffitt, 1993; Sampson & Laub, 1993), thus it is critical to consider these

developmental trajectories. Using longitudinal panel data, this analysis examines how substance use varies by age and how paternal incarceration alters this developmental trajectory. The consequences of paternal incarceration may also vary considerably by gender; however, the findings of previous studies have been mixed with regard to gender differences for outcome variables like antisocial behavior (Murray, et al., 2007; Gabel & Schindledecker, 1993).

Data and Methods

Data

Data are from the nationally representative in-home portion of the National Longitudinal Study of Adolescent Health (Add Health). The Add Health in-home sample consists of approximately 15,000 respondents enrolled in grades 7-12 during Wave I interviews in 1995. Follow-up interviews were conducted one year later (Wave II) and again in 2001 (Wave III). Interviews used in this analysis are from self-reports of respondents and parents, which were obtained using computer and Audio-CASI interview methods (Harris, Halpern, Entzel, Tabor, Bearman, & Udry, 2008), thereby increasing validity of the results. As noted by Hagan and Foster (Foster & Hagan, 2007; Hagan & Foster, 2003), the high rate of responses at Wave III (72% of Wave 1 sample) and use of audio-CASI interviews, substantially increase reliability for sensitive questions on substance abuse and paternal incarceration.

Since paternal incarceration data is present at Wave III interviews, while other predictor variables are based on completed interviews at Wave I, only respondents who completed interviews at both Waves I and III are included in the analysis. As a result,

panels are generated containing 14377 observations of 5230 males and 16657 observations of 6039 females.

To deal with missing data, multiple imputation for missing values was conducted using STATA's add-on 'ice' procedure. Multiple imputation has been shown to replicate the error structure of the observed information matrix, optimally utilize cases containing non-missing data (relative to case-wise deletion and use of dummy variables), and produce unbiased point estimates and standard errors (Allison, 2002; Horton & Kleinman, 2007). The STATA ice procedure assumes that the data were missing at random and contingent upon variables specified in the model (Horton & Kleinman, 2007; Royston, 2005). To increase randomness in the imputation process, median values for cases with observations were taken from 21 randomly imputed datasets using the ice procedure. Results from models using dummy variables to denote missing values yielded similar coefficients to the results presented below.

Explanatory Variables

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 or release, thus we are unable to distinguish incarcerations occurring prior to the child's birth from those during childhood. Nevertheless, the measure provides an indication of whether or not the respondent's biological father has ever been incarcerated. National estimates of the age of prisoners suggest that most of the fathers incarcerated within Add Health would have been incarcerated early in the child's life (Bonczar, 2003; West & Sabol, 2009). The large stigma associated with criminal histories (Pager, 2003; Uggen, Manza, & Thompson

2006) and general findings of reliability for self-reports of delinquency and arrest

(Farrington, Jolliffe, Loeber, Stouthamer-Loeber, & Kalb; Hindelang, 1981; Hindelang,

Hirschi, & Weis, 1979) likely negate the potential of falsely reporting that fathers have

served time in jail or prison. Cases in which respondents refused to answer this question

or indicated no knowledge of their father's history of incarceration were also coded as

'missing.' These factors should downwardly bias associations between father's history of

incarceration and their child's drug use, thus reducing the chances of type II errors.

To measure parental substance abuse, we utilize data from Wave I parent

interviews to construct an indicator variable of the biological mother having issues with

heavy drinking. The variable is coded a 1 if: (1) their biological mother indicated

consuming five or more drinks on one or more occasions during the last thirty days, or

(2) the interviewed parent indicated that the biological mother had a history of

alcoholism.

Three measures are adopted to capture peer influences and low self-control. Peer

drug use is measured by the respondent's Wave I report of how many of the respondent's

three closest friends use marijuana monthly. To capture low self-control, we use Wave I

parental reports of the child having temperament issues, as well as self-reports of having

been arrested as a juvenile.

In modeling drug use trajectories, a number of controls are utilized, including:

self-reported race and ethnicity; age at interview; a measure of family socioeconomic

status, taking into account mother/father's education and type of work; whether

respondent resided with both biological parents; neighborhood poverty; school

attachment; a measure of parental supervision; and the respondent's closeness and

involvement with the biological father.

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?" This question was asked across all three waves of Add Health and provides a raw count of frequency of use. To reduce the influence of outliers, approximately 30 observations were recoded to fit the maximum value in a continuous frequency range from 0 to 120. The deletion and recoding of these outlying cases had relatively little effect on estimated regression coefficients.

Hard Drug Use. To capture more serious (hard)drug use, such as cocaine, heroin, and methamphetamines, a longitudinal measure is adopted from Cleveland and Wiebe's (2008) analysis of drug use among Add Health siblings. Cleveland and Weibe's scale captures hard drug use for questions varying 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 LSD, PCP, ecstasy, mushrooms, speed, ice, heroin, or pills, without a doctor's prescription; or (iv) ever injected (shot up with a needle) any illegal drug, such as heroin, or cocaine. For Wave II, respondents were asked if this same set of events had occurred since Wave I interviews. For Wave III, respondents were asked if they had used, during the past year, (i) crystal meth; (ii) any form of cocaine, "including powder, freebase, or crack,"; or (iii) drugs listed in Wave 1 categories (iii)-(iv). From these questions, a dictomous 'hard drug use' indicator variable is used to denote if a respondent indicated 'yes' to any question at a given wave.

Statistical Models

Frequency of Marijuana Use

The pattern of marijuana use in Add Health for the panel of respondents is non-normally

distributed, with 80% of male observations and 85% of female observations indicating

no use during the 30 days prior to the last interview at any wave. In such cases, as Long

(1997) suggests, the use of a Poisson regression for rate counts is warranted.

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 added (Rabe-Hesketh &

Skrondal, 2008).   With this modeling structure, the resulting observations are assumed to

be identically distributed and mathematically characterized as:

$\ln(y_{it})= \beta_0 + \beta\mathbf{Age}_{it} + \beta\mathbf{X}_{it} + \nu_{i1}$,

where y_{it} represents the number of times individual i at wave t reports using marijuana

over thirty days; β_0 represents the intercept; $\beta\mathbf{Age}_{it}$ represents the row vector of estimated

coefficients and the respondent *i*'s age at wave t**; $\beta\mathbf{X}_{i1}$** represents the vector of control

variables and estimated coefficients; and ν_{i1} is the 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 and Skrondal

(2008) 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. Models are fitted using the 'xtpoisson' command in STATA 10.1.

Hard Drug Use

To model the probability of a respondent's hard drug use during the last period prior to interview, a multi-level logistic regression model with an individual-level random effect to control for multiple observations per respondent is utilized (Rabe-Hesketh & Skrondal, 2008). The probability of hard drug use by individual i at wave t, p_{it} is predicted by:

$$p_{it} = \frac{1}{1 + e^{y_{it}}},$$

such that $y_{it=}\beta_0 + \boldsymbol{\beta}\mathbf{Age}_{it} + \boldsymbol{\beta}\mathbf{X}_{it} + v_i + e_{ij,}$

where β_0 represents the estimated slope; $\boldsymbol{\beta}\mathbf{Age}_{it}$ represents the row vector of estimated coefficients and the respondent i's age at wave t; $\boldsymbol{\beta}\mathbf{X}_{it}$ represents the vector of control vectors and estimated coefficients; v_i is the individual-level intercept $v_i|\mathbf{x}_{ij}\sim N(0,\psi)$; and $e_{ij,}|\mathbf{x}_{ij},v_i$ fits a standard logistic distribution. Models are fitted using the "xtlogit" command in STATA 10.1. As estimated beta coefficients are used to gauge the direction of effects and the predicted age-drug use trajectories presented in Figures 3-4, we report estimated regression coefficients and standard errors in lieu of odds ratios and 95% confidence intervals.

Results

Frequency of Marijuana Use. Using the procedures outlined above, estimated frequency of marijuana use for males and females is presented in Tables 2-3.

Males. Among males (Table 2), having a father ever incarcerated (FEI) is strongly associated with increased marijuana use as respondent's age. Controlling for age, race, family socioeconomic status, family structure, and neighborhood poverty in Model 1, FEI increases the frequency of marijuana use by a factor of $e^{(0.62)}=1.86$ (p<0.001) as respondents age from adolescence into adulthood.

The interaction of FEI with age in Model 2 is highly significant (Likelihood Ratio Test ($\chi^2=242.1$, d.f.=2): p<0.000001) and suggests that father's incarceration is associated with a varying trajectory of marijuana use relative to those whose father has not been incarcerated. Plotting the predicted probabilities from the estimated group by age, Figure 1 shows the trajectories for frequency of marijuana use. For respondents without an FEI, marijuana use peaks around age 21 at a frequency of slightly less than five times per month. In contrast, for respondents whose biological father has been incarcerated, marijuana use begins at a higher initial frequency, of approximately once per month, and plateaus at approximately 7.5 times per month. These results suggest frequency of marijuana use for those without an FEI becomes increasingly prevalent during adolescence and young adulthood, but begins declining in the early twenties. In contrast, those with an FEI have both a heightened likelihood in rates of marijuana use and display continued elevated use into young adulthood.

In Model 3, mediating mechanisms are introduced to test robustness of the association between FEI and marijuana use observed in Model 1. These include low self-control, early criminal justice involvement, mother's history of alcoholism or binge drinking, father's involvement with the respondent, childhood physical abuse, school involvement, and drug use among close friends. After adding these possible mediators, the association between FEI and marijuana use declines by approximately one-fourth in

14

magnitude, but remains highly significant at the p<0.001 level. In Model 4, the interaction of father's incarceration with age remains significant and is largely unchanged. These results suggest that having a father ever incarcerated is directly associated with increased marijuana use over time and alters use trajectories so that males with FEI maintain heightened marijuana use into the mid-twenties.

Females. Among females (Table 3), having an (FEI) is strongly associated with increased marijuana use. Controlling for age, race, family socioeconomic status, family structure, and neighborhood poverty in Model 1, FEI increases the frequency of marijuana consumed by a factor of 1.52 (p<0.01) as respondents age from adolescence into adulthood.

The interaction of FEI with age in Model 2 is highly significant (Likelihood Ratio Test (χ^2=400.8, d.f.=2): p<0.000001), suggesting that FEI is associated with a varying trajectory of marijuana use. Plotting the predicted probabilities for each group by age, Figure 2 shows the trajectories for females' frequency of marijuana use. For respondents whose biological father has not undergone incarceration, marijuana use peaks around age 21 at a frequency of 1.8 times per month. In contrast, those with an FEI peak/plateau at a higher frequency that ranges from 2 to 2.5 times per month between the ages of 17-22 before beginning to rapidly decline. These results suggest that females follow trajectories of marijuana use that peak in late adolescence and young adulthood, before declining as individuals enter their mid-twenties; however, those with an FEI use marijuana more frequently during early adolescence and have high sustained levels of use during late adolescence before converging to patterns similar to those who do not have an FEI during their the mid-twenties.

In Model 3, the association between FEI and marijuana use declines by approximately one-half in magnitude, becoming marginally significant ($p<0.05$, one tailed). In Model 4, the interaction of father's incarceration with age remains highly significant in predicting frequency of marijuana use. These results suggest that individuals who have a father with a history of incarceration follow a different trajectory of marijuana use relative to others, with the main effect also substantially mediated by controls.

Hard Drug Use. Using the multilevel logistic regression outlined above, hard drug use for males and females is presented in Tables 4-5.

Males. Among males (Table 4), paternal incarceration is strongly associated with increased hard drug use. In Model 1, father's incarceration increases the risk of hard drug use by a factor of 3.86 ($p<0.001$) as respondents age from adolescence into adulthood. This highly elevated risk is comparable to results from Murray and Farrington (2008).

The interaction of FEI with age in Model 2 is significant (Likelihood Ratio Test (χ^2=8.6, d.f.=2): $p<0.0136$), suggesting that FEI is associated with a diverging trajectory of hard drug use. Plotting the predicted probabilities from Model 2 by FEI and age, Figure 3 shows the trajectories for hard drug use. For respondents whose biological father has not been incarcerated, hard drug use rises exponentially to a predicted use of ~8%-9% at ages 23-24. While following a similar exponential curve, hard drug use for those whose fathers have been incarcerated rises much more quickly from 1% at age 16 to ~15% at age 19, essentially plateauing afterwards at a rate of 13-15%. Given non-interviews for ~80% of incarcerated respondents and the decreased likelihood for interview for respondents experiencing homelessness or extreme poverty, this "plateau"

16

may result from issues of selection that downwardly bias estimates. Nevertheless, those having an FEI have an increased probability of hard drug use, with an earlier onset and more-rapid increase from late adolescence into early adulthood. In contrast, those without an FEI have a t lower, more-gradually increasing probability of hard drug use from ages 12-24.

As possible mediating variables are introduced in Model 3, the direct association of FEI with hard drug use remains highly significant (p<0.001), but declines in magnitude by approximately 45%. In Model 4, the interactions of father's incarceration with age and age squared are also statistically significant, suggesting that the moderating effect in hard drug use trajectories remains. Consequently, having an FEI is both directly associated with increased drug use over time (O.R.=2.12), and alters use trajectories so that males whose father was ever incarcerated experience a heightened probability of hard drug use, which rapidly increases as they transition into young adulthood.

The mediation of FEI in Model 3 suggests that, while FEI remains a robust and significant predictor, some theoretically relevant variables explain part of the association between FEI and hard drug use. Significant predictors that mediate FEI include family socioeconomic status, child temperament issues, juvenile arrest, peer drug use, and physical abuse. Accordingly, psychological and social factors mediate the link between father's incarceration and hard drug use trajectories among males.

Females. Among females (Table 5), FEI is strongly associated with increased hard drug use. In Model 1, father's incarceration increases risk of hard drug use by a factor of 2.32 (p<0.001) as respondents age from adolescence into adulthood. This association is ~60% of the magnitude of risk observed for males with an FEI reported in Table 4.

The interaction of FEI with age in Model 2 is non-significant (Likelihood Ratio Test (χ^2=0.26, d.f.=2): p<0.83), suggesting that father's incarceration does not alter the age trajectories for females' hard drug use. Figure 4 shows the predicted probabilities from Model 2 by FEI and age. At age 24, the predicted percentage of females using hard drugs rises to approximately 3.5% among those whose biological father has not been incarcerated, while 6% of those reporting an FEI have a heightened use trajectory with similar slope. Therefore, FEI significantly only increases likelihood of hard drug use at all ages in the sample, contrasting to the altered age-use trajectories for males presented above.

As possible mediating variables are introduced in Model 3 of Table 5, the direct association of FEI with hard drug use remains (p<0.05), but declines by~50% in size. In Model 4, the interactions of father's incarceration with age remain statistically non-significant. Consequently, FEI is directly associated with increased hard drug use over time (O.R.=1.51), but no evidence is found to suggest that FEI alters female age-hard drug use patterns.

For Model 3, mediation effects are observed for the association between FEI and hard drug use. Significant mediators include family socioeconomic status, juvenile arrest, peer drug use, school attachment, and physical abuse. Thus psychological and social factors partially explain the association between father's incarceration and hard drug use among females.

Limitations of Current Study

This study is not without limitations. The school-based sampling design, and the fact that individuals in jail or prison were not interviewed at Wave III, excludes

individuals most likely to be caught up in the criminal justice system. With national surveys of prison inmates reporting approximately one-half of state and federal inmates meeting clinical diagnosis criteria for substance abuse (Mumola & Karburg, 2004), the exclusion of this population potentially downwardly biases results among men.

Unfortunately, the current Add Health study is limited in the number of questions asked about the biological father, including histories of substance abuse. While mother's history of binge drinking or alcoholism helps to capture intergenerational effects from the mother, father's effects remain an unobserved potential mediator. Datasets that capture father's substance abuse patterns along with incarceration would help to disentangle this correlation. While presently unavailable, biomarker collection will become available with the release of Wave IV data (Harris et al., 2008) that may control for genetic propensities passed through the father.

While the measure of hard drug use, adapted from Cleveland and Wiebe (2008), captures a broad range of more serious drugs across three waves of data collection, hard drug use does not measure the frequency at which more specific types of drugs, such as heroin, crystal meth, or cocaine, are used.   Recent research suggests that long-term use patterns vary by type of drug (Hser et al., 2008). Future research examining types of drug may yield additional insights into influences of paternal incarceration on substance use among children.

Given incarceration is also known to break apart families (Western, Loopo & McLanahan, 2004) and family instability is related to substance abuse (Sheridan, 1995), timing of paternal incarceration also remains important. Future studies that examine length and timing of incarceration may reveal additional insights to whether family

instability related to paternal incarceration may explain future substance abuse among children.

Finally, while this study substantially expands existing literature linking paternal incarceration with substance abuse among children, causal inference is limited by the lack information on paternal incarceration. As Thornberry (2009) recently noted, causal inference for consequences of parental incarceration increases with direct measurement across generations. Consequently, such future research would help establish (1) if paternal incarceration is causally linked to child substance abuse and (2) how mediating mechanisms related to paternal incarceration, such as family instability, poverty, and stress, influence children's future drug use.

Conclusion

In this paper, we have investigated the effects of paternal incarceration on substance abuse, uncovering two notable findings. First, having a father ever incarcerated (FEI) is associated with increased marijuana and hard drug use among males and females. Second, father's incarceration is associated with altered age-drug use trajectories among males and females. Furthermore, these associations are robust to alternative mediating variables including parental substance abuse, low self-control, early juvenile delinquency, family structure and socioeconomic status, peer drug use, school attachment, and father closeness and attachment. In doing so, this paper provides some of the first large-scale and non-clinical evidence that having an incarcerated father is associated with increased drug use during the transition from adolescence into adulthood.

This association also holds for a national sample of U.S. males and females. With basic demographic and family controls, having a father ever incarcerated is associated

among males and females, respectively, with (1) a 1.86 (p<0.001) and 1.52 (p<0.01) rate of increase in the frequency of marijuana use; and (2) a 3.86 (p<0.001) and 2.32 (p<0.001) odds increase in hard drug use. These results remain robust to a number of mediating variables and controls.

For FEI-age interactions, a father's incarceration is associated with altered age-use trajectories for marijuana (both males and females) and hard drug (males only). As described above, these trajectories differ by drug and gender. Among males, FEI is associated with an age trajectory of increasing marijuana and hard drug use. For females, FEI is associated with an age trajectory of early, prolonged marijuana use; however, for hard drugs, females with an FEI have a heightened probability of use that has a similar trajectory to females reporting no FEI. For all groups, these trajectories remain robust to mediating effects.

In general, mediation variables for FEI are similar for sex and type of drug use. Of the potential mediators, early involvement in the criminal justice system, low self-control, family socioeconomic status, neighborhood poverty, school attachment, peer drug use, race, and physical abuse are found to most strongly correlate with marijuana and hard drug use. Interestingly, father's relationship characteristics and mother's substance use are generally non-significant, suggesting that for the sample, paternal relationships and intergenerational substance use do not mediate the association between FEI and drug use.

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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
Frequency of Marijuana Use in Last Thirty Days

Variable	Male: No Report	Male: Report	Female: No Report	Female: Report
Wave I	1.50 (7.34)	3.65 (13.52)	0.81 (4.80)	1.61 (7.27)
Wave II	1.86 (8.54)	3.11 (10.49)	0.86 (4.40)	2.00 (8.58)
Wave III	4.03 (12.81)	7.46 (18.67)	1.83 (7.96)	2.00 (6.49)

Hard Drug Use

Variable	Male: No Report	Male: Report	Female: No Report	Female: Report
Wave I	0.057 (0.23)	0.092 (0.28)	0.059 (0.23)	0.07 (0.25)
Wave II	0.063 (0.24)	0.10 (0.30)	0.07 (0.24)	0.08 (0.27)
Wave III	0.20 (0.40)	0.28 (0.45)	0.13 (0.34)	0.17 (0.37)

Independent Predictors
Alternative Explanatory Variables

Variable	Male: No Report	Male: Report	Female: No Report	Female: Report
Low Self-Control. Parent indicates respondent has temperament issues. Used by Hagan and Foster (2001) as a measure of social control.	0.25 (0.43)	0.30 (0.46)	0.26 (0.43)	0.31 (0.46)
Biological Mother's Binge-Drinking/Alcoholism. Indicator variable from parent interviews for: (1) Biological mother's self-report of binge-drinking; (2) Mother/Caregiver's report that biological brother had history of alcoholism.	0.09 (0.28)	0.13 (0.33)	0.09 (0.29)	0.15 (0.35)
Juvenile Arrest. Respondent's self-report of being arrested prior to age 18.	0.06 (0.23)	0.12 (0.32)	0.01 (0.09)	0.02 (0.14)
Friends' Marijuana Use. Number of closest three friends who used marijuana monthly at Wave I.	0.56 (0.96)	0.79 (1.11)	0.51 (0.88)	0.72 (1.03)
Repeated Physical Abuse. Repeated physical abuse by parent or caregiver before age 12.	0.07 (0.26)	0.16 (0.36)	0.07 (0.25)	0.13 (0.33)
Race				
White [Reference]	0.53 (0.49)	0.46 (0.49)	0.52 (0.49)	0.46 (0.49)
Black	0.19 (0.3)	0.281 (0.45)	0.23 (0.42)	0.31 (0.46)
Hispanic	0.15 (0.36)	0.19 (0.39)	0.15 (0.35)	0.16 (0.36)
Asian	0.10 (0.29)	0.032 (0.17)	0.07 (0.26)	0.03 (0.17)
Native American	0.01 (0.12)	0.03 (0.17)	0.015 (0.12)	0.03 (0.17)
Other Race	0.01 (0.10)	0.01 (0.10)	0.01 (0.10)	0.01 (0.08)
Age				
Wave I	15.66 (1.69)	15.59 (1.67)	15.49 (1.72)	15.30 (1.64)
Wave II	16.28 (1.59)	16.34 (1.58)	16.09 (1.60)	16.01 (1.55)
Wave III	22.06 (1.73)	22.01 (1.69)	21.87 (1.73)	21.67 (1.65)
Two Biological Parents. Respondent resided with both biological parents at Wave I.	0.59 (0.49)	0.31 (0.46)	0.57 (0.49)	0.27 (0.44)

	(1)	(2)	(3)	(4)
Family SES. Family socioeconomic status at Wave I. Developed by Ford, Bearman, and Moody (1999) for use in Add Health.	6.67 (2.50)	5.84 (2.50)	6.42 (2.59)	5.58 (2.51)
Neighborhood Poverty. Proportion of families census tract residing below poverty level at Wave I.	0.11 (0.12)	0.15 (0.14)	0.12 (0.13)	0.15 (0.15)
Father Closeness. Respondent's reported closeness to biological father.	4.03 (1.20)	3.48 (1.41)	3.67 (1.31)	3.01 (1.418)
Father Involvement. Scale measuring respondent's Wave I activities with father during the past month for the following activities: (1) gone shopping, (2) played a sport, (3) attended church service or activity, (4) talked about relationship issues, and (5) attended concert, sporting event, movie, play, or museum. Coded as: '1'= Yes, '0'=No.	1.32 (1.30)	0.93 (1.24)	1.08 (1.20)	0.752 (1.14)
Parental Supervision. Wave 1 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.	1.45 (1.20)	1.39 (1.23)	1.48 (1.16)	1.54 (1.19)
School Attachment. Wave I index measuring school attachment scale used by Hagan and Foster (2001), averaging responses to questions of agreeing or disagreeing with the following questions: (1) You feel close to others at school, (2) You are happy at school, and (3) 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	3.96 (0.61)	3.80 (0.72)	3.92 (0.69)	3.78 (0 .74)
Number of Observations	12540	1837	14299	2358
Number of Respondents	4569	661	5189	859

Table 2: Poisson Regression for Frequency of Marijuana Use Among Males
[regression coefficients, with standard errors in parentheses]

__Independent Predictors__	(1)	(2)	(3)	(4)
Father Ever Incarcerated (FEI)	0.62***	7.99***	0.46***	7.84***
	(0.13)	(0.51)	(0.12)	(0.51)
Age	1.28***	1.47***	1.29***	1.47***
	(0.02)	(0.03)	(0.02)	(0.03)
Age Squared	-0.03***	-0.03***	-0.03***	-0.03***
	(0.0007)	(0.0006)	(0.0005)	(0.0005)
Interactions				
*FEI*Age*		-0.75***		-0.76***
		(0.05)		(0.05)
*FEI *Age-Squared*		0.02***		0.02***
		(0.001)		(0.001)
Race				
White [Reference]				
Black	-0.14	-0.14	0.01	0.01
	(0.12)	(0.12)	(0.11)	(0.11)
Hispanic	-0.13	-0.13	-0.40***	-0.40***
	(0.12)	(0.12)	(0.11)	(0.11)
Asian	-0.57***	-0.57***	-0.80***	-0.80***
	(0.15)	(0.15)	(0.14)	(0.14)
Native American	0.05	0.05	0.09	0.09
	(0.32)	(0.32)	(0.30)	(0.30)
Other Race	0.16	0.17	0.46	0.47
	(0.41)	(0.41)	(0.38)	(0.38)
Two biological parents	-0.39***	-0.39***	-0.30**	-0.30**
	(0.09)	(0.09)	(0.09)	(0.09)
Family SES	0.04*	0.04*	0.06***	0.06***
	(0.02)	(0.02)	(0.02)	(0.02)
Neighborhood poverty	-1.19**	-1.19**	-1.23***	-1.23***
	(0.37)	(0.37)	(0.36)	(0.36)
Low self-control			0.40***	0.40***
			(0.09)	(0.09)
Biological Mother's Binge-Drinking/Alcoholism			0.38**	0.38**
			(0.13)	(0.13)
Juvenile Arrest			0.98***	0.98***
			(0.16)	(0.16)
Friends' Marijuana Use			0.63***	0.63***
			(0.04)	(0.04)
Repeated Physical Abuse			0.42**	0.43**
			(0.14)	(0.14)
Father Closeness			0.03	0.03
			(0.04)	(0.04)
Father Involvement			0.06+	0.06+
			(0.03)	(0.03)
Parental Supervision			0.04	0.04
			(0.03)	(0.03)
School Attachment			-0.40***	-0.40***
			(0.06)	(0.06)
Intercept	-12.28***	-14.08***	-12.09***	-13.90***
	(0.26)	(0.29)	(0.37)	(0.39)
Alpha	8.85***	8.85***	7.43***	7.42***
	(0.237)	(0.237)	(0.206)	(0.206)
Log-Likelihood	-32811.87	-32690.84	-32571.44	-32450.53
Number of Observations	14377	14377	14377	14377
Number of Respondents	5230	5230	5230	5230

*** p<0.001, ** p<0.01, * p<0.05 [Two-tailed test] + p<0.05 [One-Tailed test]
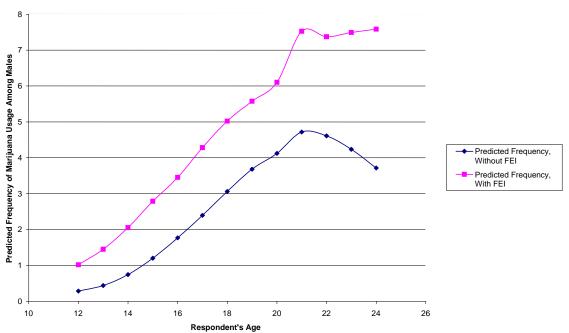
**Figure 1: Predicted Frequency of Marijuana Usage During 30 Last Days for Adolescent
Males ages 12-24, by Whether Respondent's Biological Father Was Ever Incarcerated**
[predicted frequencies based on model coefficients in Model (2) of Table 2]

Table 3: Poisson Regression for Frequency of Marijuana Use Among Females
[regression coefficients, with standard errors in parentheses]

Independent Predictors	(1)	(2)	(3)	(4)
Father Ever Incarcerated (FEI)	0.41**	4.35***	0.20+	4.20***
	(0.13)	(0.71)	(0.12)	(0.71)
Age	1.02***	1.10***	1.02***	1.11***
	(0.03)	(0.03)	(0.03)	(0.03)
Age Squared	-0.02***	-0.03***	-0.02***	-0.03***
	(0.00)	(0.00)	(0.00)	(0.00)
Interactions				
*FEI*Age*	-	-0.31***	-	-0.32***
		(0.08)		(0.08)
*FEI *Age-Squared*	-	0.01**	-	0.01**
		(0.00)		(0.00)
Race				
White [Reference]				
Black	-0.36**	-0.36**	-0.66***	-0.67***
	(0.12)	(0.12)	(0.11)	(0.11)
Hispanic	-0.43**	-0.43**	-0.56***	-0.55***
	(0.13)	(0.13)	(0.12)	(0.12)
Asian	-0.86***	-0.86***	-0.77***	-0.77***
	(0.18)	(0.18)	(0.17)	(0.17)
Native American	0.61+	0.58+	0.07	0.02
	(0.33)	(0.33)	(0.31)	(0.31)
Other Race	0.03	0.05	-1.28**	-1.27**
	(0.46)	(0.46)	(0.43)	(0.43)
Two biological parents	-0.33***	-0.33***	-0.14	-0.15
	(0.09)	(0.09)	(0.09)	(0.09)
Family SES	0.01	0.01	0.05*	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)
Neighborhood poverty	-1.18**	-1.18**	-0.78*	-0.79*
	(0.38)	(0.38)	(0.34)	(0.34)
Low self-control			0.26**	0.25**
			(0.09)	(0.09)
Biological Mother's Binge-Drinking/Alcoholism			0.29*	0.30*
			(0.13)	(0.13)
Juvenile Arrest			1.58***	1.59***
			(0.38)	(0.38)
Friends' Marijuana Use			0.78***	0.78***
			(0.05)	(0.05)
Repeated Physical Abuse			0.33*	0.33*
			(0.15)	(0.15)
Father Closeness			-0.04	-0.04
			(0.04)	(0.04)
Father Involvement			-0.04	-0.04
			(0.04)	(0.04)
Parental Supervision			0.01	0.01
			(0.04)	(0.04)
School Attachment			-0.22***	-0.23***
			(0.06)	(0.06)
Intercept	-9.68***	-10.70***	-9.87***	-10.89***
	(0.31)	(0.34)	(0.40)	(0.42)
Alpha	11.14***	11.16***	9.06***	9.09***
	(0.326)	(.327)	(0.276)	(0.277)
Log-Likelihood	-22389.53	-22189.06	-22149.31	-21950.43
Number of Observations	16657	16657	16657	16657
Number of Respondents	6039	6039	6039	6039

*** $p<0.001$, ** $p<0.01$, * $p<0.05$ [Two-tailed test] + $p<0.05$ [One-Tailed test]
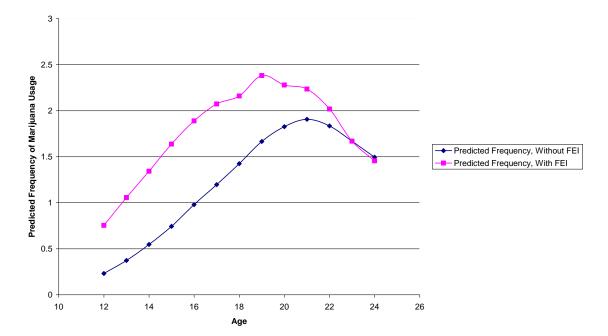
Figure 2: Predicted Frequency of Marijuana Usage During Last 30 Days for Adolescent Females, Ages 12-24, by Whether Respondent's Biological Father Was Ever Incarcerated
[predicted frequencies based on model coefficients in Model (2) of Table 3]

Table 4: Multilevel Logistic Regression for Hard Drug Use Among Males
[regression coefficients, with standard errors in parentheses]

Independent Predictors	(1)	(2)	(3)	(4)
Father Ever Incarcerated (FEI)	1.35***	-12.05*	0.75***	-12.78**
	(0.21)	(4.87)	(0.19)	(4.82)
Age	1.66***	1.45***	1.63***	1.42***
	(0.18)	(0.19)	(0.18)	(0.19)
Age Squared	-0.03***	-0.03***	-0.03***	-0.03***
	(0.005)	(0.005)	(0.005)	(0.005)
Interactions				
FEI*Age		1.43**		1.44**
		(0.51)		(0.50)
FEI *Age-Squared		-0.04**		-0.04**
		(0.01)		(0.01)
Race				
White [Reference]				
Black	-3.25***	-3.27***	-3.09***	-3.11***
	(0.27)	(0.27)	(0.25)	(0.25)
Hispanic	-0.38+	-0.38+	-0.64***	-0.64***
	(0.20)	(0.20)	(0.19)	(0.19)
Asian	-1.50***	-1.52***	-1.41***	-1.43***
	(0.28)	(0.28)	(0.25)	(0.26)
Native American	0.16	0.15	0.07	0.06
	(0.51)	(0.51)	(0.46)	(0.46)
Other Race	-1.30+	-1.31+	-1.33+	-1.34+
	(0.75)	(0.75)	(0.69)	(0.69)
Two biological parents	-0.32*	-0.32*	-0.16	-0.15
	(0.15)	(0.15)	(0.15)	(0.15)
Family SES	0.21***	0.21***	0.21***	0.21***
	(0.03)	(0.03)	(0.03)	(0.03)
Neighborhood poverty	-1.25+	-1.25+	-0.79	-0.78
	(0.70)	(0.70)	(0.64)	(0.64)
Low self-control			0.45**	0.45**
			(0.15)	(0.15)
Biological Mother's Binge-Drinking/Alcoholism			0.04	0.04
			(0.22)	(0.22)
Juvenile Arrest			2.22***	2.24***
			(0.24)	(0.24)
Friends' Marijuana Use			0.96***	0.96***
			(0.07)	(0.07)
Repeated Physical Abuse			0.55*	0.56*
			(0.22)	(0.22)
Father Closeness			0.07	0.08
			(0.07)	(0.07)
Father Involvement			0.01	0.01
			(0.06)	(0.06)
Parental Supervision			0.13*	0.13*
			(0.06)	(0.06)
School Attachment			-0.67***	-0.68***
			(0.10)	(0.10)
Intercept	-24.78***	-22.90***	-22.99***	-21.09***
	(1.79)	(1.89)	(1.81)	(1.91)
Individual-level Intercept	3.37***	3.40***	2.91***	2.93***
	(0.149)	(0.151)	(0.136)	(0.137)
Log-Likelihood	-4020.13	-4015.82	-3775.63	-3771.21
Number of Observations	14377	14377	14377	14377
Number of Respondents	5230	5230	5230	5230

*** $p<0.001$, ** $p<0.01$, * $p<0.05$ [Two-tailed test] + $p<0.05$ [One-Tailed test]
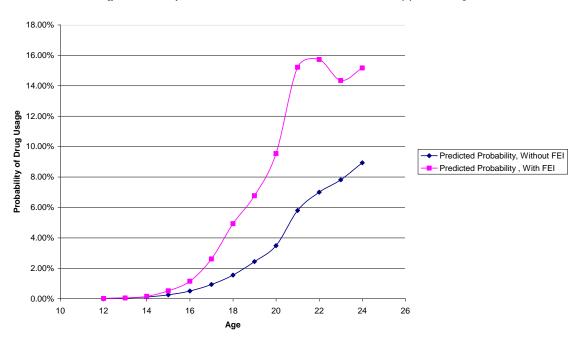
Figure 3: Predicted Percentage of Male Respondents Ages 12-24 Using Hard Drugs, by Whether Respondent's Biological Father Was Ever Incarcerated [predicted frequencies based on model coefficients in Model (2) of Table 4]

Table 5: Multilevel Logistic Regression for Hard Drug Use Among Females
[regression coefficients, with standard errors in parentheses]

Independent Predictors	(1)	(2)	(3)	(4)
Father Ever Incarcerated (FEI)	0.84***	-0.22	0.41*	-0.86
	(0.20)	(3.82)	(0.18)	(3.82)
Age	0.77***	0.76***	0.73***	0.71***
	(0.15)	(0.16)	(0.15)	(0.16)
Age Squared	-0.01***	-0.01**	-0.01***	-0.01**
	(0.004)	(0.004)	(0.004)	(0.004)
Interactions				
*FEI*Age*		0.10		0.11
		(0.42)		(0.42)
*FEI *Age-Squared*		-0.003		-0.002
		(0.01)		(0.01)
Race				
White [Reference]				
Black	-3.03***	-3.03***	-3.02***	-3.02***
	(0.25)	(0.25)	(0.23)	(0.23)
Hispanic	-0.23	-0.23	-0.30+	-0.30+
	(0.19)	(0.19)	(0.18)	(0.18)
Asian	-1.47***	-1.47***	-1.27***	-1.27***
	(0.29)	(0.29)	(0.27)	(0.27)
Native American	1.21**	1.22**	0.69+	0.69+
	(0.43)	(0.43)	(0.40)	(0.40)
Other Race	-0.35	-0.35	-0.50	-0.50
	(0.68)	(0.67)	(0.63)	(0.63)
Two biological parents	-0.21	-0.21	0.15	0.15
	(0.14)	(0.14)	(0.15)	(0.15)
Family SES	0.14***	0.14***	0.15***	0.15***
	(0.03)	(0.03)	(0.03)	(0.03)
Neighborhood poverty	-3.17***	-3.16***	-2.42***	-2.41***
	(0.68)	(0.68)	(0.63)	(0.63)
Low self-control			0.05	0.05
			(0.14)	(0.14)
Biological Mother's Binge-Drinking/Alcoholism			0.15	0.15
			(0.20)	(0.20)
Juvenile Arrest			2.34***	2.34***
			(0.47)	(0.47)
Friends' Marijuana Use			0.96***	0.96***
			(0.07)	(0.07)
Repeated Physical Abuse			0.77***	0.77***
			(0.22)	(0.22)
Father Closeness			-0.08	-0.08
			(0.06)	(0.06)
Father Involvement			0.03	0.03
			(0.06)	(0.06)
Parental Supervision			0.02	0.02
			(0.06)	(0.06)
School Attachment			-0.59***	-0.59***
			(0.09)	(0.09)
Intercept	-14.16***	-13.96***	-11.82***	-11.57***
	(1.42)	(1.54)	(1.46)	(1.57)
Individual-level Intercept	3.17***	3.16***	2.79***	2.79***
	(0.129)	(0.129)	(0.120)	(0.120)
Log-Likelihood	-4082.88	-4082.75	-3880.93	-3880.65
Number of Observations	16657	16657	16657	16657
Number of Respondents	6039	6039	6039	6039

*** p<0.001, ** p<0.01, * p<0.05 [Two-tailed test] + p<0.05 [One-Tailed test]
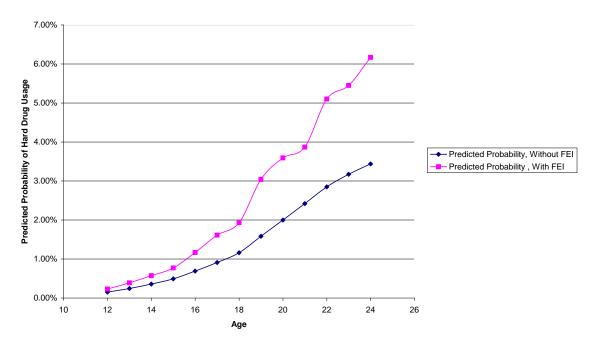
Figure 4: Predicted Percentage of Female Respondents Ages 12-24 Using Hard Drugs, by Whether Respondent's Biological Father Was Ever Incarcerated

[predicted frequencies based on model coefficients in Model (2) of Table 5]