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## Paternal Jail Incarceration and Birth Outcomes: Evidence from New York City, 2010–2016

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### Abstract

**Objectives**—To examine population-level associations between paternal jail incarceration during pregnancy and infant birth outcomes using objective measures of health and incarceration.

**Methods**—We use multivariate logistic regression models and linked records on all births and jail incarcerations in New York City between 2010 and 2016.

**Results**—0.8% of live births were exposed to paternal incarceration during pregnancy or at the time of birth. After accounting for parental sociodemographic characteristics, maternal health behaviors, and maternal health care access, paternal incarceration during pregnancy remains associated with late preterm birth (OR = 1.34, 95% CI = 1.21, 1.48), low birthweight (OR = 1.39, 95% CI = 1.27, 1.53), small size for gestational age (OR = 1.35, 95% CI = 1.17, 1.57), and NICU admission (OR = 1.14, 95% CI = 1.05, 1.24).

**Conclusions**—We found strong positive baseline associations ( $p < 0.001$ ) between paternal jail incarceration during pregnancy with probabilities of all adverse outcomes examined. These

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associations did not appear to be driven purely by duration or frequency of paternal incarceration. These associations were partially explained by parental characteristics, maternal health behavior, and health care. These results indicate the need to consider paternal incarceration as a potential stressor and source of trauma for pregnant women and infants.

### Keywords

Incarceration; Pregnancy; Birth outcomes; Jails; Preterm birth; Low birth weight; Small for gestational age

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### Introduction

Exposure to incarceration is now common for Americans, whether directly through one's own incarceration or indirectly through a family member's incarceration. Nearly 7% of Americans can expect to ever spend time in prison (Bonczar, 2003) upwards of 45% of Americans have had an immediate family member incarcerated in jail or prison (Enns et al., 2019). These rates are even higher for historically marginalized populations—nearly one-third of Black men are likely to ever be imprisoned (Bonczar, 2003), and three-fifths of men who identify as Black have ever had an immediate family member incarcerated in jail or prison (Enns et al., 2019). As incarceration has the potential to negatively impact health, these racial disparities in incarceration and family incarceration exposure indicate that mass incarceration could exacerbate population-level racial health inequities (Wang & Wildeman, 2011; Wildeman & Wang, 2017). Other analyses have shown, for example, that racially unequal risks of imprisonment are associated with racial disparities in adult and infant mortality (Patterson, 2010; Wildeman, 2012) and rates of AIDS infection (Johnson & Raphael, 2009).

Although much research has considered how incarceration affects the health and wellbeing of currently and formerly incarcerated persons (Binswanger et al., 2009; Massoglia, 2008; Schnittker, 2007; Turney et al., 2012), comparatively fewer studies have considered the consequences of incarceration on non-incarcerated family members' health (Lee et al., 2014; Roetger & Boardman, 2012; Wakefield & Wildeman, 2013; Wildeman, 2012). However, the fetal origins hypothesis (Almond & Currie, 2014; Barker, 1995) and stress paradigm, which propose causal pathways between prenatal stressors and shocks during pregnancy to infant and later-life health (Pearlin, et al., 1981), provide evidence of linkages between family member incarceration and the health of non-incarcerated persons to whom they are tied. These perspectives provide two potential pathways for this linkage: first, that jail incarceration, a direct stressor for an incarcerated person, could plausibly expand to cause secondary stress and adverse health consequences for family members, and second, that underlying sociodemographic and economic conditions that put people at higher risk of family members' jail incarceration are the same ones that might independently and negatively affect non-incarcerated persons' health (Pearlin et al., 1981; Testa et al., 2020).

Prior research investigating the relationship between incarceration and non-incarcerated family members' health generally finds evidence of negative long-term health consequences of incarceration for the individual ever incarcerated (Massoglia & Pridemore, 2015) and

the health of their family members (Wildeman & Muller, 2012). However, analyses of the effects of paternal incarceration on child health are currently limited in at least three ways (Wildeman et al., 2018). First, nearly all studies to date on paternal incarceration's health effects rely on self-reported, and therefore, potentially imprecise or biased, measures of health and incarceration. Second, survey attrition of both fathers ever-incarcerated and their children tends to be high. The combination of racial/ethnic patterning in paternal incarceration and survey attrition presents challenges to our understanding of institutional factors shaping the health of children and racial/ethnic disparities therein; Black children are more likely to be affected by both paternal incarceration and survey attrition than white children (Wildeman, 2009). Third, studies have focused exclusively on prisons or have been unable to differentiate between prison and jail incarceration, with little study of the consequences of paternal jail incarceration, although jail incarceration is far more common than imprisonment and tends to be shorter-term, with uniquely uncertain and volatile conditions of confinement that includes pretrial detention for many (Turney and Connor, 2019). All of these distinctions between jail and prison incarceration mean that infant health may be differently associated with parental jail incarceration than parental imprisonment.

In this article, we address these limitations using a dataset that links all births in New York City (NYC) from 2010–2016 with all NYC jail incarcerations during those years to provide the first-ever estimates of the association between paternal jail incarceration and infant birth outcomes in the U.S. using administrative measures of paternal incarceration and child health. In addition to estimating overall associations, we explore variation across racial/ethnic groups and with respect to the frequency, timing, duration, pretrial detention (pre- vs. post-trial) and facility type (i.e., jail only, jail and prison) of paternal incarceration, providing a broad descriptive assessment of how paternal incarceration may be associated with birth outcomes.

## Data and Methods

### Data

We linked administrative data from the New York City (NYC) Department of Correction (DOC) and the New York City Bureau of Vital Statistics (BVS) to create a child-level data set of all children born in NYC from January 1, 2010 through December 31, 2016 ( $N = 855,632$ ). The two sets of records were linked using the following identifiers of parents and persons incarcerated in jail in the BVS and DOC records, respectively: first name, last name, sex, date of birth, the last four digits of their Social Security Number, and residential address. When available, middle and maiden names served as additional linkage criteria. Data analysis was conducted using data that was de-identified after the birth, death, and jail records were linked.

### Analytic Sample

Retaining only the strongest matches, of the 855,632 infants born between 2010 and 2016, 3.8% or 32,634 linked to at least one adult (parental) jail record and 0.9% or 7299 linked to at least one maternal or paternal jail record during pregnancy or at the time of birth. The

analytic sample was restricted using five criteria, omitting births (1) whose full gestational periods were not observed in the data (N = 92,809); (2) that were multiple births (N = 32,541); (3) without named birth fathers on the birth certificate (N = 87,047); (4) missing information for any outcome or covariate measures in the models described below (N = 123,594); or (5) were exposed to maternal incarceration during gestation (N = 1041). The final analytic sample consisted of 627,118 births, or 73% of live births between 2010 and 2016 in NYC. Supplementary analyses indicate that births in the analytic sample were somewhat positively selected relative to all 2010–2016 NYC births and less likely than excluded births to have been exposed to paternal jail incarceration during the pregnancy (Appendix Tables 5 and 6).

### Paternal Incarceration

A newborn was identified as having been exposed to paternal incarceration if the father named on their birth record linked to a NYC jail spell between 2010 and 2016 in the DOC records. A “spell” was a single jail intake; a father linking to more than one incarceration intake would be described as having had multiple jail “spells.” The incarceration spell was temporally situated relative to the birth using the child’s birthdate and father’s jail admission and discharge dates to identify exposure to gestational paternal incarceration.

We also examined variation in paternal incarceration exposure using measures of duration, frequency, timing, pretrial detention, and facility type. We measured frequency of paternal incarceration using a categorical measure of the number of paternal jail spells that overlapped with the gestational period (0, 1, or 2 + spells). Timing was captured using three binary indicators of whether the father was incarcerated in each trimester, with incarceration at the time of birth included in the indicator of third trimester incarceration. This categorical measure of timing allowed us to examine associations of birth outcomes with paternal incarceration in specific trimesters net of incarceration in other trimesters. Longest incarceration and cumulative duration of incarceration were described using categorical measures of the length of fathers’ longest jail spell and total cumulative duration of incarceration in gestation (1 or fewer, 2–7, 8–30, or 31 + days). Pretrial detention was a binary indicator that described whether any of the father’s incarceration spells during the gestational period was pre-trial. Facility type was identified using jail discharge codes (no jail incarceration, jail only, jail and prison).

### Infant Outcomes

Additional information about birth outcomes, infant date of birth, and socioeconomic, demographic, and health characteristics and contexts were obtained from the BVS records. Birth records filed by the infant’s parent(s) were the source of birth and parental identifiers and the infant’s date of birth, while additional information is collected via confidential medical birth reports from health care providers and attached to the birth records by BVS. Each of the eight birth outcomes examined was measured using a binary indicator: late (32–36 weeks), early (28–31 weeks), and extremely early (< 28 weeks) preterm birth; low birthweight (< 2500 g); small for gestational age (SGA, born < 2500 g at 37 weeks or later);<sup>20</sup> admission to a neonatal intensive care unit (NICU); low 5-minute Apgar score (< 7 on a scale of 1–10); and infant death. Analysis of SGA drew only on full-term births.

Infant death was ascertained using mortality-birth record linkage and indicated death from non-congenital causes at less than one year of age. Mortality information for 2016 births was unavailable, so 2016 births were excluded from analyses of infant death.

### Additional Measures

We accounted for an array of additional characteristics and contexts that have been identified in prior research as correlates of parental incarceration and adverse infant health. These measures included key parental sociodemographic characteristics at the time of birth: maternal and paternal age, race/ethnicity, education, and marital status. Race/ethnicity was described using the following mutually exclusive categories: white, Black, Hispanic, and other. Maternal and paternal education were described using categorical measures for each parent: less than a high school degree; high school degree completion, Graduate Educational Development (GED) exam completion, or equivalent; and at least some postsecondary education. Parental marital status was a flag indicating whether the infant's parents were married at the time of birth.

We also included measures of maternal health and health behaviors during pregnancy. These measures were: a continuous measure of maternal body mass index (BMI); indicators of whether the mother used cigarettes or alcohol while pregnant; whether they were diagnosed with pre-gestational hypertension, gestational hypertension, or gestational diabetes; and whether they had any prior live births, and among them, any low birthweight or preterm births. Finally, we included two measures of health care: a categorical indicator of the trimester of the woman's first prenatal care visit (1st trimester, 2nd trimester, 3rd trimester/none) and an indicator of whether Medicaid paid for the delivery. Table 1 presents a statistical description of these measures.

### Analytic Strategy

The analysis proceeded in three stages. First, we identified baseline associations between paternal incarceration during pregnancy and birth outcomes (Model 1). Second, we estimated associations between paternal incarceration during pregnancy and birth outcomes using nested logistic regression models that accounted for paternal characteristics (Model 2), maternal characteristics and health (Model 3), and health care (Model 4). We also re-estimate these models using a restricted sample exclusively comprised of births insured by Medicaid/Family Health Plus to examine whether the estimated associations are also found in a comparison of births likely to be more socioeconomically similar. Finally, in supplementary analyses, we estimated these associations (1) in stratified models to explore potential heterogeneity in these associations across racial/ethnic groups; (2) using measures that detail the frequency, timing, duration, pretrial detention and facility of gestational paternal incarceration; and (3) using an expanded sample that includes births with fathers not named on birth records. Here, we focus on presentation of the main models and summarize the supplementary analyses, reporting the full supplementary results in the Appendix. We report all estimates as adjusted odds ratios produced using the *khb* package in Stata 14.0 to allow comparison of estimates across nonlinear model specifications (Kohler et al., 2011; Stata, 2015).

## Results

A full statistical description of the analytic sample is presented in Tables 1 and 2. In the analytic sample, fathers of 0.8% of births were ever incarcerated in a NYC jail while the child was in utero (N = 5032). Infants exposed to gestational paternal incarceration and infants who were not differed substantially on virtually all characteristics. Notably, infants exposed to paternal jail incarceration were substantially more likely to be born to Black or Hispanic women and men and less likely to have parents with postsecondary education. They were also more likely to have been born to women who used cigarettes while pregnant, had previous low birth weight or preterm births, and initiated prenatal care later in pregnancy. Additionally, while majorities of infants in both groups had their births covered by public insurance, 85% of births exposed to paternal jail incarceration in gestation were covered by public insurance as opposed to 55% of births in the non-exposed group (Table 1).

### Paternal Incarceration

Among those births exposed to paternal incarceration during gestation, fathers of 81% of births experienced one jail incarceration spell and 19% experienced multiple spells (Table 2). Incarceration was more likely to occur within the second or third than the first trimester of gestation; for 5% of births, the father was incarcerated at some point during each of all three trimesters. The length and duration of fathers' jail incarceration varied. One-quarter of births were to fathers incarcerated for a total of one day or less than a day during gestation, while another quarter of births were to fathers incarcerated for a total of longer than one month. 11% of births were exposed to paternal jail spells that ended with fathers' transfer to prison. Additional paternal incarceration details are described in Table 2.

### Infant Birth Outcomes

Table 2 also reports the unadjusted prevalence of the adverse infant birth outcomes examined in this analysis. 7% of births in the sample were preterm (6% late preterm and 1% early preterm), 6% were low birthweight, 2% were SGA, 9% were admitted to a NICU, 1% had a low 5-min Apgar score, and less than 1% of births died in infancy. Births to fathers incarcerated during gestation were more likely to experience all seven of these outcomes, with proportions experiencing some outcomes nearly twice as large in this group as among births without paternal incarceration during pregnancy.

### Associations between Paternal Incarceration and Infant Birth Outcomes

To explore associations between paternal jail incarceration and birth outcomes, we estimated each outcome as a function of a dichotomous indicator of paternal jail incarceration during pregnancy, adding measures of paternal characteristics (Model 2), maternal characteristics and health (Model 3), and health care (Model 4). The baseline models indicated that paternal jail incarceration during gestation was statistically associated with higher odds of all seven outcomes (OR range = 1.58–2.40), with estimated effect sizes of nearly or over twice the odds of low birthweight (OR = 1.92, 95% CI = 1.76, 2.10), a low Apgar score (OR = 1.96, 95% CI = 1.53, 2.53), and infant death (OR = 2.40, 95% CI = 1.59, 3.64).

Adjustments for paternal characteristics (Model 2) and maternal characteristics and health (Model 3) moderated these associations, eliminating statistically distinguishable differences in odds of infant death. Births exposed to paternal incarceration during pregnancy still had higher odds of late preterm and low birthweight birth, SGA, requiring NICU admission, and a low Apgar score. Estimates from the fully adjusted models, which added controls for health insurance source and timing of prenatal care, yielded similar associations as Model 3. Births exposed to paternal incarceration during pregnancy had between 30 and 40% greater odds of being born late preterm (OR 1.34, 95% CI 1.21, 1.48), low birthweight (OR = 1.39, 95% CI = 1.27, 1.53), SGA (OR = 1.35, 95% CI = 1.17, 1.57), and with a low Apgar score (OR = 1.31, 95% CI = 1.02, 1.70); and 14% greater odds of NICU admission (OR = 1.14, 95% CI = 1.05, 1.24).

Limited information about socioeconomic status makes it difficult to discern whether the estimates presented in Table 3 might be explained by unobserved economic disparities that correlate with risks of both adverse birth outcomes and paternal incarceration. We therefore re-estimated these associations for the subsample of births insured by public insurance (i.e. Medicaid/Family Health Plus), which are disproportionately likely to be births to socioeconomically disadvantaged persons and families. As shown in Table 4, these results are nearly identical to the main results discussed above.

We estimated supplementary models to explore heterogeneity across racial/ethnic groups and different types of paternal jail incarceration, and to test whether our estimates were sensitive to our definition of the analytic sample. Stratified models for births to women identifying as white, Black, Hispanic, and of another racial/ethnic group were somewhat limited by prohibitively small cell sizes. However, we found, generally, that paternal jail incarceration in gestation was negatively associated with birth outcomes for infants in all racial/ethnic groups, although with variable magnitude and precision across models, and scant evidence of racial/ethnic differences in these associations (Appendix Table 7). Models disaggregating gestational paternal incarceration by the frequency (number of spells), timing (trimester), duration (longest single spell and cumulative), pretrial detention, and facility type (jail only, jail and prison) of paternal incarceration in gestation showed that these associations were not driven by births with more intensive exposure (Appendix Tables 8, 9, 10).

To further test the robustness of our main findings, we also estimated broader models estimated using an analytic sample that includes the main analytic sample in addition to births missing fathers on the birth record previously excluded from the analysis. As the lack of paternal identifiers for the added group did not allow linkage of birth fathers to jail incarceration records, these models effectively assume that none of these missing fathers were incarcerated in NYC jails during gestation (Appendix Tables 11 and 12). The results of these supplemental models are nearly identical to the results of the main analyses.

## Discussion

This U.S.-based study uses linked administrative records to examine associations between paternal jail incarceration and infant birth outcomes. Using data on all live births and jail

incarcerations in NYC from 2010–2016, the analyses provide support for three conclusions, all of which suggest the need for more intensive research on the consequences of family incarceration for child health. First, this analysis finds strong descriptive associations between paternal incarceration in pregnancy and all seven outcomes. Births exposed to paternal jail incarceration during gestation were associated with 58% to over 200% higher odds of adverse outcomes than unexposed births. Limited other work has examined the relationship between paternal jail incarceration and birth outcomes, but the findings presented here are consistent with prior studies identifying strong associations between parental imprisonment and infant mortality (Wildeman, 2012, pp. 242, 244–245) and preterm birth (Sufrin, et al., 2019). Second, after accounting for differences in parental characteristics, maternal health, and health care, infants of fathers incarcerated during gestation were more likely to be born late preterm, low birthweight, SGA, and require NICU admission.

To place these estimates in context, we can consider the fully-adjusted estimated associations in relation to the baseline prevalence of each of the outcomes studied. The baseline prevalence of the negative infant birth outcomes we analyzed range from less than 1% to 6% (Table 2). The estimated associations that remain statistically distinguishable from zero in the fully adjusted models translate to substantively meaningful increases relative to baseline prevalence: a 2-percentage point increase in the likelihoods of late preterm and low birth weight birth (baseline prevalence of 6%), a 1-percentage point increase in the likelihood of NICU admission (baseline prevalence of 9%), and increase of a less-than-1-percentage point increase in the likelihoods of SGA birth and a low Apgar score (baseline prevalence of 2% and 1%, respectively). We can also compare these estimates to estimated associations between infant birth outcomes and maternal smoking in pregnancy, a well-known risk factor for poor perinatal health that is more direct and usually of longer exposure than paternal jail incarceration (Abraham et al., 2017; Kleinman et al., 1988; Nieburg et al. 1985; Sexton & Hebel, 1984). The estimated associations for paternal incarceration are 64% to 92% the magnitude of estimated associations for maternal smoking (OR range = 1.43–2.07), suggesting that paternal incarceration is a strong, though more modest, risk factor for adverse infant health. Further, supplementary analyses that disaggregate paternal jail incarceration do not provide evidence that these associations are driven by births to fathers experiencing particularly long or frequent paternal incarceration during gestation. This may be due to nonlinear relationships between paternal incarceration during pregnancy and birth outcomes, perhaps due to the negative consequences associated with even lower-level exposure to family incarceration (Turney & Conner, 2019, pp. 280–281; Cho, 2009; Wildeman et al., 2016).

Administrative data provide unique opportunities for examining associations between parental incarceration and infant outcomes, but they are nonetheless limited. Two important limitations stem from the fact that these data exclusively capture incarceration in NYC jails. First, we are unable to account for parental incarceration in prisons. Second, we are unable to capture jail or prison incarceration that occurs outside NYC. Both of these limitations mean that some infants currently included in our comparison group (with fathers who were not incarcerated in NYC jails during the pregnancy) may, in fact, have been incarcerated in jails in another municipality or in prisons. Our inability to differential likelihoods of



adverse birth outcomes of infants in the two comparison groups may be underestimated in our analysis.

Additional limitations relate to generalizability to the NYC population. Estimates of baseline prevalence of some outcomes examined in these analyses are slightly lower than prevalence estimates in published tabulations of NYC births in 2016 (e.g., 8.9% preterm births vs. 7%) (NYC DOHMH, 2018). This discrepancy is likely driven by the analysis' necessary restriction to singleton births and birth records with paternal information. These constraints yield an analytic sample that appears advantaged socioeconomically and on birth outcomes relative to all NYC births (see Appendix Tables 5 and 6). This suggests that our estimated associations between gestational paternal incarceration and infant birth outcomes may be somewhat conservative, as they omit some of the most disadvantaged infants born in NYC between 2010 and 2016. Additionally, aspects of our study were constrained by limited cell sizes: we were unable to account for spatial variation as geographic covariates rendered the main adjusted models inestimable. Also, in the race-stratified models, large confidence intervals and some prohibitively small cell sizes suggest race-specific results are somewhat underpowered and should be interpreted cautiously.

The analysis is also limited by data collection practices affecting birth and medical records. As in other research on marginalized populations and behaviors, available measures of health behaviors that can impact birth outcomes are likely impacted by underreporting (Groves et al., 2009; Waller & Swisher, 2006) and inconsistent measurement; evidence suggests maternal drug tests are unequally administered across racial and marital groups (Kerker et al., 2004; Kunins et al., 2007). The data also do not include measures of fathers' health behaviors potentially associated with birth outcomes. Further, although the direct linkage of births to incarcerated fathers is a major strength of this study, 10% of 2010–2016 birth records are missing fathers entirely. This missing information about fathers means that an acknowledgment of paternity (AOP) was not filed by then-unmarried parents (although streamlining of AOP procedures has improved filing rates over recent years). Additionally, NY state law defaults a legal husband as the father of record even if they are not the birth father, meaning additional biological paternal information may be missing.

Finally, maternal health and health behaviors appear to explain some of the baseline differences in birth outcomes across births exposed and not exposed to paternal incarceration in gestation. However, the inability to observe the timing of births relative to measurement of maternal health and health behaviors makes it unclear whether they mediate these associations. More broadly, although we attempt to account for factors plausibly linked to both paternal incarceration during pregnancy and birth outcomes, such as maternal health, parental education, and prenatal care, these estimates do not speak to causal processes—including processes shaped by structural racism.

### **Public Health Implications**

This study makes an important contribution to our understanding of the relationship between family incarceration and health. Using novel data that provide uniquely detailed and reliable measures of demographic and health characteristics related to birth outcomes and risks of criminal justice system involvement, this study shows that families touched

by the correctional system during pregnancy are more likely to have adverse infant health outcomes, with potential implications for adult wellbeing and the intergenerational transmission of health (Eriksson, 2016). Although this study is not able to speak to plausibly causal effects of paternal incarceration on infant birth outcomes, these findings importantly corroborate existing evidence of associations between parental incarceration and child health at other stages of early life using uniquely detailed information about the timing and nature of this adverse life event.

The magnitudes of these estimated associations are substantial, suggesting that paternal incarceration during gestation is a salient risk factor for adverse infant outcomes and should be considered more broadly by medical professionals as a form of trauma and stress that can affect health in early life and pregnancy. Alongside insights from other work on the consequences of incarceration for families (e.g., Arditti et al., 2003; Bales & Mears, 2008), our findings support calls for expanded visitation and access to phone and internet communication for persons who are incarcerated, which may mitigate some of the stress and strain that jail incarceration may impose on co-parents navigating pregnancy and the birth of a child (Dumont et al., 2014; Thoits, 2010). Further, our results provide support for decarceration as a health intervention, as pre-trial detention and even low levels of exposure to jail incarceration were strongly associated with adverse infant birth outcomes (Appendix 8, 9, 10). Combined with evidence of the unequal distribution of paternal incarceration (Wakefield & Wildeman, 2013; Wildeman, 2009), these findings highlight incarceration as part of the broader U.S. landscape of racial health inequality for the children and partners, whether former or current, of incarcerated persons. Although prior work provides extensive evidence on the negative health impact of imprisonment and incarceration overall (Massoglia & Pridemore, 2015, p.293; Turney & Conner, 2019, pp. 272–273, 280–281), this study’s focus on jail incarceration suggests that concerns about negative public health consequences should also extend to lower levels of criminal justice involvement.

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## Appendix

See Tables 5, 6, 7, 8, 9, 10, 11, 12, 13.

**Table 5**

Comparison of characteristics of births included and excluded from analysis

	Overall	Included	Excluded	$\rho$
Paternal age at birth (years)	33.07 (7.32)	33.05 (7.27)	33.17 (7.59)	0.000
Paternal race/ethnicity (%)				
Black	0.16	0.77	0.64	0.000
Hispanic	0.24	0.59	0.72	0.000
Other	0.27	0.27	0.64	0.000
White	0.32	0.01	0.80	0.000
Paternal education (%)				
< High school degree	0.18	0.18	0.18	0.603
High school degree/GED	0.21	0.21	0.20	0.000
Postsecondary education	0.49	0.49	0.46	0.000
Parental marital status (% married)	0.60	0.60	0.57	0.000
Maternal age at birth (years)	29.81 (6.11)	29.82 (6.04)	29.76 (6.43)	0.000
Maternal race/ethnicity (%)				
Black	0.20	0.20	0.25	0.000
Hispanic	0.30	0.30	0.32	0.000
Other	0.18	0.18	0.17	0.000
White	0.32	0.07	0.33	0.000
Maternal education (%)				
< High school degree	0.20	0.20	0.23	0.000
High school degree/GED	0.22	0.22	0.22	0.046
Postsecondary education	0.58	0.58	0.56	0.000
Maternal body mass index	25.04 (5.65)	25.01 (5.62)	25.21 (5.81)	0.000
Maternal health behaviors in pregnancy (%)				
Smoked cigarettes	0.01	0.01	0.01	0.000
Alcohol use	0.01	0.01	0.01	0.000
Trimester of prenatal care initiation (%)				
1st trimester	0.73	0.73	0.71	0.000
2nd trimester	0.20	0.20	0.22	0.000
3rd trimester or none	0.07	0.07	0.07	0.000
Health insurance coverage (% Medicaid)	0.58	0.58	0.57	0.000
Maternal health conditions (%)				
Pre-gestational hypertension	0.01	0.01	0.02	0.000
Gestational hypertension	0.04	0.04	0.04	0.694
Gestational diabetes	0.06	0.06	0.05	0.000
Mother's prior birth outcomes (%)				
Live births	0.56	0.55	0.60	0.000

	Overall	Included	Excluded	$\rho$
Low birth weight	0.09	0.09	0.07	0.000
Preterm	0.08	0.09	0.08	0.000
<i>N</i>	855,632	713,529	142,103	

Estimates are reported as proportions or means with standard deviations in parentheses and units in the row headers. Reported p-values accompany estimated differences between infants with and without paternal incarceration during the gestational period or at birth

**Table 6**

Comparison of paternal incarceration exposure in pregnancy and birth outcomes of births included and excluded from analysis

	Overall	Included	Excluded	$\rho$
<i>Infant birth outcomes</i>				
Preterm birth				
Late (32–36 weeks)	0.08	0.06	0.16	0.000
Early (28–31 weeks)	0.01	0.01	0.02	0.000
Extremely early (< 28 weeks)	0.01	0.00	0.02	0.000
Low birth weight (< 2500 g)	0.08	0.06	0.19	0.000
Small for gestational age <sup>c</sup> (born 37 weeks or later, < 2500 g)	0.03	0.03	0.06	0.000
NICU admission	0.10	0.09	0.16	0.000
Low 5-min Apgar score (< 7, range 1–10)	0.01	0.01	0.01	0.000
Infant death (< 1 year old, non-congenital) <sup>d</sup>	0.00	0.00	0.01	0.000
Paternal incarceration in pregnancy or at birth	0.01	0.01	0.00	0.000
<i>Paternal incarceration details<sup>a</sup></i>				
Number of spells	1.24 (0.57)	1.24 (0.56)	1.28 (0.63)	0.146
1 spell	0.81	0.81	0.79	0.266
2 + spells	0.19	0.19	0.21	0.266
Timing of jail incarceration relative to birth <sup>b</sup>				
Trimester 1	0.37	0.37	0.38	0.693
Trimester 2	0.47	0.47	0.49	0.505
Trimester 3	0.50	0.50	0.53	0.219
Entire pregnancy	0.06	0.06	0.07	0.118
At birth	0.03	0.03	0.02	0.094
Longest single jail incarceration spell (days)	25.24 (44.27)	25.07 (44.05)	27.12 (46.62)	0.320
1 Day or less	0.24	0.25	0.20	0.018
2–7 Days	0.32	0.32	0.36	0.066
8–30 Days	0.21	0.20	0.22	0.572
31 + Days	0.23	0.23	0.23	0.852
Cumulative duration (days)	29.90 (51.94)	29.47 (51.04)	34.48 (60.66)	0.038
1 Day or less	0.24	0.24	0.19	0.007

	Overall	Included	Excluded	$\rho$
2–7 Days	0.29	0.29	0.33	0.066
8–30 Days	0.21	0.21	0.21	0.950
31 + Days	0.26	0.26	0.27	0.532
Pretrial detention	0.40	0.40	0.39	0.677
Facility type (discharge to prison)				
N (All)	855,632	713,529	142,103	
<i>N (births w/gestational paternalincarceration)</i>	5912	5408	504	

Estimates are reported as proportions or means with standard deviations in parentheses and units noted in the row headers. Reported p-values accompany estimated differences between infants with and without paternal incarceration during the gestational period or at birth

<sup>a</sup>Estimates of paternal incarceration details other than overall proportion restricted to births with paternal incarceration during gestation (N = 5901)

<sup>b</sup>Categories of timing of paternal jail incarceration relative to the birth are not mutually exclusive

<sup>c</sup>Analysis restricted to full term births (37 weeks or later) (N = 694,225)

<sup>d</sup>Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 650,342)

**Table 7**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, by race/ethnicity

	White	Black	Hispanic	Other
Infant birth outcomes				
Preterm birth				
Late (32–36 weeks)	1.32*	1.37***	1.23*	1.16
	[1.08, 2.64]	[1.20, 1.57]	[1.04, 1.45]	[0.60, 2.23]
Early (28–31 weeks)	0.81	1.19	0.84	2.46
	[0.11, 5.88]	[0.85, 1.67]	[0.49, 1.44]	[0.59, 10.20]
Extremely early (< 28 weeks)	1.98	0.96	1.99**	2.24
	[0.48, 8.17]	[0.64, 1.45]	[1.31, 3.05]	[0.30, 16.47]
Low birth weight	1.98***	1.24**	1.37***	1.98**
	[1.35, 2.90]	[1.10, 1.41]	[1.18, 1.60]	[1.19, 3.29]
Small for gestational age <sup>a</sup>	2.41**	1.17	1.26	2.16*
	[1.41, 4.11]	[0.95, 1.45]	[0.98, 1.63]	[1.05, 4.48]
NICU admission	1.88***	1.10	1.04	1.71*
	[1.36, 2.60]	[0.98, 1.23]	[0.90, 1.20]	[1.08, 2.71]
Low 5-minute Apgar score (< 7)	2.16	1.13	1.64*	na
	[0.79, 5.89]	[0.79, 1.59]	[1.08, 2.47]	
Infant death <sup>b</sup>	4.18	1.03	1.62	na
	[0.99, 17.70]	[0.56, 1.89]	[0.85, 3.06]	
Father characteristics	X	X	X	X
Maternal characteristics and health	X	X	X	X
Health care access	X	X	X	X
<i>N</i>	222,566	103,943	179,421	121,188

“na” indicates that an estimate is not available because paternal incarceration was perfectly correlated with that outcome. Results are reported as odds ratio estimates of the direct effect of paternal incarceration from the full model (Model 4), which includes covariates of paternal age at birth, race/ethnicity, and education; maternal age at birth, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; and trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid. Models also include an interaction term between race/ethnicity and the focal indicator of gestational paternal incarceration. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group of those with no paternal incarceration in the gestational period or at birth. 95% confidence intervals are reported in brackets

<sup>a</sup>Analysis restricted to full term births (37 weeks or later)

<sup>b</sup>Estimate restricted to births in 2010–2015 because infant death data were not yet available for births in 2016

**Table 8**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, by frequency and timing of incarceration

	Number of jail spells (Reference: None)		Timing of incarceration relative to birth (Reference: No incarceration in specified trimester)		
	1 spell	2 + spells	Trimester 1	Trimester 2	Trimester 3
Infant birth outcomes					
Preterm birth					
Late (32–36 weeks)	1.38***	1.18	1.04	1.21*	1.22*
	[1.24, 1.54]	[0.92, 1.49]	[0.87, 1.25]	[1.02, 1.42]	[1.05, 1.43]
Early (28–31 weeks)	1.20	0.89	1.20	0.59	1.50*
	[0.89, 1.62]	[0.44, 1.79]	[0.74, 1.94]	[0.34, 1.01]	[1.02, 2.21]
Extremely early (< 28 weeks)	1.25	1.67	1.09	1.41	0.97
	[0.90, 1.73]	[0.94, 2.97]	[0.65, 1.82]	[0.90, 2.21]	[0.61, 1.55]
Low birth weight	1.42***	1.29*	1.08	1.11	1.32***
	[1.28, 1.57]	[1.04, 1.59]	[0.91, 1.28]	[0.95, 1.30]	[1.15, 1.52]
Small for gestational age <sup>a</sup>	1.36***	1.32	1.01	1.03	1.44**
	[1.15, 1.61]	[0.94, 1.85]	[0.76, 1.33]	[0.80, 1.33]	[1.15, 1.80]
NICU admission	1.14**	1.16	1.10	1.11	1.00
	[1.03, 1.25]	[0.96, 1.40]	[0.95, 1.27]	[0.97, 1.27]	[0.88, 1.15]
Low 5-minute Apgar score (< 7)	1.39*	0.98	0.88	1.64*	0.82
	[1.06, 1.84]	[0.51, 1.90]	[0.53, 1.45]	[1.11, 2.43]	[0.53, 1.28]
Infant death <sup>b</sup>	1.36	1.22	0.92	1.53	1.00
	[0.86, 2.15]	[0.46, 3.28]	[0.41, 2.06]	[0.80, 2.92]	[0.51, 1.98]
Father characteristics	X	X	X	X	X
Maternal characteristics and health	X	X	X	X	X
Health care access	X	X	X	X	X

N = 627,118. Results are reported as odds ratio estimates from the full model (Model 4), which includes covariates of paternal age at birth, race/ethnicity, and education; maternal age at birth, race/ethnicity, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; and trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group. 95% confidence intervals are reported in brackets

<sup>a</sup>Analysis restricted to full term births (37 weeks or later) (N = 585,865)

<sup>b</sup> Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 526,060)

**Table 9**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, by longest spell and pre/post-trial incarceration

	Duration of longest single jail incarceration spell (Reference: None)				Pretrial detention (Reference: None)	
	1 day or less	1 day to 1 week	1 week to 1 month	> 1 month	Pretrial	Post-trial
Infant birth outcomes						
Preterm birth						
Late (32–36 weeks)	1.41** [1.16, 1.72]	1.29** [1.09, 1.54]	1.40** [1.13, 1.73]	1.29* [1.04, 1.60]	1.33** [1.13, 1.56]	1.22*** [1.19, 1.26]
Early (28–31 weeks)	1.10 [0.62, 1.95]	1.34 [0.86, 2.07]	1.01 [0.54, 1.90]	1.00 [0.54, 1.87]	1.54* [1.05, 2.24]	0.88 [0.59, 1.31]
Extremely early (< 28 weeks)	1.14 [0.61, 2.13]	1.50 [0.95, 2.38]	1.41 [0.77, 2.57]	1.22 [0.65, 2.28]	1.61* [1.07, 2.43]	1.15 [0.78, 1.70]
Low birth weight	1.49*** [1.24, 1.78]	1.39*** [1.19, 1.63]	1.41** [1.15, 1.72]	1.28* [1.04, 1.56]	1.58*** [1.37, 1.82]	1.27*** [1.13, 1.44]
Small for gestational age <sup>a</sup>	1.37* [1.02, 1.85]	1.47** [1.14, 1.88]	1.33 [0.95, 1.86]	1.20 [0.86, 1.68]	1.55*** [1.24, 1.93]	1.23* [1.01, 1.50]
NICU admission	1.04 [0.87, 1.24]	1.11 [0.96, 1.29]	1.40*** [1.18, 1.66]	1.07 [0.89, 1.28]	1.23** [1.08, 1.40]	1.08 [0.97, 1.21]
Low 5-minute Apgar score (< 7)	1.16 [0.67, 2.01]	1.51* [1.01, 2.28]	1.03 [0.55, 1.93]	1.45 [0.87, 2.43]	1.62* [1.12, 2.33]	1.12 [0.79, 1.59]
Infant death <sup>b</sup>	1.75 [0.83, 3.71]	1.19 [0.56, 2.53]	1.08 [0.40, 2.91]	1.07 [0.40, 2.88]	1.86* [1.07, 3.25]	0.97 [0.52, 1.82]
Father characteristics	X	X	X	X	X	X
Maternal characteristics and health	X	X	X	X	X	X
Health care access	X	X	X	X	X	X

N = 627,118. Results are reported as odds ratio estimates from the full model (Model 4), which includes covariates of paternal age at birth, race/ethnicity, and education; maternal age at birth, race/ethnicity, education, body mass index, marital status at birth, indicators of prior low birth weight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; and trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group. 95% confidence intervals are reported in brackets

<sup>a</sup> Analysis restricted to full term births (37 weeks or later) (N = 585,865)

<sup>b</sup> Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 526,060)

**Table 10**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, by cumulative duration and facility of incarceration

	Cumulative duration of jail incarceration (Reference: None)				Incarceration facility (Reference: None)	
	1 day or less	1 day to 1 week	1 week to 1 month	> 1 month	Jail only	Jail and prison
Infant birth outcomes						
Preterm birth						
Late (32–36 weeks)	1.39**	1.31**	1.41**	1.28*	1.34***	1.35*
	[1.14, 1.70]	[1.09, 1.57]	[1.14, 1.75]	[1.04, 1.56]	[1.21, 1.49]	[1.01, 1.80]
Early (28–31 weeks)	1.11	1.35	0.99	1.04	1.22	0.55
	[0.63, 1.97]	[0.85, 2.13]	[0.52, 1.85]	[0.59, 1.85]	[0.92, 1.62]	[0.18, 1.71]
Extremely early (< 28 weeks)	1.15	1.41	1.75*	1.06	1.33	1.38
	[0.62, 2.16]	[0.85, 2.31]	[1.02, 2.98]	[0.57, 1.98]	[0.98, 1.80]	[0.61, 3.10]
Low birth weight	1.47***	1.40***	1.43***	1.27*	1.41***	1.29
	[1.23, 1.77]	[1.19, 1.66]	[1.17, 1.74]	[1.05, 1.53]	[1.28, 1.55]	[0.98, 1.70]
Small for gestational age <sup>a</sup>	1.33	1.53**	1.26	1.24	1.40***	1.01
	[0.97, 1.80]	[1.19, 1.98]	[0.90, 1.77]	[0.92, 1.69]	[1.20, 1.64]	[0.61, 1.67]
NICU admission	1.03	1.10	1.34**	1.13	1.13**	1.21
	[0.86, 1.22]	[0.95, 1.29]	[1.13, 1.60]	[0.96, 1.34]	[1.04, 1.24]	[0.95, 1.55]
Low 5-minute Apgar score (< 7)	1.09	1.61*	1.21	1.26	1.30	1.47
	[0.61, 1.93]	[1.06, 2.44]	[0.68, 2.14]	[0.76, 2.11]	[0.99, 1.71]	[0.73, 2.96]
Infant death <sup>b</sup>	2.05*	1.13	1.33	0.93	1.17	2.05
	[1.01, 4.13]	[0.50, 2.54]	[0.55, 3.23]	[0.34, 2.48]	[0.73, 1.89]	[0.76, 5.51]
Father characteristics	X	X	X	X	X	X
Maternal characteristics and health	X	X	X	X	X	X
Health care access	X	X	X	X	X	X

N = 627,118. Results are reported as odds ratio estimates from the full model (Model 4), which includes covariates of paternal age at birth, race/ethnicity, and education; maternal age at birth, race/ethnicity, education, body mass index, marital status at birth, indicators of prior low birth weight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; and trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group. 95% confidence intervals are reported in brackets

<sup>a</sup>Analysis restricted to full term births (37 weeks or later) (N = 585,865)

<sup>b</sup>Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 526,060)



**Table 11**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, including births missing paternal birth record information

	Model 1	Model 2	Model 3	Model 4
Infant birth outcomes				
Preterm birth				
Late (32–36 weeks)	1.63*** [1.48, 1.79]	1.31*** [1.19, 1.45]	1.30*** [1.18, 1.44]	1.31*** [1.18, 1.44]
Early (28–31 weeks)	1.74*** [1.34, 2.28]	1.12 [0.86, 1.47]	1.09 [0.83, 1.43]	1.09 [0.83, 1.44]
Extremely early (< 28 weeks)	2.34*** [1.77, 3.09]	1.32 [0.99, 1.74]	1.27 [0.96, 1.68]	1.27 [0.96, 1.69]
Low birth weight	1.79*** [1.64, 1.95]	1.38*** [1.27, 1.51]	1.35*** [1.23, 1.47]	1.34*** [1.23, 1.47]
Small for gestational age <sup>a</sup>	1.64*** [1.42, 1.89]	1.35*** [1.17, 1.56]	1.32*** [1.14, 1.52]	1.31*** [1.13, 1.52]
NICU admission	1.50*** [1.39, 1.63]	1.17*** [1.08, 1.27]	1.13** [1.05, 1.23]	1.14** [1.05, 1.23]
Low 5-minute Apgar score (< 7)	1.75*** [1.36, 2.24]	1.28 [1.00, 1.65]	1.27 [0.99, 1.63]	1.27 [0.99, 1.63]
Infant death <sup>b</sup>	1.88** [1.24, 2.84]	1.36 [0.90, 2.07]	1.29 [0.85, 1.97]	1.30 [0.85, 1.98]
Flag for father missing on record	X	X	X	X
Father characteristics		X	X	X
Maternal characteristics and health			X	X
Health care access				X

N = 713,529. Results are reported as odds ratios. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group of those with no paternal incarceration in the gestational period or at birth. 95% confidence intervals are reported in brackets

<sup>a</sup> Analysis restricted to full term births (37 weeks or later) (N = 664,044)

<sup>b</sup> Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 604,048). Model 1 is an unadjusted/bivariate model. Models 2–4 incrementally add covariates for the following sets of measures: (2) paternal age at birth, race/ethnicity, and education; (3) maternal age at birth, maternal race/ethnicity, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; (4) trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid

**Table 12**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, restricted to births insured by Medicaid/family health plus, by race/ethnicity (Stratified Models)

	White	Black	Hispanic	Other
Infant birth outcomes				
Preterm birth				

	White	Black	Hispanic	Other
Late (32–36 weeks)	1.55 [0.97, 2.49]	1.32*** [1.14, 1.54]	1.25* [1.04, 1.49]	0.91 [0.39, 2.09]
Early (28–31 weeks)	1.18 [0.16, 8.68]	1.20 [0.82, 1.74]	0.83 [0.47, 1.48]	1.85 [0.25, 13.72]
Extremely early (< 28 weeks)	na	0.94 [0.59, 1.49]	1.84* [1.14, 2.97]	2.88 [0.38, 21.95]
Low birth weight	2.31*** [1.55, 3.46]	1.20* [1.04, 1.38]	1.38*** [1.17, 1.63]	1.92* [1.08, 3.43]
Small for gestational age <sup>+</sup>	2.89*** [1.67, 5.01]	1.13 [0.90, 1.42]	1.26 [0.96, 1.64]	2.10 [0.95, 4.61]
NICU admission	2.00*** [1.40, 2.88]	1.08 [0.95, 1.22]	0.99 [0.84, 1.15]	1.55 [0.91, 2.65]
Low 5-minute Apgar score (< 7)	1.84 [0.57, 5.95]	1.16 [0.80, 1.70]	1.49 [0.94, 2.37]	na
Infant death <sup>++</sup>	na	0.76 [0.36, 1.63]	1.22 [0.57, 2.61]	na
Father characteristics	X	X	X	X
Maternal characteristics and health	X	X	X	X
Health care access	X	X	X	X
<i>N</i>	76,054	66,525	134,799	69,856

“na” indicates that an estimate is not available because paternal incarceration was perfectly correlated with that outcome. Results are reported as odds ratio estimates of the direct effect of paternal incarceration from the full model (Model 4), which includes covariates of paternal age at birth, race/ethnicity, and education; maternal age at birth, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; and trimester of first prenatal care visit. Models also include a flag indicating whether birth father was missing from the birth record. Asterisks denote statistically significant differences at the \*\*\**p* < 0.001 \*\**p* < 0.01 \**p* < 0.05 levels from the reference group of those with no paternal incarceration in the gestational period or at birth. 95% confidence intervals are reported in brackets

<sup>a</sup>Analysis restricted to full term births (37 weeks or later)

<sup>b</sup>Estimate restricted to births in 2010–2015 because infant death data were not yet available for births in 2016

**Table 13**

Estimated associations between paternal incarceration during pregnancy and birth outcomes, including births missing paternal information, by race/ethnicity (Stratified Models)

	White	Black	Hispanic	Other
Infant birth outcomes				
Preterm birth				
Late (32–36 weeks)	1.31 [0.84, 2.04]	1.34*** [1.17, 1.53]	1.22* [1.04, 1.43]	1.30 [0.71, 2.37]
Early (28–31 weeks)	0.74 [0.10, 5.33]	1.18 [0.85, 1.64]	0.80 [0.47, 1.36]	2.23 [0.54, 9.22]
Extremely early (< 28 weeks)	1.93 [0.47, 7.95]	0.93 [0.62, 1.39]	1.91** [1.25, 2.92]	na
Low birth weight	1.93**	1.22**	1.36***	1.90*

	White	Black	Hispanic	Other
	[1.33, 2.81]	[1.08, 1.38]	[1.17, 1.58]	[1.16, 3.12]
Small for gestational age <sup>a</sup>	2.30**	1.15	1.26	2.23*
	[1.35, 3.91]	[0.94, 1.41]	[0.99, 1.61]	[1.12, 4.44]
NICU admission	1.80***	1.09	1.05	1.70*
	[1.31, 2.48]	[0.98, 1.22]	[0.92, 1.21]	[1.09, 2.66]
Low 5-minute Apgar score (< 7)	2.11	1.08	1.63*	na
	[0.77, 5.75]	[0.77, 1.52]	[1.09, 2.44]	
Infant death <sup>b</sup>	na	0.98	1.60	na
		[0.53, 1.80]	[0.85, 3.04]	
Flag for father missing on record	X	X	X	X
Father characteristics		X	X	X
Maternal characteristics and health			X	X
Health care access				X
<i>N</i>	225,328	140,686	212,560	128,865

“na” indicates that an estimate is not available because paternal incarceration was perfectly correlated with that outcome. Results are reported as odds ratio estimates of the direct effect of paternal incarceration from the full model (Model 4), which includes covariates of paternal age at birth, race/ethnicity, and education; maternal age at birth, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; and trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid. Models also include a flag indicating whether the birth father was missing from the birth record. Asterisks denote statistically significant differences at the \*\*\* $p < 0.001$  \*\* $p < 0.01$  \* $p < 0.05$  levels from the reference group of those with no paternal incarceration in the gestational period or at birth. 95% confidence intervals are reported in brackets

<sup>a</sup>Analysis restricted to full term births (37 weeks or later)

<sup>b</sup>Estimate restricted to births in 2010–2015 because infant death data were not yet available for births in 2016

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**Significance Statement**

Paternal incarceration is now common in the United States, with likely consequences for the wellbeing of families of persons ever incarcerated. However, most research on the health effects of paternal incarceration focuses on imprisonment and relies largely on self-reported measures of health and incarceration. This study uses linked administrative jail, birth, and death records from 2010–2016 in New York City to analyze objective measures of health and jail incarceration. The analysis finds strong baseline associations between paternal incarceration in pregnancy and infant health, with robust adjusted associations for odds of late preterm birth, low birthweight, SGA, and NICU admission.

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**Table 1**

Birth characteristics of analytic sample

	Gestational paternal incarceration			
	Overall	No	Yes	P
Paternal age at birth (Years)	33.06 (7.24)	33.10 (7.22)	28.13 (7.29)	0.000
Paternal race/Ethnicity (%)				
White	0.36	0.36	0.04	0.000
Black	0.18	0.18	0.56	0.000
Hispanic	0.28	0.28	0.37	0.000
Other	0.18	0.18	0.03	0.000
Paternal education (%)				
< High school degree	0.21	0.21	0.41	0.000
High school degree/GED	0.24	0.23	0.43	0.000
Postsecondary education	0.56	0.56	0.17	0.000
Parental marital status (Married) (%)	0.68	0.68	0.16	0.000
Maternal age at birth (Years)	30.11 (5.89)	30.14 (5.88)	25.48 (5.94)	0.000
Maternal race/Ethnicity (%)				
White	0.35	0.36	0.06	0.000
Black	0.17	0.16	0.49	0.000
Hispanic	0.29	0.29	0.42	0.000
Other	0.19	0.19	0.03	0.000
Maternal Education (%)				
< High school degree	0.18	0.18	0.36	0.000
High school degree/GED	0.21	0.21	0.30	0.000
Postsecondary education	0.61	0.61	0.34	0.000
Maternal body mass index	24.81 (5.47)	24.80 (5.46)	26.70 (6.45)	0.000
Maternal health behaviors in pregnancy (%)				
Smoked cigarettes	0.01	0.01	0.04	0.000

	Gestational paternal incarceration			P
	Overall	No	Yes	
Alcohol use	0.01	0.01	0.01	0.851
Trimester of prenatal care initiation (%)				
1st trimester	0.75	0.75	0.62	0.000
2nd trimester	0.19	0.19	0.29	0.000
3rd trimester or none	0.06	0.06	0.09	0.000
Health insurance coverage (Medicaid) (%)	0.55	0.55	0.84	0.000
Maternal health (%)				
Pre-gestational hypertension	0.01	0.01	0.02	0.000
Gestational hypertension	0.04	0.04	0.05	0.000
Gestational diabetes	0.06	0.06	0.03	0.000
Mother's prior birth outcomes (%)				
Live birth	0.55	0.55	0.55	0.187
Low birthweight	0.09	0.09	0.10	0.002
Preterm	0.09	0.09	0.10	0.000
N	627,118	622,086	5032	

Estimates are reported as proportions or means with standard deviations in parentheses and units noted in the row headers. Reported p-values accompany estimated differences between infants with and without paternal incarceration during the gestational period or at birth



**Table 2**  
Summary of paternal incarceration exposure among births in analytic sample

	Gestational paternal incarceration			P
	Overall	No	Yes	
Infant birth outcomes (%)				
Preterm birth				
Late (.32–.36 weeks)	0.06	0.06	0.09	0.000
Early (.28–.31 weeks)	0.01	0.01	0.01	0.000
Extremely early (< 28 weeks)	0.00	0.00	0.01	0.000
Low birthweight (< 2500 g)	0.06	0.06	0.11	0.000
Small for gestational age <sup>c</sup> (born 37 weeks or later, < 2500 g)	0.02	0.02	0.04	0.000
NICU admission	0.09	0.09	0.13	0.000
Low 5-min Apgar score (< 7, range 1–10)	0.01	0.01	0.01	0.000
Infant death (< 1 year old, non-congenital) <sup>d</sup>	0.00	0.00	0.01	0.000
Paternal incarceration in gestation (%)	0.01	0.00	1.00	–
Paternal incarceration details <sup>a</sup>				
Number of spells (#, %)	–	–	1.24 (0.56)	–
1 Spell	–	–	0.81	–
2 + Spells	–	–	0.19	–
Timing of jail incarceration <sup>b</sup> (%)				
Trimester 1	–	–	0.37	–
Trimester 2	–	–	0.47	–
Trimester 3	–	–	0.49	–
Entire pregnancy	–	–	0.05	–
At birth	–	–	0.03	–
Longest single jail spell (Days, %)	–	–	23.90 (42.61)	–
1 Day or less	–	–	0.25	–
2–7 Days	–	–	0.33	–
8–30 Days	–	–	0.20	–
31 + Days	–	–	0.22	–

	Gestational paternal incarceration		p	
	Overall	No		Yes
Cumulative duration (Days, %)	-	-	28.15 (49.47)	-
1 Day or less	-	-	0.25	-
2-7 Days	-	-	0.30	-
8-30 Days	-	-	0.21	-
31 + Days	-	-	0.25	-
Pretrial detention (%)	-	-	0.40	-
Facility type (%)				
Jail only	-	-	0.89	-
Jail and prison	-	-	0.11	-
<i>N</i>	627,118	622,086	5032	

Estimates are reported as proportions or means with standard deviations in parentheses and units noted in the row headers. Reported p-values accompany estimated differences between infants with and without paternal incarceration during the gestational period or at birth

<sup>a</sup>Estimates of paternal incarceration details other than overall proportion restricted to births with paternal incarceration during gestation (N = 5901)

<sup>b</sup>Categories of timing of paternal jail incarceration relative to the birth are not mutually exclusive

<sup>c</sup>Analysis restricted to full term births (37 weeks or later) (N = 585,865)

<sup>d</sup>Analysis restricted to births in 2010-2015 because infant death data were not yet available for births in 2016 (N = 526,060)

**Table 3**  
Estimated associations between paternal incarceration during pregnancy and infant birth outcomes

	Model 1	Model 2	Model 3	Model 4
<b>Infant birth outcomes</b>				
<b>Preterm birth</b>				
Late (32–36 weeks)	1.65*** [1.50, 1.82]	1.36*** [1.24, 1.49]	1.34*** [1.21, 1.48]	1.34*** [1.21, 1.48]
Early (28–31 weeks)	1.82*** [1.38, 2.39]	1.36*** [1.38, 2.39]	1.13 [0.86, 1.50]	1.14 [0.86, 1.50]
Extremely early (< 28 weeks)	2.46*** [1.86, 3.26]	1.19 [0.90, 1.57]	1.32 [0.99, 1.76]	1.33 [1.00, 1.77]
<b>Low birth weight</b>				
	1.92*** [1.76, 2.10]	1.44*** [1.32, 1.58]	1.39*** [1.27, 1.53]	1.39*** [1.27, 1.53]
<b>Small for Gest. Age<sup>a</sup></b>				
	1.72*** [1.49, 1.99]	1.39*** [1.21, 1.62]	1.36*** [1.17, 1.58]	1.35*** [1.17, 1.57]
<b>NICU admission</b>				
	1.58*** [1.45, 1.71]	1.18*** [1.08, 1.28]	1.14** [1.04, 1.24]	1.14** [1.05, 1.24]
<b>Low 5-min. Apgar (&lt;7)</b>				
	1.96*** [1.53, 2.53]	1.34* [1.03, 1.72]	1.31* [1.02, 1.70]	1.31* [1.02, 1.70]
<b>Infant death<sup>b</sup></b>				
	2.40*** [1.59, 3.64]	1.42 [0.93, 2.15]	1.33 [0.87, 2.02]	1.33 [0.87, 2.03]
<b>Father characteristics</b>				
		X	X	X
<b>Maternal characteristics and health</b>				
		X	X	X
<b>Health care access</b>				
				X

N = 627,118. Results are reported as odds ratios estimates. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group of those with no paternal incarceration in the gestational period or at birth. 95% confidence intervals are reported in brackets

<sup>a</sup> Analysis restricted to full term births (37 weeks or later) (N = 585,865)

<sup>b</sup> Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 526,060). Model 1 is an unadjusted/bivariate model. Models 2–4 incrementally add covariates for the following sets of measures: (2) paternal age at birth, race/ethnicity, and education; (3) maternal age at birth, maternal race/ethnicity, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; (4) trimester of first prenatal care visit and indicator of whether the delivery was covered by Medicaid

Estimated associations between paternal incarceration during pregnancy and birth outcomes among births insured by Medicaid/family health plus

Table 4

	Model 1	Model 2	Model 3	Model 4
Infant birth outcomes				
Preterm birth				
Late (32–36 weeks)	1.60*** [1.44, 1.78]	1.37*** [1.23, 1.53]	1.35*** [1.20, 1.50]	1.35*** [1.21, 1.51]
Early (28–31 weeks)	1.72*** [1.28, 2.33]	1.21 [0.89, 1.64]	1.15 [0.85, 1.56]	1.15 [0.85, 1.56]
Extremely early (< 28 weeks)	2.20*** [1.61, 3.02]	1.42** [1.03, 1.95]	1.36 [0.99, 1.87]	1.37 [0.99, 1.89]
Low birth weight	1.85*** [1.67, 2.04]	1.45*** [1.31, 1.60]	1.41*** [1.27, 1.56]	1.41*** [1.28, 1.56]
Small for Gest. Age <sup>a</sup>	1.69*** [1.44, 1.98]	1.39*** [1.19, 1.64]	1.37*** [1.17, 1.61]	1.37*** [1.16, 1.61]
NICU admission	1.41*** [1.28, 1.54]	1.14** [1.05, 1.26]	1.13** [1.03, 1.24]	1.13* [1.03, 1.24]
Low 5-Min. Apgar (<7)	1.89*** [1.43, 2.49]	1.30 [0.98, 1.73]	1.30 [0.98, 1.72]	1.30 [0.98, 1.72]
Infant death <sup>b</sup>	1.75* [1.06, 2.87]	1.15 [0.70, 1.91]	1.09 [0.66, 1.80]	1.09 [0.66, 1.81]
Father characteristics		X	X	X
Maternal characteristics and health			X	X
Health care access				X

N = 347,234. Results are reported as odds ratio estimates. Asterisks denote statistically significant differences at the \*\*\*p < 0.001 \*\*p < 0.01 \*p < 0.05 levels from the reference group of those with no paternal incarceration in the gestational period or at birth. 95% confidence intervals are reported in brackets

<sup>a</sup> Analysis restricted to full term births (37 weeks or later) (N = 323,821)

<sup>b</sup> Analysis restricted to births in 2010–2015 because infant death data were not yet available for births in 2016 (N = 290,947). Model 1 is an unadjusted/bivariate model. Models 2–4 incrementally add covariates for the following sets of measures: (2) paternal age at birth, race/ethnicity, and education; (3) maternal age at birth, maternal race/ethnicity, education, body mass index, marital status at birth, indicators of prior low birthweight birth, prior preterm birth, maternal smoking during this pregnancy, pre-pregnancy hypertension, gestational hypertension, and gestational diabetes; (4) trimester of first prenatal care visit