

LIFE COURSE CENTRE WORKING PAPER SERIES

Examining the Relationship between Parental Imprisonment in Childhood and Risk of Sexually Transmitted Infections among US Adults in Early and Mid-Adulthood

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No. 2019-30

December 2019

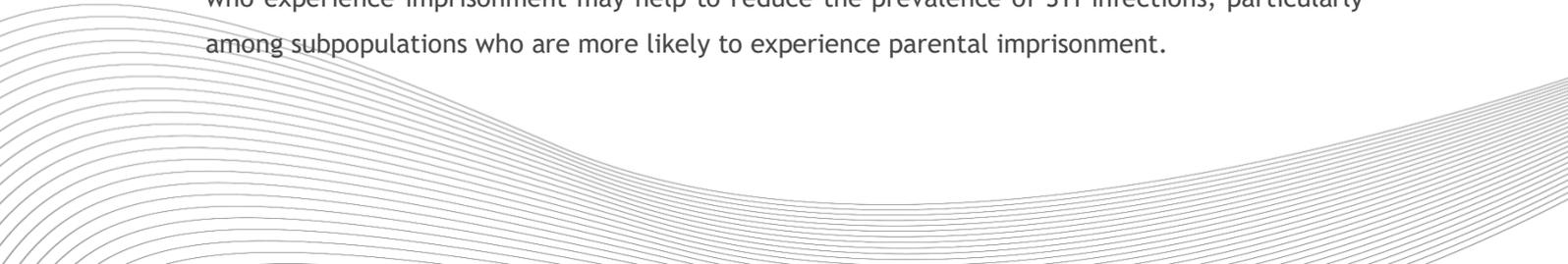
NON-TECHNICAL SUMMARY

Approximately one-in-six young adults in the United States report that at least one biological parent was imprisoned at some point in childhood. Parental imprisonment is recognized as a childhood trauma linked to adversity at later stages in the life course, including homelessness, poor educational outcomes, antisocial behavior, imprisonment, substance abuse, mental health issues, and poverty. In recent decades, research has explored the relationship between parental imprisonment in later life, with parental imprisonment linked to a higher risk of infant and adult mortality, obesity, respiratory illnesses, physical disability, and developmental delays in childhood. Recent cross-sectional studies have also found associations between parental imprisonment and risk of sexually transmitted infections (STIs), including HIV/AIDs, chlamydia, and gonorrhea.

Building on cross-sectional research, we examine the relationship between childhood parental imprisonment and reported STI infection in adulthood, examining patterns by age, gender of parent and child, and ethnicity of respondent. Among adults ages 24-32, both mother and father imprisonment were similarly linked with increased lifetime reports for being diagnosed with an STI. Lifetime risk for STIs increased similarly among women and minority groups, however risks compounded by gender, ethnicity, and history of parental imprisonment. For example, 10% of non-black males with no history of parental imprisonment reported ever having an STI, while 62% of black females with a history of parental imprisonment reported ever having an STI. Longitudinal analysis for individuals ages 18-32 showed that having a history of father imprisonment was associated with a higher risk of being diagnosed with an STI in the prior year, with similar compounded risk by gender, ethnicity, and history of father imprisonment.

When taken in context of existing research, our findings help to shed insight into how increased risk of STIs may impact adults who have experienced parental imprisonment. First, given that substantive bodies of research have shown that women and minorities are at greater risk for STIs, experiencing parental imprisonment increases an individual's risk of STI infection. Secondly, STIs are often asymptomatic at time of infection, but are associated with increased risk for a range of later health issues, including infertility, cancer, low birth weight and preterm birth in women, mortality, and antibiotic-resistant bacterial infections. This implies that the increased risk of STI infection serves as a life course event linked with health issues in later life, and may act as a mechanism through which parental imprisonment is associated with later health issues. Lastly, by examining risk over time, we are able to better establish the association between experiencing paternal imprisonment in childhood and later adult risk for STI infection.

We end by noting that STI infection rates have increased substantially in both the US and Australia in the last decade. Our study suggests that developing policies and interventions for individuals who experience imprisonment may help to reduce the prevalence of STI infections, particularly among subpopulations who are more likely to experience parental imprisonment.



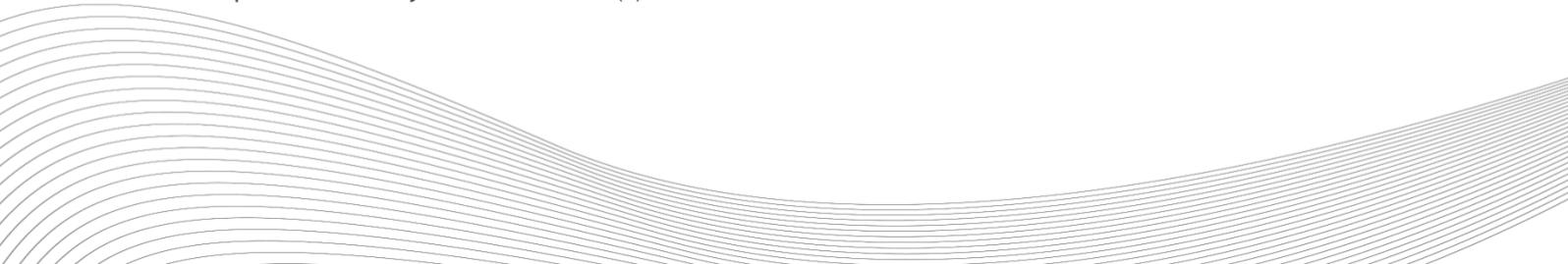
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Acknowledgments: This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Information on how to obtain the Add Health data files is available on the Add Health website (<http://www.cpc.unc.edu/addhealth>). No direct support was received from grant P01-HD31921 for this analysis.

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ABSTRACT

One-in-six young adults in the U.S. have experienced parental imprisonment. While prior cross-sectional studies associate parental imprisonment and increased risk of STI infection, methodological issues restrict inference of parental imprisonment as a risk factor for general STI infection along the life course. Using data from the National Longitudinal Study of Adolescent to Adult Health, we examine how parental imprisonment is linked to self-reported risk of 1) lifetime STI infection using logistic regression and 2) over the prior twelve months at two waves when respondents were ages 18-26 and 26-32 using multi-level logistic regression. We further examine how probabilities of STI infection vary by gender, ethnicity, and history of parental imprisonment. Father only imprisonment is associated with increased odds of 1.26 (95% confidence interval (CI): 1.11, 1.43) of lifetime STI infection and a 1.19 increased odds (95% CI: 1.01, 1.37) of STI infection in the past 12 months between ages 18-32. Maternal imprisonment is associated with higher risk of lifetime STI; however, 95% CIs overlapped with 1 adjusted for confounders (95% CI: 0.84, 1.35). Examining predicted probabilities of STI infection, our findings show additive risks for women, blacks, and parental imprisonment. Overall, our findings indicate parental imprisonment modestly increases STI risk.

Keywords: sexually transmitted infections; parental imprisonment; mass incarceration; health status disparities; minority health

Suggested citation: Roettger, M. E. & Houle, B. (2019). 'Examining the Relationship between Parental Imprisonment in Childhood and Risk of Sexually Transmitted Infections among US Adults in Early and Mid-Adulthood'. *Life Course Centre Working Paper Series*, 2019-30. Institute for Social Science Research, The University of Queensland.

Currently, 2.6 million U.S. children have a parent in prison, with 4% of white, 24% of black, and 11% of Hispanic children ever experiencing parental imprisonment (Sykes & Pettit, 2014). Parental imprisonment is linked to a range of adversities from birth to death, including prenatal exposure to alcohol and drugs, poor academic and educational outcomes, criminal behavior and subsequent imprisonment (Lee, Fang, & Luo, 2013; Murray, Bijleveld, Farrington, & Loeber, 2014; Roettger & Dennison, 2018). Research has linked parental imprisonment to a range of health issues such as sexually transmitted infections (STIs), depression, cardiovascular and metabolic diseases, respiratory issues and premature mortality (Turney, 2014; Van De Weijer, Smallbone, & Bouwman, 2018; Wildeman, Andersen, Lee, & Karlson, 2014; Wildeman, Goldman, & Turney, 2018).

Rates of STI infection have generally increased in the U.S. For example, chlamydial infection rates doubled from 251.4 to 528.8 per 100,000 between 2000 and 2017, while gonorrhea infection rates increased by 75% from 99.1 to 171.9 cases per 100,000 between 2009 and 2017 (Centers for Disease Control and Prevention, 2018). An STI that is undetected and left untreated may result in a range of chronic health issues such as infertility or adverse birth outcomes (chlamydia, gonorrhea), cervical and testicular cancers (HPV), and mortality (syphilis, HIV/AIDS) (American College of Obstetricians and Gynecologists, 2017; Centers for Disease Control and Prevention, 2018; Johnson, Ghanem, Zenilman, & Erbeding, 2011). Increased risk for STIs associated with experiencing parental imprisonment may thus lead to significantly increased risks for subsequent health consequences for individuals and their children.

In cross-sectional analyses of the National Longitudinal Study of Adolescent to Adult Health (Add Health), parental imprisonment has been associated with STI infection in adolescence and adulthood (Khan, Scheidell, Rosen, Geller, & Brotman, 2018; Le, Deardorff, Lahiff, & Harley, 2019; Lee, et al., 2013; London, Quinn, Scheidell, Frueh, & Khan, 2017).

Further studies have linked STI infection with substance abuse, childhood trauma, early sexual activity, and risky sexual behavior (Heard-Garris et al., 2018; Khan, et al., 2018; Le, et al., 2019; Lee, et al., 2013; London, et al., 2017; Nebbitt, Voisin, & Tirmazi, 2017; Turney & Goldberg, 2019). These analyses also suggest that women (London, et al., 2017) and minorities (Khan, et al., 2018; Nebbitt, et al., 2017) who experience parental imprisonment may be at greater risk for STI infections. Parental imprisonment has also been associated with altered age trajectories for engaging in delinquent behavior and drug use (Roettger & Swisher, 2011; Roettger, Swisher, Kuhl, & Chavez, 2011). Some research examining cross-sectional risk of STI infection at multiple time points suggests that STI infection risk associated with parental imprisonment may vary by life stage and be mediated by factors such as child abuse, substance use, or sexual risk taking (Khan, et al., 2018; London, et al., 2017).

While cross-sectional studies suggest that parental imprisonment is associated with later STI infection, there remain a number of important gaps that limit our understanding of the links between parental incarceration and STI risk. First, longitudinal research extends this research to a) determine how the association between parental imprisonment and STI risk may comparatively hold over adulthood, and b) understand the potential confounding or mediating roles of other related factors that can help to mediate STI risk (Allison, 2014). Secondly, research is also needed to examine STI risk disparities for parental imprisonment by parent/child gender and ethnicity (Wildeman, et al., 2018), particularly in light of findings that women and African Americans are more likely to contract an STI (Paul, Van Roode, Herbison, & Dickson, 2009; Upchurch, Mason, Kusunoki, & Kriechbaum, 2004; Wildsmith, Schelar, Peterson, & Manlove, 2010). Third, most studies have focused on associations with 1-3 STIs (Le, et al., 2019; Lee, et al., 2013; London, et al., 2017), rather than examining the broader association between parental imprisonment and a range of STIs that may lead to

health complications. Finally, potential methodological issues in prior studies also may limit inference, including only analyzing complete cases and using small cell sizes where findings are subject to greater uncertainty.

Our study extends previous research on the relationship between parental imprisonment and STI infection by using a longitudinal framework to analyze individual risk for being infected with a broad subset of STIs linked with parental incarceration in prior Add Health studies. We estimate 1) the cumulative risk of STI diagnosis at ages 24-32 addressing issues of survey weighting and missing data, and 2) longitudinal analysis of 12-month risk of STI diagnosis between the ages of 18-32. We examine if gender of parent and child differentiates risk, along with mediating patterns for 1) sociodemographic, 2) familial and neighborhood characteristics, 3) individual risk and resiliency, and 4) sexual risk factors. Taken together, these analyses provide us with a comprehensive and detailed understanding of how parental imprisonment may be associated with individual patterns of STI infection in early to mid-adulthood. Furthermore, we examine the extent to which moderating patterns of STI infection risk may vary by race, gender, and (in longitudinal models) age of respondent. A recent literature review identified only one longitudinal study examining health outcomes associated with parental imprisonment over multiple time points (Wildeman, et al., 2018), highlighting the potential contribution of this study to the broader literature on adverse health issues related to parental imprisonment.

METHODS

Data

We use data from the U.S. National Longitudinal Study of Adolescent to Adult Health (Add Health). The Add Health study initially surveyed approximately 90,000 students enrolled in grades 7-12 (ages 12-18) in 1994-1995 in in-school interviews. Our study follows

a subpopulation of ~20,750 respondents who were randomly selected from the in-school sample for in-home interviews. These respondents were followed up at three later waves: ~14,700 respondents at Wave 2 in 1996, 15,200 respondents at Wave 3 in 2001-2002, and ~15,700 respondents at Wave 4 in 2007-2008. Of the original sample, the proportion completing surveys at each round were: 71% at Wave 2, 73% at Wave 3, and 75% at Wave 4. All later waves contain only respondents who were interviewed at Wave I (Kathleen Mullan Harris et al., 2019).

Our analytic sample consists of 15,684 individuals who completed questionnaires at Wave I4, when questions about biological mother and father imprisonment were first asked; including 14,796 individuals with valid survey weights.

Measures

STI infections. Our outcome measure of STI infection is a dichotomous indicator for respondents reporting being told by a doctor, or other health professional of being infected with any of the following STIs: 1) chlamydia, 2) gonorrhea, 3) trichomoniasis, 4) syphilis, 5) hepatitis B, 6) human papilloma virus (HPV), 7) HIV/AIDs, and 8) other sexually transmitted diseases, not elsewhere reported by respondents such as genital herpes, genital warts, vaginitis, urethritis, pelvic inflammatory disease, or cervicitis.

From these reports, we construct an indicator for 1) ever being infected with an STI and 2) being infected with an STI in the 12 months prior to interview (available at Waves III and IV). For lifetime infection we supplement Wave IV reports with reports of being infected with any of the STIs listed above at earlier Waves, addressing cases where respondents are known to deny STI infections in self-reports at older ages (Dariotis, Pleck, Sonenstein, Astone, & Sifakis, 2009).

Parental imprisonment. At Wave IV, respondents were asked “Has your biological mother/father ever been in prison?” and “At what age was your biological mother/father first incarcerated?” Using these questions, we construct indicator variables for if the biological mother/father was first incarcerated prior to age 18. We code separate measures for (1) father imprisonment, (2) mother imprisonment, and (3) and mutually exclusive categories of mother and/or father imprisonment. While prior research suggests recollection of childhood traumas and reporting of parental imprisonment yields reliable estimates (Foster & Hagan, 2013; Winegar & Lipschitz, 1999), recollection of the specific age at first parent imprisonment may be less reliable, particularly in early childhood. We thus code parental imprisonment as occurring at childhood (age<18).

Demographic controls. We include respondent age at each wave, biological sex, and if the respondent identified as black, white, Hispanic, Native American, Asian, or other racial classification at Wave I.

Familial/neighborhood controls. We control for mother’s reported level of education and family structure at Wave I. We include Wave I neighborhood SES as the proportion of families in the respondent’s census tract residing below the poverty level.

Individual risk measures. For individual controls, we incorporate measures of measured body mass index (BMI; kg/m²) at Wave II, an indicator for physical child abuse (Wave IV self-report), difficult child temperament (Wave I parent interview), a Wave I school attachment scale, adolescent marijuana usage in the 30 days prior to the interview (Wave I), binge drinking in the prior 12 months to the interview (Waves I, III, & IV), and a 12-item Wave I delinquency score for acts that may result in arrest and imprisonment (for details of the school attachment and delinquency scales used in this analysis, see Guo et al (Guo, Roettger, & Cai, 2008)).

STI risk factors. Measures include the number of sexual partners before age 18 and parental reports of the degree to which they discussed STI risk with respondents on a 5-point Likert scale.

Analytical strategy

To analyze the risk of lifetime STI infection, we use logistic regression.

Add Health uses multiplicative weights ranging between 20-18,342 (mean 1480.28, SD 1425.65) to create a representative national cohort at wave 4 (Kathleen M. Harris et al., 2009). This is a potential issue in prior studies where small cell sizes, combined with Add Health multiplicative weights and missing data, may substantially increase uncertainty for prior research. Analysis of unweighted data and controls to address sample bias may, alternatively, more efficiently estimate STI risk (Cameron & Trivedi, 2005). We focus our presentation on the unweighted results, but also compare coefficients between the weighted and unweighted data (Bollen, Biemer, Karr, Tueller, & Berzofsky, 2016).

To analyze the probability of STI infection over time, we use a two-level random effects logistic regression model where self-reports of STI infection in the prior twelve months at each wave are nested within individuals.

Prior cross-sectional studies noted above that examined parental imprisonment and STI infection have used complete case analysis: (1) excluding cases where more socially marginal groups tend to have higher levels of survey non-response in Add Health, and (2) deleting 12% of cases of mothers (78/643) and 20% of cases of fathers (458/2283) who respondents reported had been imprisoned, but did not know the exact age of imprisonment. We impute 75 datasets using multiple imputation (MI) by chained equations to address missing data issues, particularly given that the effects of parental imprisonment are found to

be less significant among more disadvantaged groups (Graham, 2012; Royston & White, 2011; Wildeman, et al., 2018).

To reduce the potential effects of heteroscedasticity among predictor variables, all non-weighted analyses are estimated using Huber-White standard errors.

Predicted probabilities and 95% CIs are generated by estimating means and standard errors using reported model estimates. These estimates results use baseline demographic controls for age, race/ethnicity, and respondent gender to estimate variation among these groups, in the absence of mediators.

All analyses are conducted using STATA 15.1.

RESULTS

Table 1 contains descriptive statistics by respondent's history of parental imprisonment. Parental imprisonment is associated with a range of higher risks, including a higher cumulative lifetime risk for STI infection and in the 12 months prior to interview at Waves III and IV. Respondents with histories of parental imprisonment were less likely to have lived with both biological parents at Wave I, have a caregiver report lower parental educational attainment, have a parent report difficult child temperament, and report physical abuse in childhood. In adolescence, parental imprisonment is also linked with increased delinquency, binge drinking, marijuana usage, along with a higher number of sexual partners.

Lifetime STI infection

Table 2 contains results for lifetime risk of STI infection. The odds of STI infection were higher for imprisonment of the biological father (Odds ratio (OR): 1.49, 95% confidence interval (CI): 1.33, 1.68) and biological mother (OR: 1.48, 95% CI: 1.20, 1.89) in the baseline sociodemographic model (Model 1). Modest declines in these estimates were

associated with familial and neighborhood factors (Model 2), individual risk factors (Model 3), and sexual behavior risk factors (Model 4), with 95% CIs for the OR of maternal imprisonment overlapping with the null value of 1 (OR: 1.24, 95% CI: 0.90, 1.55) in Model 3. Biological father remained a risk factor for STI infection (OR: 1.22, 95% CI: 1.08, 1.38) with the inclusion of all controls, while the 95% CIs for the odds ratio of maternal imprisonment included the null value of 1 (OR: 1.07, 95% CI: 0.84, 1.35).

Similar odds ratios for STI infection were observed for models for imprisonment of the biological father only (OR: 1.52, 95% CI: 1.34, 1.71), biological mother only (OR: 1.59, 95% CI: 1.20, 2.10), and biological mother and father (OR: 1.58, 95% CI: 1.16, 2.15). Similar mediation patterns were observed for biological father and biological mother imprisonment, with 95% CIs showing odds ratios >1 for biological father only (Models 1-5), biological mothers only (Models 1-4), and both father and mother imprisonment (Models 1-4).

Supplemental Table S1 adds sample weights to the models presented in Table 2. Overall, findings show substantively similar point estimates to those presented in Table 2, with wider confidence intervals.

We found no significant interactions for parental imprisonment with gender and race. To examine cumulative risk, we estimated joint probabilities for lifetime STI infection by child gender, black/non-black ethnicity, and mother or father imprisonment. Table 3 presents predicted probabilities for ever being infected with an STI by gender, parental imprisonment history, and black/non-black ethnic classification. These results show that being female, having an incarcerated parent, and being black have additive effects for ever being infected with an STI. For example, a non-black male with no history of paternal imprisonment has a predicted probability of infection of 8.9% (95% CI: 8.2%, 9.6%), while those with a history

of paternal imprisonment has a predicted probability of 12.5% (95% CI: 11.2%, 13.9%). In contrast, black women reporting no history of parental imprisonment had a 52.4% (95% CI: 50.2%, 54.6%) predicted probability of STI infection, compared to 61.7% (95% CI: 58.8%, 64.7%) with a history of paternal imprisonment. Similar predicted probabilities are associated with maternal imprisonment.

Longitudinal risk of STI infection

Table 4 examines longitudinal odds of STI infection in the 12-months prior to the interview. In these models, father imprisonment in the baseline model was associated with higher odds of STI infection (OR: 1.33, 95% CI: 1.13, 1.56). This association showed slight mediation when controls were introduced for familial and neighborhood (Model 2), individual (Model 3) and sexual behavior factors (Model 4); however, the 95% CIs for paternal imprisonment included the null value of 1 (95% CI: 0.98, 1.37) when all controls were included (Model 5). Maternal imprisonment showed no association with 12-month STI risk (Model 5 95% CI: 0.75, 1.40). In comparing imprisonment risk for categories of father and/or mother imprisonment, the 95% CIs of the association for father only imprisonment and STI risk remained >1 across all models, but mother only imprisonment, and father and mother imprisonment showed no associations with STI risk.

To test for differences in father imprisonment and 12-month STI risk, we examined if age, ethnicity and gender moderated results for paternal imprisonment, but found no statistically significant moderation patterns. In lieu of moderation, we examined if predicted probabilities of STI diagnosis by age, ethnicity and gender showed additive effects, as illustrated by Figures 1A (non-black respondents) and 1B (black respondents). In all models there is a higher probability of diagnosis through the mid-20s, before the probability of STI diagnosis stabilizes. In Figure 1A, the predicted probability of diagnosis of an STI in the past

12 months is higher for women than men, with parental imprisonment associated with a modest increase in risk. These figures illustrate additive effects for paternal imprisonment, being black, and being a woman, with nearly one-fifth of black women who experience paternal imprisonment being diagnosed with an STI in the 12-months prior to interviews.

Sensitivity analysis

We conducted supplementary analyses to 1) compare MI results with complete case analysis for the main findings (Supplemental Tables 2 and 3); 2) compare the findings by Le et al (Le, et al., 2019) for laboratory-confirmed infections of chlamydia and gonorrhea with our own analysis for respondent self-reports of lifetime chlamydia and/or gonorrhea infection (Supplemental Table 4); and 3) test moderation results using complete case analysis by examining interactions for parental imprisonment by gender, race/ethnicity, and age (longitudinal results only). Comparisons 1) and 3) yielded substantively similar results. For 2), our results were consistent with prior research on variations between lab-confirmed and self-reported STI infection: 1) father only, and 2) mother and father imprisonment were lower, but within 95 CIs, but our odds for mother only imprisonment were lower than the results reported by Le et al (Iritani, Ford, Miller, Hallfors, & Halpern, 2006; Le, et al., 2019).

DISCUSSION

Using a national cohort sample, this study demonstrates that paternal imprisonment in childhood is consistently associated with higher lifetime odds of STI infection and in longitudinal annual risk for adults ages 18-32. While other studies have examined STI and sexual risk associated with parental imprisonment, our study is the first to systematically examine both cumulative and longitudinal associations between parental imprisonment and risk of a broad spectrum of STI infections. Due to the increases in STI infection rates over the last decade and the number of children impacted by parental imprisonment, greater

understanding of this topic has important health and policy implications for children of prisoners and research on populations disproportionately at risk for STI infection.

In doing so, we assessed how these associations vary by parent gender, while also examining how familial, neighborhood, individual, and sexual behavior risk factors mediate these associations. In the baseline sociodemographic models, we found that experiencing paternal imprisonment is consistently linked with both cumulative odds of STI infection and annual STI infection. For lifetime risk, 1) any maternal imprisonment and 2) mother imprisonment with and without father imprisonment yielded similar odds of STI infection; however, these associations were not apparent in longitudinal models, possibly due to relatively small sample size.

In examining mediation patterns, familial/neighborhood, individual, and sexual risk factors only partially mediated the association between parental imprisonment and STI infection. While factors such as risky sexual behaviors and substance abuse have been found to potentially mediate the relationship between parental imprisonment and STI infection (Khan, et al., 2018; Le, et al., 2019), our analysis establishes that STI infection risk linked with parental imprisonment remains when accounting for single risk factors such as familial household composition and SES, child abuse and temperament issues, general deviant behavior and substance use, and adolescent sexual activity.

By examining predicted probabilities, we are able to provide a clearer understanding of how joint parental imprisonment, ethnicity, and respondent gender lead to variations in STI infection at the population level. We found that both maternal and paternal imprisonment similarly increased the lifetime probability of STI infection, with women and black respondents having compounded risk of STI infection. A similar pattern was observed for biological father's imprisonment and the longitudinal odds of STI infection. Taken together,

these findings suggest that parental imprisonment may lead to increased risk of multiple STI infections. For example, parental imprisonment among black adult women is associated with a 60% lifetime risk and 15-20% annual risk of STI infection, suggesting a new STI infection occurring every 3-4 years.

Our study has a number of strengths. Our combination of cumulative and longitudinal analysis for STI infection allowed us to test if the general association between parental imprisonment and STI infection consistently holds over time for a broad range of STIs. By using strategies to systematically address limitations of prior research and the Add Health data, we have been able to strengthen our understanding of the validity of the association between parental imprisonment and STI risk; this has been done by use of multiple imputation, including a broader range of self-reported STIs, comparing weighted and non-weighted data, ensuring sufficiently large cell sizes for parental imprisonment to reduce uncertainty, and using a single childhood cutoff (age>18) to reduce inaccuracies for potential recall bias for early age imprisonment. Using predicted probabilities, we were able to examine the magnitude of the effect of parental imprisonment risk and having an STI infection in a national cohort, when considering age, gender, and ethnicity of respondents. Lastly, by examining STI infection over time and supplementing Wave IV STI reports of lifetime infection with reports of STI infection at earlier ages, we are able to 1) control for recall bias (Dariotis, et al., 2009) and 2) allow for additional time for cases where asymptomatic STI infections may be underreported due to lack of testing (LeFevre, 2014), known sources of biases for self-reported which may lead to underestimation at a single point in time.

Our study also has limitations. Research comparing laboratory testing for STIs in Add Health with self-reports at Wave 3 showed that self-reports for STI infection rates were slightly lower overall for the general population, with greater under-reports for minorities

(Iritani, et al., 2006). Increased prevalence of parental imprisonment among minorities and disadvantaged groups may lead to underestimation of our reported findings. As many STIs may be asymptomatic and revealed only with testing, our longitudinal analysis represents prevalence of ‘diagnosis,’ not infection rates (Dariotis, et al., 2009; Rogers, Miller, Miller, Zenilman, & Turner, 2002). Due to variation in questions across waves, we were unable to examine longitudinal models in adolescence, or analyze changes in STI risk between adolescence and adulthood. Parental imprisonment is also based on recollection, and administrative data may provide more reliable data within a jurisdiction (Geller, Jaeger, & Pace, 2016). Our study also makes use of Add Health, and other data sources are needed to confirm our findings and prior research. The Add Health data also lack information on parental criminality, parental sexual histories, and other risk factors which may help to understand the underlying causal mechanisms between parental imprisonment and STI risk.

Conclusion

This study provides evidence that paternal imprisonment in childhood is associated with elevated lifetime and longitudinal annual risks of having an STI infection in early and mid-adulthood. We find that annual and lifetime risk of STI infection associated with parental imprisonment is compounded by gender and ethnicity. For adults who have experienced parental imprisonment in childhood, increased testing and treatment for STIs may help to reduce the prevalence of STIs in the US.

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Table 1: Means, standard deviations and test of group means for individual, family, neighborhood, and sexual risk variables, by exposure to parental imprisonment in childhood (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Parental Imprisonment [n=2339]		No parental Imprisonment [n=12997]		Test of Group Means
	Mean/%	SD	Mean /%	SD	p-value (p<)
Parent Imprisonment					
Gender of Parent					
<i>Father imprisoned</i>	90.49%				
<i>Mother Imprisoned</i>	21.46%				
Joint Parental Imprisonment					
<i>Father only Imprisoned</i>	78.80%				
<i>Mather only imprisoned</i>	12.84%				
<i>Mother & Father Both Imprisoned</i>	12.84%				
Ever STI Diagnosis	31.53%		21.10%		0.0001
STI Diagnosis, Prior 12 Months					
<i>Wave 3</i>	7.77%		5.39%		0.0001
<i>Wave 4</i>	9.71%		7.06%		0.0001
Demographic Measures					
Age at Interview (years)					
<i>Wave 1</i>	15.41	(1.70)	15.63	(1.74)	0.0001
<i>Wave 3</i>	21.76	(1.74)	21.95	(1.77)	0.0001
<i>Wave 4</i>	28.32	(1.75)	28.52	(1.79)	0.0001
Respondent Gender					
<i>Male</i>	44.91%		47.08%		0.0500
<i>Female</i>	55.09%		52.92%		0.0500
Racial Phenotype (Wave 1)					
<i>White</i>	46.38%		54.00%		0.0001
<i>Black</i>	31.69%		20.74%		0.0001
<i>Hispanic</i>	16.53%		15.87%		0.4387
<i>Asian</i>	1.76%		6.91%		0.0001
<i>Native American</i>	2.83%		1.55%		0.0001
<i>Other/Multiple Race</i>	0.81%		0.92%		0.6020
Family & Neighborhood Measures					
Family Structure (Wave 1)					
<i>Two Biological Parents</i>	21.96%		57.82%		0.0001
<i>Single Mother</i>	36.09%		21.23%		0.0001
<i>Single Father</i>	4.62%		3.10%		0.0002
<i>Two Parent, One Biological</i>	25.09%		12.92%		0.0001
<i>Other Family Structure</i>	12.24%		4.92%		0.0001
Completed Parental Education					
<i>Bachelor's Degree</i>	15.34%		25.61%		0.0001
<i>High School</i>	60.52%		57.96%		0.0183
<i>Less Than High School</i>	24.14%		16.43%		0.0001

Percentage of families in respondent's census tract below poverty level	14.29%		11.47%		0.0001
<i>Individual Measures</i>					
<i>School Attachment (Wave 1)</i>	3.64	(0.92)	3.77	(0.96)	0.0001
Self-Reported BMI (Wave 1)	22.96	(4.70)	22.56	(4.49)	0.0001
Measured BMI (Wave 2)	23.47	(5.43)	23.07	(5.03)	0.0024
History of physical child abuse	15.99%		7.65%		0.0001
Parent's report, child temperament issues (Wave 1)	38.33%		29.47%		0.0001
Delinquent Activity Scale (Wave 1)	2.66	(4.34)	1.71	(3.29)	0.0001
Frequency of marijuana usage prior 30 days (wave 1)	0.38	(0.93)	0.23	(0.71)	0.0001
Reported Binge Drinking, Prior 12 months					
Wave 1	0.75	(1.37)	0.59	(1.18)	0.0001
Wave 3	1.02	(1.44)	1.12	(1.42)	0.0038
Wave 4	1.03	(1.41)	0.95	(1.29)	0.0096
<i>Sexual Risk Measures</i>					
Parental Discussion of STI risk with Respondent	3.26	(0.94)	3.12	(0.96)	0.0001
Number of Sex Partners Prior (age<18)	4.64	(9.92)	2.79	(6.45)	0.0001

Table 2: Odds ratios and 95% confidence intervals for lifetime STI diagnosis among adults ages 26-32 reporting parental imprisonment in childhood (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Model 1	Model 2	Model 3	Model 4	Model 5
Biological Father Imprisonment	1.49 [1.33, 1.68]	1.36 [1.21, 1.54]	1.33 [1.19, 1.49]	1.38 [1.23, 1.55]	1.22 [1.08, 1.38]
Biological Mother Imprisonment	1.48 [1.20, 1.82]	1.24 [1.00, 1.53]	1.24 [0.90, 1.55]	1.27 [1.08, 1.69]	1.07 [0.84, 1.35]
Biological Father only Imprisonment	1.52 [1.34, 1.71]	1.40 [1.23, 1.58]	1.37 [1.22, 1.55]	1.41 [1.25, 1.59]	1.26 [1.11, 1.43]
Biological Mother only Imprisonment	1.59 [1.20, 2.10]	1.34 [1.01, 1.78]	1.40 [1.05, 1.87]	1.47 [1.11, 1.96]	1.21 [0.89, 1.62]
Biological Mother & Father Imprisonment	1.58 [1.16, 2.15]	1.34 [0.98, 1.84]	1.30 [0.95, 1.78]	1.45 [1.07, 1.99]	1.12 [0.81, 1.55]

Notes: Results are presented for parental imprisonment (age<18) for (1) any reported biological father imprisonment, (2) any report of biological mother imprisonment and (3) combined reports of biological father and mother imprisonment. Model 1= Parental Imprisonment + respondent age + respondent ethnicity + respondent gender. Model 2= Model 1 + Wave 1 Family Structure + parent educational attainment + census tract family poverty rate. Model 3= Model 1 +respondent BMI + Adolescent School Attachment + childhood physical abuse + difficult child temperament. Model 4=Model 1+ parental discussion of STI risk + number of sex partners prior to age 18. Model 5=all variables used in prior models.

Table 3: Predicted probabilities and 95% confidence intervals for ever being infected with an STI, by parent gender, child gender, and black/non-black racial classification (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Non-Black, Male	Non-Black, Female	Black, Male	Black, Female
Biological Father Imprisonment	12.5% [11.2%, 13.9%]	29.3% [27.0%, 31.7%]	35.8% [32.7%, 38.8%]	61.7% [58.8%, 64.7%]
No Biological Father Imprisonment	8.9% [8.2%, 9.6%]	22.1% [21.1%, 23.2%]	27.6% [25.6%, 29.5%]	52.4% [50.2%, 54.6%]
Biological Mother Imprisonment	13.5% [11.0%, 16.0%]	30.4% [25.6%, 35.1%]	37.7% [32.7%, 42.7%]	63.2% [58.4%, 68.0%]
No Biological Mother Imprisonment	9.6% [8.9%, 10.0%]	23.0% [22.0%, 24.1%]	29.1% [27.1%, 31.0%]	53.7% [51.7%, 55.8%]

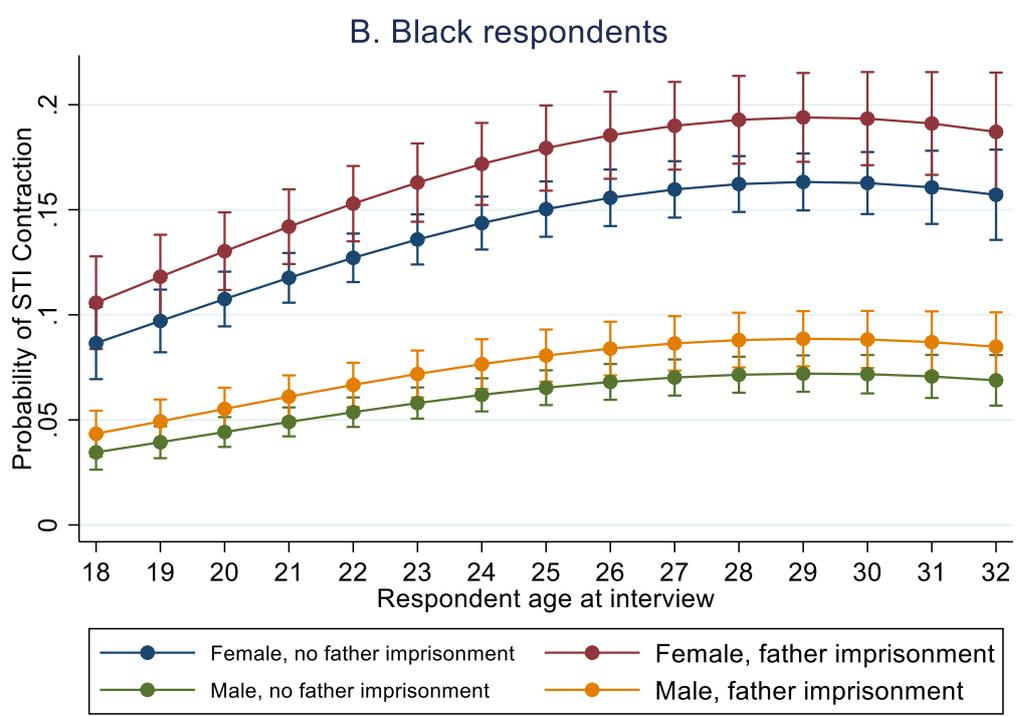
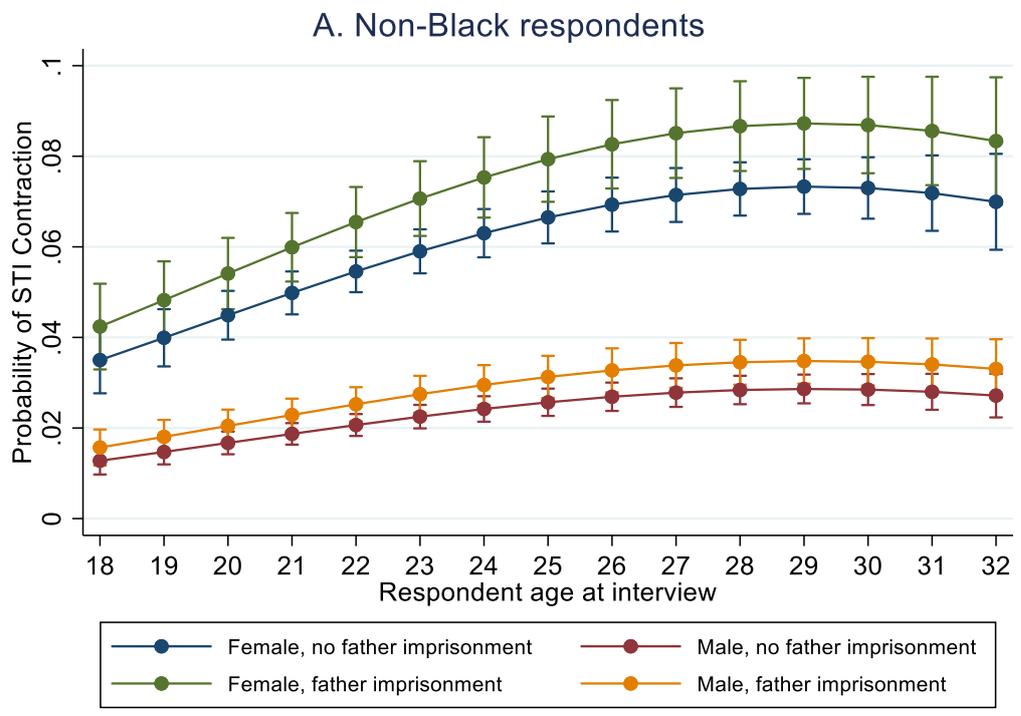
Notes: Predicted Probabilities generated based on Model 1 of Table 2 for respondents reporting if their (1) biological father or (2) biological mother was imprisoned at age<18.

Table 4: Odds ratios and 95% confidence intervals for longitudinal risk of STI infection in the 12 months prior to interview, ages 18-32 (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Model 1	Model 2	Model 3	Model 4	Model 5
Biological Father Imprisonment	1.33 [1.13, 1.56]	1.26 [1.06, 1.50]	1.22 [1.03, 1.43]	1.26 [1.07, 1.49]	1.15 [0.98, 1.37]
Biological Mother Imprisonment	1.22 [0.89, 1.66]	1.10 [0.81, 1.51]	1.09 [0.80, 1.48]	1.17 [0.85, 1.58]	1.02 [0.75, 1.40]
Biological Father only Imprisonment	1.36 [1.15, 1.60]	1.30 [1.10, 1.54]	1.25 [1.06, 1.50]	1.30 [1.10, 1.55]	1.19 [1.01, 1.41]
Biological Mother only Imprisonment	1.43 [0.96, 2.14]	1.33 [0.88, 2.00]	1.31 [0.88, 1.95]	1.37 [0.92, 2.05]	1.24 [0.81, 1.86]
Biological Mother & Father Imprisonment	1.12 [0.69, 1.82]	1.03 [0.63, 1.70]	0.95 [0.58, 1.56]	1.06 [0.65, 1.74]	0.89 [0.54, 1.46]

Notes: Model 1= Parental Imprisonment + respondent age + respondent ethnicity + respondent gender. Model 2= Model 1 + Wave 1 Family Structure + parent educational attainment + census tract family poverty rate. Model 3= Model 1 + respondent BMI + Adolescent School Attachment + childhood physical abuse + difficult child temperament. Model 4=Model 1+ parental discussion of STI risk + number of sex partners prior to age 18. Model 5=all variables used in prior models.

Figures 1A-1B: Age-graded risk for self-reported STI infection in 12 months prior to interview for A) non-Black respondents and B) Black respondents. Infection probabilities are presented by respondent gender and father's history of imprisonment (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).



Notes: Estimates based on Model 1 in Table 3 for biological father imprisonment

Supplemental Table 1. Weighted odds ratios and 95% confidence intervals for ever being infected with an STI infection among adults ages 26-32 reporting parental imprisonment in childhood (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Model 1	Model 2	Model 3	Model 4	Model 5
Biological Father Imprisonment	1.47 [1.24, 1.74]	1.34 [1.13, 1.59]	1.34 [1.12, 1.60]	1.38 [1.16, 1.65]	1.24 [1.04, 1.48]
Biological Mother Imprisonment	1.40 [1.04, 1.89]	1.17 [0.86, 1.59]	1.20 [0.89, 1.62]	1.28 [0.94, 1.74]	1.03 [0.76, 1.41]
Biological Father only Imprisonment	1.46 [1.22, 1.75]	1.35 [1.13, 1.61]	1.34 [1.11, 1.63]	1.39 [1.16, 1.66]	1.25 [1.04, 1.51]
Biological Mother only Imprisonment	1.40 [0.94, 2.10]	1.18 [0.78, 1.76]	1.17 [0.78, 1.77]	1.28 [0.83, 1.98]	1.01 [0.66, 1.54]
Biological Mother & Father Imprisonment	1.59 [1.13, 2.23]	1.36 [0.96, 1.93]	1.38 [0.98, 1.94]	1.43 [1.00, 2.05]	1.18 [0.83, 1.69]

Notes: Results are presented for parental imprisonment (age<18) for (1) any reported biological father imprisonment, (2) any report of biological mother imprisonment and 3) combined reports of biological father and mother imprisonment. Model 1= Parental Imprisonment + respondent age + respondent ethnicity + respondent gender. Model 2= Model 1 + Wave 1 Family Structure + parent educational attainment + census tract family poverty rate. Model 3= Model 1 +respondent BMI + Adolescent School Attachment + childhood physical abuse + difficult child temperament. Model 4=Model 1+ parental discussion of STI risk + number of sex partners prior to age 18. Model 5=all variables used in prior models.

Supplemental Table 2. Complete Case analysis for odds ratios and 95% confidence intervals for ever being infected with an STI infection among adults ages 26-32 reporting parental imprisonment in childhood (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Model 1	Model 2	Model 3	Model 4	Model 5
Biological Father Imprisonment	1.48 [1.32, 1.65]	1.34 [1.19, 1.51]	1.36 [1.17, 1.57]	1.35 [1.19, 1.53]	1.24 [1.06, 1.44]
Biological Mother Imprisonment	1.48 [1.21, 1.82]	1.19 [0.96, 1.48]	1.14 [0.86, 1.51]	1.29 [1.03, 1.63]	0.93 [0.69, 1.25]
Biological Father only Imprisonment	1.49 [1.32, 1.67]	1.37 [1.21, 1.55]	1.40 [1.21, 1.63]	1.37 [1.20, 1.56]	1.29 [1.10, 1.51]
Biological Mother only Imprisonment	1.64 [1.27, 2.12]	1.33 [1.01, 1.74]	1.44 [1.02, 2.01]	1.48 [1.12, 1.95]	1.16 [0.81, 1.69]
Biological Mother & Father Imprisonment	1.55 [1.11, 2.15]	1.21 [0.86, 1.72]	0.95 [0.60, 1.50]	1.26 [0.86, 1.84]	0.76 [0.47, 1.25]

Notes: Results are presented for parental imprisonment (age<18) for (1) any reported biological father imprisonment, (2) any report of biological mother imprisonment and 3) combined reports of biological father and mother imprisonment. Model 1= Parental Imprisonment + respondent age + respondent ethnicity + respondent gender. Model 2= Model 1 + Wave 1 Family Structure + parent educational attainment + census tract family poverty rate. Model 3= Model 1 +respondent BMI + Adolescent School Attachment + childhood physical abuse + difficult child temperament. Model 4=Model 1+ parental discussion of STI risk + number of sex partners prior to age 18. Model 5=all variables used in prior models.

Supplemental Table 3. Complete case analysis for odds ratios and 95% confidence intervals for longitudinal risk of STI infection in the 12 months prior to interview, ages 18-32 (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Model 1	Model 2	Model 3	Model 4	Model 5
Biological Father Imprisonment	1.30 [1.10, 1.53]	1.22 [1.03, 1.45]	1.16 [0.94, 1.42]	1.10 [1.00, 1.43]	1.07 [0.86, 1.33]
Biological Mother Imprisonment	1.21 [0.88, 1.65]	1.05 [0.75, 1.46]	1.20 [0.80, 1.81]	1.23 [0.88, 1.72]	1.08 [0.71, 1.65]
Biological Father only Imprisonment	1.33 [1.13, 1.58]	1.27 [1.06, 1.51]	1.22 [0.99, 1.51]	1.23 [1.02, 1.48]	1.14 [0.91, 1.42]
Biological Mother only Imprisonment	1.36 [0.93, 2.01]	1.22 [0.80, 1.85]	1.64 [1.00, 2.70]	1.46 [0.96, 2.22]	1.48 [0.88, 2.47]
Biological Mother & Father Imprisonment	1.15 [0.69, 1.92]	0.95 [0.56, 1.61]	0.79 [0.38, 1.63]	1.04 [0.58, 1.85]	0.67 [0.31, 1.44]

Notes: Results are presented for parental imprisonment (age<18) for (1) any reported biological father imprisonment, (2) any report of biological mother imprisonment and 3) combined reports of biological father and mother imprisonment. Model 1= Parental Imprisonment + respondent age + respondent ethnicity + respondent gender. Model 2= Model 1 + Wave 1 Family Structure + parent educational attainment + census tract family poverty rate. Model 3= Model 1 +respondent BMI + Adolescent School Attachment + childhood physical abuse + difficult child temperament. Model 4=Model 1+ parental discussion of STI risk + number of sex partners prior to age 18. Model 5=all variables used in prior models.

Supplemental Table 4. Odds ratios and 95% confidence intervals for ever being infected with gonorrhea or chlamydia among adults ages 26-32 reporting parental imprisonment in childhood (National Longitudinal Study of Adolescent to Adult Health, 1994-2008).

	Model 1	Model 2	Model 3	Model 4	Model 5
Biological Father Imprisonment	1.58 [1.40, 1.77]	1.36 [1.21, 1.54]	1.45 [1.29, 1.63]	1.48 [1.32, 1.67]	1.28 [1.13, 1.44]
Biological Mother Imprisonment	1.58 [1.29, 1.91]	1.28 [1.04, 1.56]	1.41 [1.16, 1.73]	1.49 [1.23, 1.82]	1.20 [0.97, 1.48]
Biological Father only Imprisonment	1.58 [1.41, 1.78]	1.38 [1.22, 1.58]	1.48 [1.31, 1.68]	1.49 [1.32, 1.58]	1.29 [1.14, 1.48]
Biological Mother only Imprisonment	1.78 [1.30, 2.45]	1.45 [1.05, 2.00]	1.60 [1.16, 2.21]	1.67 [1.21, 2.30]	1.34 [0.97, 1.86]
Biological Mother & Father Imprisonment	1.73 [1.36, 2.20]	1.41 [1.10, 1.81]	1.55 [1.21, 1.98]	1.62 [1.27, 2.07]	1.29 [1.00, 1.67]

Notes: Results are presented for parental imprisonment (age<18) for (1) any reported biological father imprisonment, (2) any report of biological mother imprisonment and 3) combined reports of biological father and mother imprisonment. Model 1= Parental Imprisonment + respondent age + respondent ethnicity + respondent gender. Model 2= Model 1 + Wave 1 Family Structure + parent educational attainment + census tract family poverty rate. Model 3= Model 1 +respondent BMI + Adolescent School Attachment + childhood physical abuse + difficult child temperament. Model 4=Model 1+ parental discussion of STI risk + number of sex partners prior to age 18. Model 5=all variables used in prior models.