

Imprisonment and Infant Mortality

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ABSTRACT

This article estimates the effects of imprisonment on infant mortality using data from the United States, 1990-2003. Results using state-level data show consistent effects of imprisonment rates on infant mortality rates and absolute Black-White inequality in infant mortality rates. Estimates suggest that had the American imprisonment rate remained at the 1973 level—the year the prison boom began—the infant mortality rate would be 5.1 percent lower, and absolute Black-White inequality in the infant mortality rate would be 23.3 percent lower. Results using novel micro-level data from the Pregnancy Risk Assessment Monitoring System (PRAMS) show that recent parental incarceration elevates early infant mortality risk, that effects are concentrated in the postneonatal period, and that domestic violence moderates these relationships. Notably, results suggest that recent parental incarceration elevates the risk of early infant death by 29.6 percent for the average infant in the sample. Taken together, the results show that imprisonment has consequences for population health and inequality in population health and should be considered when assessing variation in health across nations, states, neighborhoods, and individuals.

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As imprisonment has become common for marginal men, so also has the imprisonment of fathers, boyfriends, husbands, and sons become common for poor families (Comfort 2008; Wildeman 2009). Considerable research has already documented how the social patterning of the risk of imprisonment (Pettit and Western 2004; Western and Wildeman 2009) and effects of this experience on subsequent life-chances (Lopoo and Western 2005; Massoglia 2008a; Pager 2003; Schnittker and John 2007; Western 2002, 2006) exacerbate inequality among adult men (Massoglia 2008b; Western 2002, 2006). But since the diminished life-chances of formerly-incarcerated men also affect their families (Comfort 2007), mass imprisonment might also exacerbate inequality among American families. Of these broader effects, effects on childhood inequality may be most vital. If parental imprisonment not only signals marginalization but also directly harms children, then the effects of mass imprisonment on inequality could persist in the lives of the children of the prison boom long after their parents die. Mass imprisonment, then, would emerge as a novel engine of durable inequality (Tilly 1999) in America.

But does parental incarceration harm children? Preliminary research suggests that having a parent go to prison negatively affects children's educational attainment, participation in crime, and societal adjustment more generally (Foster and Hagan 2009; Hagan and Dinovitzer 1999; Murray and Farrington 2008; Wakefield 2009; Wildeman 2008). Furthermore, these effects linger, leaving children of incarcerated parents with an elevated risk of a host of forms of social exclusion (Foster and Hagan 2007). Research shows, for instance, that children of incarcerated fathers have a high risk of experiencing homelessness in the transition to adulthood (Foster and Hagan 2007).² Such severe disadvantage, though uncommon, deserves attention not only because it represents an extreme of social exclusion, but also because it may permanently diminish the life-chances of the children who experience it. Other research, however, finds that if a father was

² For an excellent macro-level example, see the analysis of foster care caseloads by Swann and Sylvester (2006).

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abusive, the negative effects of his incarceration on his children diminish to the point that his removal may even benefit them (Wildeman 2008). Thus, research also suggests that for some segment of children, paternal absence because of incarceration may promote wellbeing.

In this article, I extend the current research by considering the effects of imprisonment on another form of severe disadvantage: Infant mortality. Although quite uncommon, infant mortality is interesting not only because it is a key measure of population health, but also because the American infant mortality rate far exceeds those of comparably developed nations (Table 1; OECD 2006) and large Black-White disparities in the infant mortality rate persist (Singh and Kogan 2007). While infant mortality is of broad interest, the causes of the relatively high American infant mortality rate and racial disparity in it remain poorly understood. It is plausible that infant mortality rates and inequality in them would be affected by imprisonment rates, as other macro-level factors tied to the distribution of power and resources influence the infant mortality rate and inequality in it (Beckfield and Krieger *Forthcoming*; Hall and Lamont 2009; LaVeist 1992). On the micro-level, the “fundamental cause” perspective (Link and Phelan 1995) suggests that by diminishing the resources and information to which families have access, experiences such as parental imprisonment could elevate infant mortality risk (Wise 2003).

Long ago, Durkheim ([1897] 1951) stressed the importance of examining the population-level determinants of suicide, arguing that aggregate-level effects constituted social facts irreducible to effects on individuals. Not long after, Weber (1978:13) argued that for population-level arguments to be defensible they need to be grounded in plausible microfoundations. In considering the effects of imprisonment on infant mortality, I use both macro- and micro-level data, simultaneously providing insight into population processes and individual risks. On the macro-level, I use state-level panel data to consider how imprisonment rates influence infant

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mortality rates and racial disparities in infant mortality rates. I find that had the American imprisonment rate remained at its 1990 level, the infant mortality rate and Black-White gap in the infant mortality rate would be 2.5 and 11.1 percent lower, respectively. Had it remained at the 1973 level, the infant mortality rate and Black-White gap in the infant mortality rate would be 5.1 and 23.3 percent lower, respectively. That the change in the imprisonment rate explains nearly one-quarter of the absolute Black-White gap in the infant mortality rate speaks to the necessity of considering the penal system in studies of American inequality. On the micro-level, I use novel data from the Pregnancy Risk Assessment Monitoring System (PRAMS) to consider the effects of recent parental incarceration on infant mortality. My results suggest that parental incarceration elevates infant mortality risk, that the effects are concentrated in the postneonatal period, and that domestic violence moderates the relationship. The effect size, moreover, is large: I find that recent parental incarceration increases the risk of early infant death by 29.6 percent for the average infant in the sample. Taken together, these results demonstrate that imprisonment affects population health and inequality in population health and should therefore be considered when assessing variation in health across nations, states, neighborhoods, and individuals.

THE CONTOURS OF AMERICAN INFANT MORTALITY

Like most countries, the United States has experienced a sharp decline in its infant mortality rate over the second half of the 20th century (Singh and Kogan 2007:e931). Like most longstanding democracies, America now has an infant mortality rate well below 10 per 1,000 (OECD 2006). Still, the American infant mortality rate is notable in three ways. First, it exceeds the infant mortality rate of all longstanding democracies by at least 30 percent (OECD 2006; Table 1). Second, declines in the American infant mortality rate—both absolute and relative—have been

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smaller than those of comparably developed democracies over the last 15 years (OECD 2006; Table 1). The American infant mortality rate even increased in 2002 (MacDorman et al. 2005:1). Finally, although the absolute Black-White infant mortality gap has declined substantially in recent years, it remains quite large. In 2006, for example, the Black infant mortality rate was 13.3 per 1,000; for Whites, it was just 5.6 per 1,000 (Heron et al. 2009:107).

[Insert Table 1 about here.]

POPULATION POLICIES, INDIVIDUAL RISKS, AND INFANT MORTALITY

To date, research on the effects of macro-level policies and political regimes on infant mortality rates has focused primarily on income inequality and the welfare state (Beckfield 2004; Beckfield and Krieger *Forthcoming*; Conley and Springer 2001; Wilkinson and Pickett 2009). Although the question is far from settled, most studies find that policy regimes that more fully incorporate marginal groups and more evenly distribute resources (including health care) have lower infant mortality rates and less pronounced disparities in infant mortality rates than those that do not (Beckfield and Krieger *Forthcoming*; Conley and Springer 2001; LaVeist 1992).

The “fundamental cause” perspective (Link and Phelan 1995) holds that policies and political constellations influence the infant mortality rate and inequality in this rate by altering the distribution of power and resources. To the degree that policies *improve* the wellbeing of the marginalized, they diminish the infant mortality rate and inequality in the infant mortality rate; to the degree that they *compromise* the wellbeing of the marginalized, they increase the total infant mortality rate and inequality in the infant mortality rate. Research points to a number of channels through which macro-level policies and power constellations could influence infant mortality risks and inequality in these risks, among them maternal health, stress, social support, financial

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resources, access to healthcare, and information about new technologies (Wise 2003). Since these channels are more malleable than other predictors of infant mortality (such as congenital defects) they are more likely to be associated with aggregate *change* in infant mortality risks.

Based on the current research, we might expect some factors to be more strongly associated with neonatal mortality risk, defined as death within the first 28 days, and others more strongly associated with postneonatal mortality risk, defined as death after 28 days but in the first year of life. It is likely, for instance, that drastic changes in the lives of individuals or access to new information about how to prevent infant mortality will manifest themselves in altered postneonatal mortality risks, while changes that primarily affect women's health will manifest themselves in the neonatal period (LaVeist 1992:1083). Given the large share of deaths in the postneonatal period due to Sudden Infant Death Syndrome (SIDS), practices that diminish the risk of SIDS may be especially important (Task Force on Sudden Infant Death Syndrome 2005). Although the etiology of SIDS is poorly understood, medical research suggests that the risk of SIDS-related mortality is affected by maternal smoking, childcare arrangements, and sleep position, among other factors (Task Force on Sudden Infant Death Syndrome 2005). If stressful life-events such as imprisonment lead parents to be less mindful of these important ways of diminishing SIDS-related mortality, they could increase the risks of SIDS-related mortality.

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Although some speculate that imprisonment may affect population health and disparities in population health (Beckfield and Krieger *Forthcoming*), no empirical research tests these effects. In this section, I examine research on the effects of imprisonment to argue that imprisonment influences infant mortality both as a macro-level policy regime and a micro-level risk factor.

Mass Imprisonment as a Policy Regime

The American penal system is a product of macro-level policies and political constellations (Wacquant 2001; Western 2006). Although the political roots of mass imprisonment are most recognizable at the national level, state-level variation in political alignments, policy regimes, and crime rates also lead to substantial variation in imprisonment rates. As shown in Figure 1, there is a great deal of variation in the imprisonment rate across states—even when the District of Columbia, which is the outlier, is not considered. Although discussions of policy regimes stress cross-national variation, state-level variation, therefore, is also worth considering.

[Insert Figure 1 about here.]

For imprisonment to influence infant mortality rates or inequality in infant mortality rates, a substantial share of the population would need to experience imprisonment, and there would need to be evidence of population- and individual-level effects. On the population-level, imprisonment is clearly common enough to influence population-level infant mortality rates. Estimates show that 6.6 percent of the adult population can expect to be imprisoned at some time (Bonczar 2003). The unequal distribution of this risk also suggests that it may be important for macro-level inequality. While 22.8 percent of Black men born in the early 1970s experienced imprisonment by their early 30s, 2.8 percent of White men did (Western and Wildeman 2009:231). Inequality in this risk deepens for Black men who did not finish high school, over 60 percent of whom experienced imprisonment (Western and Wildeman 2009:231). High lifetime risks of imprisonment for adults are also reflected in risks of parental imprisonment for children. Over 25 percent of Black children born in 1990 experienced paternal imprisonment, while only 3.6 percent of White children born in the same year did (Wildeman 2009:271).

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Research on the macro-level consequences of imprisonment suggests that imprisonment is not only common, but also has substantial effects on population-level outcomes. In the economic realm, imprisonment exacerbates wage inequality (Western 2002) and artificially deflates the unemployment rate (Western and Beckett 1999), leaving Black families at greater risk of poverty. Mass disenfranchisement of Black men, another consequence of mass imprisonment (Manza and Uggen 2006), may influence infant mortality by diminishing Black political representation (LaVeist 1992). In light of strong effects of female imprisonment rates on foster care caseloads, female imprisonment rates may influence macro-level risks of experiencing other severe forms of childhood disadvantage like foster care placement (Swann and Sylvester 2006). Finally, imprisonment may exacerbate racial disparities in HIV (Johnson and Raphael 2009). By exposing more Black than White men to infectious diseases, imprisonment compromises not only the health of Black men, but also of Black women.

This is not to say that imprisonment has important macro-level effects only on prisoners and their families, however. The most vital way in which imprisonment may affect those *not* connected to the penal system is by influencing their neighborhoods. Since community-level factors influence birth outcomes (Morenoff 2003) and high imprisonment rates negatively affect communities (Clear 2007), imprisonment rates may have important effects on infant mortality rates in disadvantaged neighborhoods—even for those not involved with the penal system. As such, micro-level studies may underestimate the effects of imprisonment on infant mortality by considering only the elevated mortality risks for the infants of those experiencing imprisonment.

Based on research on the macro-level consequences of imprisonment for population-level outcomes and inequality in those outcomes, I expect that state-level imprisonment rates will increase state-level infant mortality rates and Black-White inequality in infant mortality rates.

(Parental) Imprisonment as a Risk Factor

In this section, I consider the individual-level effects of imprisonment on adults and their families. Effects of imprisonment rates on infant mortality rates seem implausible if they cannot also be demonstrated at the individual-level—even if focusing on individuals underestimates the effects of imprisonment on infant mortality. Individual-level research, moreover, provides a better opportunity for differentiating between short-term and long-term effects and establishing likely moderators of the relationship between parental incarceration and infant mortality.

The most likely long-term mechanism through which imprisonment affects infant mortality is through its effects on maternal health. Having ever been incarcerated or having an ever-incarcerated partner increases the risk of having infectious or stress-related diseases (Johnson and Raphael 2009; Massoglia 2008a, 2008b), which may affect infant mortality risk. Incarceration may also contribute to chronic stress, which research links to elevated infant mortality risk (Giscombé and Lobel 2005), by diminishing the financial resources available to women (Geller et al. 2008). This is not the sole pathway through which having an incarcerated partner elevates stress, however. Ethnographic research shows that imprisonment (Nurse 2002:52-54) and contact with the criminal justice system more broadly (Goffman 2009) decrease men's ability to play the roles of partner and father by socializing them to resolve conflicts with violence and forcing them to cultivate unpredictability in daily routines in order to avoid the police. Exposure to chronic stress—especially when coupled with the stigma, withdrawal from social networks, and exposure to disease that often accompany the incarceration of a loved one (see especially Comfort 2007, 2008; see also Braman 2004)—contribute to a type of weathering (Geronimus 1992) that exacerbates neonatal mortality risk by compromising maternal health.

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Effects of imprisonment on infant mortality need not be solely long-term, however. By introducing a shock into family life that elevates the level of disadvantage an infant faces, a recent bout of parental incarceration may increase postneonatal mortality risk. The incarceration of a family member shocks families in many ways. Perhaps most importantly, incarceration diminishes financial resources, both via reduced income (Geller et al. 2008) and the high cost of maintaining contact with an inmate (Comfort 2007). The financial instability resulting from these changes likely elevates postneonatal mortality risk. Changing care arrangements may also play a role. Since the incarceration of a partner tends to upset childcare arrangements (Braman 2004) and leaving infants with caretakers who do not know how to minimize SIDS-related mortality elevates postneonatal mortality risk (Task Force on Sudden Infant Death Syndrome 2005), parental incarceration could elevate postneonatal mortality risk in this way.

In addition, since having a partner incarcerated compounds the social isolation of women (Braman 2004) and socially isolated women may be less able to gain access to information about the newest techniques used to diminish infant mortality risk, parental incarceration could also increase infant mortality risk by diminishing access to this information.³ In light of connections between stress, smoking, and postneonatal mortality risk, it is also likely that the stressful, isolating experience of having a partner incarcerated (Braman 2004) could contribute to higher levels of SIDS-related mortality (Task Force on Sudden Infant Death Syndrome 2005).

Imprisonment increases neonatal mortality risk in the long-term by contributing to a type of weathering (Geronimus 1992); it elevates postneonatal mortality risk in the short-term by introducing a shock into family life. While imprisonment likely has both short- and long-term effects of infant mortality at the micro-level, these effects are unlikely to be shared equally

³ One example of how isolation elevates infant mortality risk comes from the “back to sleep” campaign, which, although successful at getting parents to put infants to sleep on their backs (and thereby diminishing SIDS-related mortality), was much less successful among low-SES than high-SES women (Pollack and Frohna 2001).

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among the population. Since the effects of incarceration on families may vary by whether the father was violent or abusive (Murray and Farrington 2008; Wildeman 2008), I expect effects to be negligible when the incarcerated parent was abusive; substantial when they were not.

DATA, MEASURES, AND METHOD

Data

In order to test the short-term relationship between imprisonment and infant mortality, I rely on two datasets covering the period 1990-2003. One dataset tests this relationship at the *state* level, the other at the *individual* level. This period is interesting not only because it is when risks of imprisonment became salient for poor men and their families (Western and Wildeman 2009; Pettit and Western 2004; Wildeman 2009), but also because it is when the rate of decline in the U.S. infant mortality rate began to diminish dramatically (MacDorman et al. 2005).

The first stage of the analysis considers the relationship between imprisonment and infant mortality at the state-level. In assembling the dataset, annual data from the 50 states and the District of Columbia were pooled over the period 1990-2003. Variables were compiled by government agencies, so there is little missing data. The only missing data come from the District of Columbia, whose prisoners have been included in federal imprisonment rates since 2001. In order to keep the District of Columbia in the sample, the 2001 imprisonment rate is used for 2002 and 2003.⁴ For a list of data sources and descriptive statistics, see Table 2.

[Insert Table 2 about here.]

⁴ Results from robustness checks in which the years in which observations were imputed were dropped from the sample suggest that the analysis is robust to decisions about these missing data. Since the District of Columbia was an outlier on the infant mortality rate and the imprisonment rate, I also conducted analyses in which the District of Columbia was excluded. Results were robust to excluding the District of Columbia from the analysis.

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Analyses considering the predictors of infant mortality have traditionally used macro-level data, but micro-level data are especially useful when considering if effects are concentrated in the neonatal or postneonatal period or how effects vary by parental characteristics and behaviors. Micro-level data also minimize concerns about the ecological inference problem that macro-level analyses are subject to. Unfortunately, individual-level data containing information on both parental incarceration and infant mortality are rare. Even surveys that contain information about both events rarely have enough cases of infant death to consider this outcome.

Traditional survey data are not suitable for considering my research question, but one dataset is: the Pregnancy Risk Assessment Monitoring System (PRAMS) data, which is run by the Center for Disease Control (CDC). Each year since 1988, participating states have contacted 1,300 to 3,400 women who gave birth in the last two to four months.⁵ First contact is made with a letter introducing the project. An initial survey and tickler follow shortly thereafter. Those who do not return the first survey within 7 to 14 days are sent a second survey. If they fail to complete this survey, most states send a third one 7 to 14 days later.⁶ All mothers who do not respond to the final mail survey are called 7 to 14 days later. The PRAMS survey tends to have response rates in the 70 to 80 percent range, well within the acceptable range for such surveys.

Although the PRAMS data are uniquely able to answer my research question, they have numerous limitations. First, surveys are completed an average of four months after the birth, so the data do not provide a full measure of infant mortality. Since I expect the effects of parental incarceration on infant mortality to be concentrated in the postneonatal period and data rarely cover this entire period, the estimates presented here will be conservative. Second, the data do not contain a measure of parental criminality, making it difficult to differentiate between effects

⁵ For a list of participating states in the 1990-2003 period, see Table A1.

⁶ Not all states send out a third mailer now. Fewer sent out a third mailer at the beginning of the period considered.

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of parental criminality and incarceration. There are also limited measures of family income and wealth, making it difficult to know whether it is parental incarceration or poverty that is responsible for any association between parental incarceration and infant mortality. In order to deal with this concern, I limit the analytic sample to women who were on WIC at the time of the survey. Doing so also limits the sample to infants likely to receive the “treatment” of parental incarceration in light of connections between poverty and incarceration. I also limit the sample to singleton births and children with no birth defects since the predictors of infant mortality may differ for these infants. I use weights for all analyses using the PRAMS data to account for the complex sample design. For descriptive statistics for the individual-level analyses, see Table 3.

[Insert Table 3 about here.]

Measures

Infant Mortality Rate. The primary dependent variable for the state-level analysis is the infant mortality rate (per 1,000). I also rely on measures of the White infant mortality rate, Black infant mortality rate, and absolute Black-White difference in the infant mortality rate. I could only construct a measure of racial inequality in the infant mortality rate for 32 states and the District of Columbia for all years because of the large number of states that did not have enough Black births for all years to provide a reliable measure, so the *N* for those analyses is smaller.

Early Infant Mortality. For the individual-level analyses, the key dependent variable is early infant mortality.⁷ This measure is based on maternal reports of whether the infant died before the mother was interviewed or in the first year, whichever came first. Although not a true measure of infant mortality since each infant is not at risk for the full year,⁸ it is better than any

⁷ Even in this sample, which has a huge number of cases (N=134,330), the number of deaths was small (N=500).

⁸ I use the term “early infant mortality” throughout the analyses because it does not measure the entire first year.

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measure of infant death in a large dataset. For some analyses, I use measures of neonatal and postneonatal mortality since I expect effects to be strongest during the postneonatal period.

Although the measure of postneonatal mortality is truncated due to short follow-up, it should still provide the best available estimate of effects on postneonatal mortality. If effects of parental incarceration on infant death are concentrated in the postneonatal period, however, these data underestimate the magnitude of the relationship between parental incarceration and infant death.

Imprisonment Rate. The explanatory variables for the state-level analysis are male, female, and total imprisonment rates, expressed as the number of individuals in prison in any given state at the end of the year per 1,000.⁹ Since imprisonment rates are drawn from year-end prison statistics, the previous year's imprisonment rate is used to predict infant mortality. For example, the 1989 imprisonment rate is used to predict the 1990 infant mortality rate. Since the hypotheses suggest that both the male and female imprisonment rates elevate infant mortality risk, most models consider the total imprisonment rate as the dependent variable.

Recent Parental Incarceration. For the individual-level analysis, the independent variable is drawn from different measures for the 1990-1997 and 1998-2003 periods. In the first period, it is based on whether the mother reported that the father had been incarcerated in the last year. In the second period, it is based on whether the mother reported that she or the father had been incarcerated in the last year.¹⁰ Since incarceration ranges from spending a night in jail to

⁹ For the models considering the Black and White infant mortality rates, I considered using the Black and White imprisonment rates. I ultimately decided against doing so for two reasons. First, no one data source would allow me to compute imprisonment rates by race in the early period of the analysis except for the Census, which requires significant interpolation between years (Johnson and Raphael 2009). Second, the primary reason for considering effects race-specific on the infant mortality rates was to test for effects on racial inequality in the infant mortality rate. Although results showed no effects of the imprisonment rate on the White infant mortality rate, I expect that results using the White imprisonment rate to predict the White infant mortality would show significant effects.

¹⁰ Since the risk of maternal imprisonment is tiny in the year after giving birth, very few of the mothers were likely incarcerated (Wildeman 2009: 271). In light of the small number of mothers who could be expected to experience this event, changes in the measure between these two periods likely have a negligible effect on results. In addition, some states excluded incarcerated mothers from the sample, further reducing cases of maternal incarceration.

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spending years in prison, this measure is a more expansive measure of criminal justice contact than is imprisonment, which is the measure I use for the state-level analyses.

State-Level Controls. These analyses also include a host of controls. The most important of these at the state-level is the probation rate (per 1,000). This control is vital for two reasons. First, it provides a measure of the petty crime rate since probation is generally imposed only for minor crimes. Second, it shows how different types of criminal justice policies influence the infant mortality rate. Since many crimes that once were punished with probation now receive prison sentences, the probation rate shows how different the infant mortality rate might have been had policies using probation instead of prison for minor drug-related crimes continued to be the norm. Another important control is the violent crime rate (per 1,000), which is also important for two reasons. First, it diminishes concerns about it being crime rather than incarceration that is influencing the infant mortality rate. Second, because few state-level measures of the crack-cocaine epidemic exist¹¹ and changes in violent crime correspond with the severity of the crack-cocaine epidemic (Boggess and Bound 1997), including this control allows me to indirectly control for the share of the infant mortality rate attributable to crack-cocaine addiction.¹²

The state-level analysis also controls for state-level characteristics likely associated with both imprisonment rates and infant mortality rates (Table 2). One control that is not included, however, is state health care spending. Conley and Springer (2001) show that state health care spending is a strong predictor of infant mortality at the national level, but this analysis does not include this measure because it has only been readily available at the state-level since 1997

¹¹ In addition, the one paper that does use a (potentially) reliable measure of the crack-cocaine epidemic through this period (Fryer et al. 2005) shows minimal effects of crack-cocaine indexes on outcomes in the 1990s and beyond.

¹² Since drug abuse rather than imprisonment may be driving any association, I controlled for rates of admission to drug rehabilitation facilities using the Treatment Episode Data Set (TEDS) data in models not shown here but available upon request. Results were robust to including this measure in the models (see Table A1 for availability).

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(Milbank Memorial Fund 1999, 2001, 2003, 2005). Results are robust to limiting the sample to years in which these measures are available and controlling for state health care spending. Since doing so cuts the sample size substantially, I do not include this control in the main results.

Individual-Level Controls. For the individual-level analyses, factors associated with the risks of recent parental incarceration and early infant mortality are included as controls. The analysis controls for the number of months between the child's birth and when the mother responded to the interview. All models also include a quadratic term for months exposed. Most models also include controls for characteristics of the mother including whether she was married and her race, education, and age. The most rigorous models also control for maternal risk factors and characteristics of this birth (see Table 3 for a list; Alexander and Korenbrot 1995; Callaghan et al. 2006; Chomitz, Cheung, and Lieberman 1995; Kramer et al. 2000; Mathews and MacDorman 2007; Singh and Kogan 2007; Singh and Yu 1995). These models also include quadratic terms for the number of stressful life events and prenatal visits since doing so improved model fit. The scale of stressful events is based on whether the mother reported that her partner had lost his job, she had been homeless, and she or someone she was very close to had a bad problem with drugs or alcohol in the last year. The measure of abuse is based on whether the mother reported that the father had abused her before or during the pregnancy.¹³ Since I expect the effects of parental incarceration to vary by whether the father had been abusive, some models include an interaction between parental incarceration and abuse.

Method

The analytic tool used for testing the hypothesis that state-level imprisonment rates increase state-level infant mortality rates and inequality in infant mortality rates is a GLS model with

¹³ Since measures of abuse have only been available since 1995, the N for analyses considering abuse is smaller.

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random and fixed effects and an AR(1) adjustment for serial autocorrelation. Although a model with only fixed effects would have also been appropriate, a Hausman test revealed no significant differences between models with fixed and random effects ($p=.34$), so I use the random effects model with fixed effects because it is more efficient (Halaby 2004; see also Beckfield 2006). In all models, I use the imprisonment rate at time $t-1$ to predict the infant mortality rate at time t . Some models use the male or female imprisonment rate as the independent variable, but most use the total imprisonment rate since I expect that both male and female imprisonment affect the infant mortality rate and the high correlation between them ($r=.88$) leads to unstable estimates when they are included together. I also provide a common test of spuriousness by including the imprisonment rate in the year before and the year after the infant mortality rate predicted in the model (Conley and Springer 2001). In Table 5, I present identical models to those shown in Model 6 of Table 4 considering the effects of imprisonment on the Black infant mortality rate, White infant mortality rate, and Black-White inequality in the infant mortality rate.

For the individual-level data, I rely on two methods. The first considers the association between parental incarceration and infant mortality risk using a logistic regression model with state and year dummies that adjusts for covariates (Table 6). This model tests whether the association considered at the state-level also holds at the individual-level. Since I hypothesize that effects of parental incarceration on infant mortality will be concentrated in the postneonatal period, I also use multinomial logistic regression models to predict the risk of neonatal mortality or postneonatal mortality relative to survival (Table 7). These models also include state and year dummies and adjust for the same covariates as the earlier models. In some models in Tables 6 and 7, I include an interaction between parental incarceration and abuse since I hypothesize that

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abuse moderates the relationship between parental incarceration and infant mortality risk. One-sided t-tests are used throughout both levels of the analysis since all hypotheses are directional.

RESULTS

Results from State-Level Analyses

The first three models in Table 4 consider the relationship between the female, male, and total imprisonment rate and the infant mortality rate. These models include random effects, fixed effects, and an AR(1) adjustment, but they do not control for time-varying covariates. Results from Model 1, which considers the association between the female imprisonment rate and the infant mortality rate, suggest that the female imprisonment rate is a significant predictor (at the .001 level) of the infant mortality rate. Results from Model 2, which considers the association between the male imprisonment rate and the infant mortality rate, tell a similar story. The male imprisonment rate is also a statistically significant predictor (at the .001 level) of the infant mortality rate. Model 3 considers the effect of the total imprisonment rate on the infant mortality rate. Results show that the total imprisonment rate, like the male and female imprisonment rates, is a statistically significant predictor (at the .001 level) of the infant mortality rate.

[Insert Table 4 about here.]

Results from Models 1, 2, and 3 provide support for the hypothesis that male, female, and total imprisonment rates are positively associated with infant mortality rates. Since these models do not adjust for covariates likely associated with the imprisonment rate and the infant mortality rate, however, they provide only preliminary evidence. In Models 4, 5, and 6, a host of time-varying covariates are introduced into the model in order to provide a more rigorous test. Results from Model 4 suggest that the female imprisonment rate is significantly (at the .05 level)

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associated with the infant mortality rate. Each one unit increase in the female imprisonment rate (per 1,000) is associated with a .67 increase (per 1,000) in the infant mortality rate. Results from models considering the effects of the male (Model 5) and total (Model 6) imprisonment rates on the infant mortality rate after adjusting for time-varying covariates show that the male and total imprisonment rates are significantly (at the .05 level) associated with the infant mortality rate.

Results from Table 4 thus far suggest that the female, male, and total imprisonment rates are positively and significantly associated with the infant mortality rate in a series of models that include random and fixed effects, an adjustment for serial autocorrelation, and time-varying covariates. Although results provided in these analyses suggest a positive association between imprisonment and infant mortality, the relationship may be spurious—some unmeasured factor may driving both the imprisonment and infant mortality rates. In order to test for spuriousness, I simultaneously include the imprisonment rate in years $t-1$ and $t+1$ in a model that predicts the infant mortality rate in year t . Results from Model 7, which includes no controls, suggest that spuriousness may be a concern, as the coefficient for the imprisonment rate in the next year is statistically significant. Results from the more rigorous model (Model 8) that includes the full set of controls, however, suggest that the relationship is unlikely to be spurious. In that model, the coefficient for the imprisonment rate at time $t+1$ is not only not statistically significant, but also negative. The coefficient for the imprisonment rate in the previous year, on the other hand, is significant (at the .01 level) and larger (.16) than it was in the full model including all controls.

Results from Table 4 support the hypothesis that imprisonment rates are positively associated with infant mortality rates. There has been little discussion to this point of how large these effects are, however, making it difficult to know if they are substantively important. In order to provide an idea of the magnitude of the effects, I predict how different the infant

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mortality rate would be had all other covariates stayed at their means for the 1990-2003 period and only the imprisonment rate had changed. The rates considered are the 2003 rate, the 1990 rate, and the 1973 rate—the year the prison boom began.¹⁴ Estimates for these scenarios are based on the estimated effect of the imprisonment rate (.11) from Model 6 in Table 4. Results show the following: the infant mortality rate based on the 2003 imprisonment rate is 7.95 per 1,000; the infant mortality rate based on the 1990 imprisonment rate is 7.75 per 1,000; and the infant mortality rate based on the 1973 imprisonment rate is 7.54 per 1,000. According to these estimates, the infant mortality rate would have been 2.5 percent lower had the imprisonment rate remained at the 1990 level and 5.1 percent lower had it remained at the 1973 level.

Knowing how the imprisonment rate affects the infant mortality rate at the population-level is useful, but it might be even more interesting to know if the imprisonment rate contributes to the well-documented Black-White disparity in infant mortality rates. Table 5 presents results from models that consider this disparity. In Model 1, I show that the relationship between the imprisonment rate and the infant mortality rate at the population-level does not differ much from the relationship shown in Table 4. Thus, the relationship does not differ substantially when only states that have enough Black infants to estimate Black-White inequality in the infant mortality rate are used. The coefficient for the imprisonment rate in this model (.14) roughly corresponds to the coefficient demonstrated in the comparison model in Table 4 (.11) using the full sample.

In Model 2, I extend the analysis by considering the effects of the imprisonment rate on the Black infant mortality rate. In this model, the imprisonment rate is a significant predictor of the Black infant mortality rate (at the .01 level); each additional prisoner is associated with a .42 increase in the infant mortality rate. Based on the magnitude of this coefficient relative to coefficients from Model 4, it is likely that effects of the imprisonment rate on the Black infant

¹⁴ The American imprisonment rate was 4.82 per 1,000 in 2003, 2.97 per 1,000 in 1990, and 0.96 per 1,000 in 1973.

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mortality rate are larger than they are on the rate for the White population, suggesting that mass imprisonment may have substantial effects on Black-White inequality in infant mortality.

[Insert Table 5 about here.]

Results from Model 3 in Table 5 also suggest that high imprisonment rates may exacerbate Black-White inequality in infant mortality rates. In this model, the imprisonment rate does not significantly increase the White infant mortality rate, and the coefficient is small (.05) relative not only to the coefficient from the previous model predicting the Black infant mortality rate (.42), but also to the comparison model considering the total infant mortality rate (.14). This does not suggest that the White imprisonment rate would not affect the White infant mortality rate, however. It merely suggests that the total imprisonment rates in states with large Black and White populations are likely so heavily influenced by the Black imprisonment rate as to make the effects of the total imprisonment on the White infant mortality rate nonsignificant and small.

Thus far, results point toward high levels of imprisonment being associated with increases in Black-White inequality in the infant mortality rate. Model 4 tests this relationship directly by looking at effects of the imprisonment rate on Black-White disparity in the infant mortality rate. Results suggest that the imprisonment rate significantly increases the infant mortality rate (at the .05 level) and that effects are substantial. When the estimated effect of the imprisonment rate on Black-White inequality in the infant mortality rate (.34) is applied to the hypothetical scenarios considered earlier, the magnitude of these effects becomes transparent. Had the imprisonment rate remained at the 1990 level, the Black-White gap in the infant mortality rate would be 11.1 percent lower; had it remained at the 1973 level, the Black-White infant mortality gap would be 23.3 percent lower. Thus, state-level results suggest moderate effects of imprisonment on the total population-level infant mortality rates and substantial effects

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on Black-White inequality in infant mortality rates. Had mass imprisonment not taken place, the Black-White gap in the infant mortality rate might have been nearly one-quarter smaller.

Results from Individual-Level Analyses

Results from state-level analyses suggest that the imprisonment rate is positively associated with the infant mortality rate. Nonetheless, these analyses are subject to the ecological inference problem, making it important to know if infants whose parents have been incarcerated in the last year are at higher mortality risk than other infants. In addition to providing a test of the relationship demonstrated in the last section at the individual-level, the analyses presented here also consider whether effects are concentrated in the postneonatal period and strongest for infants of mothers who had not been abused by the father of the child before the birth.

Table 6 presents results from logistic regression models including state and year dummies that consider the effects of recent parental incarceration on infant mortality using the PRAMS data. Model 1 demonstrates a descriptive relationship between parental incarceration and infant mortality risk after including state and year dummies and controlling for the number of months exposed to mortality risk, including a quadratic for exposure. Results suggest that parental incarceration significantly increases infant mortality risk (at the .01 level). Being born to a recently incarcerated parent is associated with an increase of 39 percent ($e^{.33}$) in the odds of dying. Results from Model 2, which adjusts for demographic characteristics, provide further evidence that recent parental incarceration elevates early infant mortality risk. The coefficient is significant at the .05 level and increases the odds of infant mortality by 27 percent ($e^{.24}$).

[Insert Table 6 about here.]

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Results from Models 1 and 2 in Table 6 provide preliminary evidence of an association between parental incarceration and infant mortality. In Model 3 in Table 6, I provide a more rigorous test of the association by adjusting for the full range of covariates. Results from this model again show a statistically significant relationship between recent parental incarceration and early infant mortality (at the .05 level). According to estimates from this model, infants of recently incarcerated parents have 32 percent ($e^{.28}$) higher odds of dying than otherwise comparable infants not experiencing this event. The inclusion of the full range of controls does nothing to diminish the size of the coefficient. This suggests that birth outcomes are unlikely to mediate the relationship between recent parental incarceration and early infant mortality.

Results from Table 6 indicate that parental incarceration elevates infant mortality risk. Because odds-ratios do not provide insight into the absolute magnitude of these effects, I generate predicted probabilities of infant mortality for those experiencing and not experiencing parental incarceration based on results from Model 3 in Table 6 and with all other covariates set to their means. According to these estimates, children of recently incarcerated parents had a .35 percent chance of dying; other children had a .27 chance of dying. Thus, parental incarceration increases the probability of infant death by 29.6 percent for the average child. This suggests that mass incarceration's effects on infant mortality are not only significant but also substantial.

Finally, I consider variations in effects, specifically by whether the father had been abusive to the mother before or during the pregnancy. In order to consider this question, I include an interaction between parental incarceration and domestic violence in the full model. Results from this model, shown in Model 4 of Table 6, suggest that effects of parental incarceration on infant mortality risk vary by whether the father was abusive. For children of non-abusive fathers, the effects of parental incarceration on infant mortality risk increase substantially relative to

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Model 3. In this model, parental incarceration is associated with an increase of about 49 percent ($e^{.40}$) in the odds of infant mortality. For infants who experienced parental incarceration but had abusive fathers, on the other hand, this event is associated with significantly less infant mortality risk than for infants experiencing this event who did not have abusive fathers. These results suggest that while parental incarceration diminishes the chance of survival for infants of non-abusive fathers, it may be protective for infants of abusive fathers.

Results from Table 6 suggest that the macro-level relationship between imprisonment and infant mortality also exists at the micro-level, as infants of recently incarcerated parents were at significantly higher risk of mortality. Results also suggest, however, that these findings only apply to infants whose fathers were not abusive. In Table 7, I extend the analysis by considering other variations in the effects of parental incarceration on infant mortality. In this section, I use a series of multinomial logistic regression models including the same controls as those used in Table 6 to consider whether effects of parental incarceration are concentrated in the postneonatal period. Results from the descriptive model (Model 1) and the model that adjusts only for maternal characteristics (Model 2) provide support for the hypothesis that effects of parental incarceration on infant mortality are concentrated in the postneonatal period. In both models, effects are substantial (.88 and .75) and significant (at the .001 level). These results suggest that parental incarceration increases the odds of postneonatal infant mortality between 117 and 141 percent. Effects on neonatal mortality, on the other hand, are small, negative, and not significant.

[Insert Table 7 about here.]

Results from Models 1 and 2 in Table 7 provide support for the hypothesis that effects of parental incarceration on infant mortality are concentrated in the postneonatal period. Model 3 provides a more rigorous test of this relationship by including the full set of controls. Results

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from this model suggest that parental incarceration has substantial effects on the risk of postneonatal but not neonatal mortality. Effects on postneonatal mortality are statistically significant at the .01 level. Infants of recently incarcerated fathers have 90 percent higher odds ($e^{.64}$) of postneonatal mortality than otherwise comparable infants not experiencing this event. For the average infant in the sample, this adds up to an increase in postneonatal mortality of about 86 percent—up from .07 to .13 percent. Results from this model also suggest that *all* of the effects of parental incarceration on infant mortality are concentrated in the postneonatal period. In light of this, estimates presented earlier in Table 6 likely underestimate the effects of parental incarceration on infant mortality since mean exposure is only about four months.

Thus far, individual-level results provide support for the hypothesis that imprisonment increases infant mortality and that effects of recent parental incarceration on infant mortality are concentrated in the postneonatal period. In the final model in Table 7, I include an interaction between parental incarceration and domestic violence. Results provide strong evidence that the association between parental incarceration and postneonatal mortality is moderated by abuse. In this model, the interaction between parental incarceration and domestic violence is larger than the main effect of parental incarceration on postneonatal mortality risk. This provides further evidence that removing abusive fathers from the home is unlikely to elevate their infant's mortality risk. This finding is also in concert with findings from parallel research suggesting that removing these men from households may help their children (Wildeman 2008).

DISCUSSION AND CONCLUSION

This article demonstrates that imprisonment is positively associated with infant mortality at the macro- and the micro-levels. Results from a series of GLS models with random and fixed effects

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and an adjustment for serial autocorrelation provided consistent evidence that increases in the imprisonment rate are associated with increases in the infant mortality rate and Black-White inequality in the infant mortality rate at the state level. According to results from these models, had the American imprisonment rate remained at the 1990 level, the American infant mortality rate would be 2.5 percent lower, the Black-White infant mortality gap 11.1 percent lower. If the imprisonment rate had remained at the 1973 level, the Black-White infant mortality gap would be 23.3 percent lower than predicted using the 2003 imprisonment rate. Thus, had the American imprisonment rate not grown from around 100 per 100,000 to 500 per 100,000, the Black-White disparity in the infant mortality rate would have been nearly one-quarter smaller.

Results also suggest that this relationship holds not only at the macro-level, where the ecological inference problem may bias results, but also at the micro-level. Based on results from individual-level analyses, the average infant in the sample could expect to experience a 29.6 percent higher probability of dying if their parent had been incarcerated. Individual-level results also suggest that effects are concentrated in the postneonatal period, which is what was expected of this short-term shock to the environment inhabited by the infant. Furthermore, effects are concentrated among infants whose mothers had not been abused, a finding which falls in line with recent research suggesting that paternal incarceration may have positive effects for children of abusive fathers (Wildeman 2008). This finding suggests a dilemma for policymakers. At least in these data, 40 percent of fathers who had been incarcerated in the last year were abusive (Table 3). Results suggest that removing these men from families may have little effect on their infants—and may even be protective. For the other 60 percent of families experiencing parental incarceration, however, this event increases the risk of infant mortality. Thus, removing these men harms their families. There is no quick fix to the negative effects of abuse, crime, and

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incarceration on families, but policies that diminish the destructive behaviors of criminally active men without incarcerating them may provide the most benefits for infant and child wellbeing.

Taken together, these results suggest that the American experiment in mass imprisonment may be partially responsible for the distinctively high American infant mortality rate and the substantial Black-White gap in the infant mortality rate. They also suggest that subsequent analyses should consider parental incarceration as a risk factor for infant mortality. These results are provocative, but this research still has limitations. First, some omitted or poorly measured variable correlated with imprisonment and infant mortality may be driving the observed association. Although this is a possibility, the models used throughout this analysis—especially the more rigorous state-level models—diminish this possibility by controlling all bias due to stable characteristics. For the individual-level analysis, however, this is a concern since no controls for parental criminality could be included. Second, the analysis was only able to test the short-term effects of incarceration on infant mortality. Thus, I cannot rule out the possibility that incarceration only affects infant mortality in the short-term. Lack of information about cause of death and the fact that the measure of infant death does not include a full measure of infant mortality in the PRAMS data are also limitations. Since effects of parental incarceration on infant mortality are concentrated in the postneonatal period, estimates derived from the PRAMS data, which has an average follow-up of four months, likely underestimate effects of parental incarceration on infant mortality. Thus, individual-level estimates are considered conservative. Endogeneity bias is also a concern. Although some have estimated the effects of incarceration using exogenous shocks in imprisonment (Levitt 1996), these analyses have relied on exogenous shocks in (primarily Southern) states that are unlikely representative of the population (but see

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Johnson and Raphael 2006). Future research should deal with concerns about endogeneity bias by using an instrumental variable approach to test the robustness of this relationship.

Despite their limitations, these findings have a number of important implications. First, they suggest that the imprisonment rate may be an important predictor of population health and inequality in population health and should be considered in analyses comparing the health and wellbeing of nations, states, neighborhoods, and individuals. Although some have suggested that the penal state may have important implications for population health and inequality in population health (Beckfield and Krieger *Forthcoming*), this is the first study to simultaneously provide evidence at the macro- and micro-levels demonstrating an association between the penal state and a health outcome. Second, these findings fall in line with other work suggesting that the penal state is one feature of American society that has contributed to increasing differentiation between the United States and Europe since the 1970s (Western and Beckett 1999). Finally, these findings, along with studies showing that imprisonment may elevate mortality risk for recently released adults (Binswanger et al. 2007), suggest that those weighing the costs and benefits of imprisonment should include another variable in their analysis: Loss of life for the imprisoned and their family members, including their infants. So while imprisonment may save lives by removing dangerous individuals from the streets, it may also cost lives by increasing the mortality risks of prisoners and their family members. Since investment of funds into prisons may diminish investment into programs that promote population health, mass imprisonment may also have indirect effects on population health by diminishing scarce governmental resources.

Future research in this area should do no fewer than four things. First, it should interrogate the long-term effects of imprisonment on infant mortality discussed in this article. Second, it should isolate the mechanisms through which imprisonment elevates infant mortality

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risk since knowing this information could help minimize the effects of the penal state on population health, even absent changes in the imprisonment rate. Third, it should extend the study of the consequences of imprisonment for population health to other measures, especially life expectancy at birth (Beckfield 2004) and premature mortality (Krieger et al. 2008). Doing so would provide a more complete picture of the effects of mass imprisonment on population health. Finally, research should test the hypothesis that imprisonment affects population health at the national level by using the national imprisonment rate to predict population health. Whatever the results of these analyses, they will provide insight into the effects of the penal state on population health and inequality in population health—both within and between countries.

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Table 1. 1990 and 2003 Infant Mortality Rates and Change in Infant Mortality Rates

Country	IMR (1990)	IMR (2003)	Absolute Change (%)	Relative Change (%)
Australia	8.2	4.8	-3.4	-41.6
Austria	7.8	4.5	-3.3	-42.3
Belgium	6.5	4.3	-2.2	-33.8
Canada	6.8	5.3	-1.5	-22.1
Czech Republic	10.8	3.9	-6.9	-63.9
Denmark	7.5	4.4	-3.1	-41.3
Finland	5.6	3.1	-2.5	-44.6
France	7.3	4.0	-3.3	-45.2
Germany	7.0	4.2	-2.8	-40.0
Greece	9.7	4.0	-5.7	-58.8
Hungary	14.8	7.3	-7.5	-50.7
Iceland	5.8	2.4	-3.4	-58.6
Ireland	8.2	5.3	-2.9	-35.4
Italy	8.2	3.9	-4.3	-52.4
Japan	4.6	3.0	-1.6	-34.8
Korea	10.0	5.3	-4.7	-47.0
Luxembourg	7.3	4.9	-2.4	-32.9
Mexico	36.2	20.5	-15.7	-43.4
Netherlands	7.1	4.8	-2.3	-32.4
New Zealand	8.4	4.9	-3.5	-41.7
Norway	6.9	3.4	-3.5	-50.7
Poland	19.3	7.0	-12.3	-63.7
Portugal	11.0	4.1	-6.9	-62.7
Slovak Republic	12.0	7.9	-4.1	-34.2
Spain	7.6	3.9	-3.7	-48.7
Sweden	6.0	3.1	-2.9	-48.3
Switzerland	6.8	4.3	-2.5	-36.8
Turkey	55.4	28.7	-26.7	-48.2
United Kingdom	7.9	5.3	-2.6	-32.9
United States	9.2	6.9	-2.3	-25.0
Entire OECD	11.0	6.0	-5.0	-45.5

Source: OECD(2006).

Notes: All infant mortality rates are expressed per 1,000 live births. Since Korea did not report an infant mortality rate in 2003, I rely on the 2002 infant mortality rate for Korea.

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Table 2. Descriptive Statistics and Sources for All Variables Used in State-Level Analyses ($N=714$), 1990-2003

<i>Variable</i>	<i>M</i>	<i>(SD)</i>	<i>Source</i>
Infant Mortality Rate (per 1,000)	7.8	(1.9)	National/Monthly Vital Statistics Reports
Black Infant Mortality Rate (per 1,000) ^a	15.3	(3.0)	National/Monthly Vital Statistics Reports
White Infant Mortality Rate (per 1,000) ^a	6.6	(1.0)	National/Monthly Vital Statistics Reports
Black-White Inequality in the Infant Mortality Rate (per 1,000) ^a	8.7	(2.7)	National/Monthly Vital Statistics Reports
Female Imprisonment Rate (per 1,000)	0.4	(0.3)	Bureau of Justice Statistics
Male Imprisonment Rate (per 1,000)	6.4	(3.9)	Bureau of Justice Statistics
Imprisonment Rate (per 1,000)	3.4	(2.1)	Bureau of Justice Statistics
Probation Rate (per 1,000)	1.4	(0.8)	Bureau of Justice Statistics
Violent Crime Rate (per 1,000)	5.2	(3.5)	Uniform Crime Reports
Percent Foreign-Born	6.5	(5.3)	Statistical Abstracts of the U.S.
Percent with High School Diploma Plus	81.9	(5.6)	Statistical Abstracts of the U.S.
Percent Black	11.0	(11.8)	Statistical Abstracts of the U.S.
Percent Hispanic	7.0	(8.3)	Statistical Abstracts of the U.S.
Percent Residing in Urban Areas	71.9	(15.0)	Statistical Abstracts of the U.S.
GDP per Capita (in \$1,000s; 2000 dollars)	31.4	(11.4)	U.S. Bureau of Economic Analysis
GINI * 100	44.2	(2.5)	Census/American Community Survey
AFDC/TANF Cases (per 1,000)	11.9	(6.7)	U.S. Department of Health/Human Services
AFDC/TANF + Food Stamp (per month in \$100s; 2000 dollars)	7.7	(1.7)	U.S. House of Representative <i>Green Books</i>
Percent Nonmarital Births	31.5	(7.5)	National/Monthly Vital Statistical Reports
Percent of the Population in Poverty	12.7	(3.9)	Statistical Abstracts of the United States
Unemployment Rate	5.2	(1.5)	Bureau of Labor Statistics
Doctors (per 1,000)	2.3	(0.8)	Statistical Abstracts of the U.S.
Nurses (per 1,000)	8.0	(2.0)	Statistical Abstracts of the U.S.
Percent Whose Mothers Smoked	15.4	(4.9)	National/Monthly Vital Statistics Reports
Percent with No Prenatal Care	4.1	(2.0)	National/Monthly Vital Statistics Reports
Percent of Births Premature	11.3	(2.0)	National/Monthly Vital Statistics Reports
Percent of Births Low Birth Weight	7.5	(1.5)	National/Monthly Vital Statistics Reports

^a Not all states had enough cases to calculate both the Black and White infant mortality rate ($N=462$).

Imprisonment and Infant Mortality

Table 3. Descriptive Statistics by Parental Incarceration Status using PRAMS data, 1990-2003

	Parental Incarceration		No Parental Incarceration	
	<i>M</i>	(SD)	<i>M</i>	(SD)
<i>Dependent Variables</i>				
Infant Died (%)	0.5	(0.7)	0.4	(0.6)
Neonatal Mortality (%)	0.3	(0.5)	0.3	(0.5)
Postneonatal Mortality (%)	0.3	(0.5)	0.1	(0.3)
<i>Controls</i>				
Months between Birth and Interview (0-18)	4.0	(1.6)	4.1	(1.6)
Mother Married (%)	26.3	(44.0)	45.6	(49.8)
Maternal Race (%)				
White	51.9	(50.0)	50.0	(50.0)
Black	33.3	(47.1)	27.5	(44.7)
Hispanic	10.7	(30.9)	18.2	(38.6)
Other	4.1	(20.0)	4.3	(20.4)
Maternal Education (%)				
< HS	42.8	(49.5)	34.0	(47.4)
HS +	57.1	(49.5)	66.0	(47.4)
Maternal Age	-1.3	(5.2)	0.2	(5.7)
Maternal BMI (%)				
Underweight	19.1	(39.3)	15.5	(36.2)
Healthy or Overweight	61.2	(48.7)	64.7	(47.8)
Obese	19.7	(39.8)	19.8	(39.9)
Total Stressful Experiences (0-3)	1.1	(0.9)	0.4	(0.6)
Previous Births (0-18)	0.5	(0.5)	0.6	(0.5)
Previous Low Birthweight Birth (%)	7.5	(26.3)	7.1	(25.7)
Previous Preterm Birth (%)	8.5	(27.9)	7.3	(26.1)
Boy (%)	50.7	(50.0)	51.1	(50.0)
Mother Smoked (%)	29.8	(45.8)	17.8	(38.3)
Mother Drank (%)	1.7	(12.8)	0.9	(9.3)
Number of Prenatal Visits (0-81)	10.9	(4.1)	11.3	(3.9)
This Birth Low Birthweight (%)	7.9	(27.0)	7.1	(25.7)
This Birth Very Low Birthweight (%)	1.2	(10.7)	1.1	(10.6)
This Birth Preterm (%)	10.0	(30.0)	8.6	(28.0)
Child in Intensive Care (%)	11.3	(31.7)	11.3	(31.7)
Mother Reported Abuse (%) ^a	40.7	(49.1)	12.0	(32.5)
<i>N</i>	12,108	---	122,222	---

Notes: All descriptive are weighted. The sample is limited to women who were on WIC.

^a Information on abuse has only been collected since 1995, so the *N* is smaller (*N*=102,898).

Imprisonment and Infant Mortality

Table 4. Results from GLS Regression Models with Random and Fixed Effects and an AR(1) Adjustment Predicting State-Level Infant Mortality Rates by State-Level Imprisonment Rates, 1990-2003

	M1	M2	M3	M4	M5	M6	M7	M8
Female Imprisonment Rate (t-1)	1.78***	---	---	.67*	---	---	---	---
Male Imprisonment Rate (t-1)	---	.14***	---	---	.06*	---	---	---
Imprisonment Rate (t-1)	---	---	.27***	---	---	.11*	.22***	.16**
Imprisonment Rate (t+1)	---	---	---	---	---	---	.10*	-.13*
Probation Rate	---	---	---	-.10	-.10	-.10	---	-.09
Violent Crime Rate	---	---	---	.13**	.14**	.14**	---	.16**
Percent Foreign-Born	---	---	---	-.18	-.17	-.17	---	-.16
Percent HS+	---	---	---	.02	.02	.02	---	.02
Percent Black	---	---	---	.35***	.36***	.36***	---	.36**
Percent Hispanic	---	---	---	.09	.08	.08	---	.09
Percent Urban	---	---	---	-.04	-.04	-.04	---	-.05
GDP per Capita	---	---	---	-.06	-.06	-.06	---	-.05
GDP per Capita ²	---	---	---	.00	.00	.00	---	.00
GINI	---	---	---	-.10	-.13	-.13	---	-.16
AFDC/TANF Cases	---	---	---	-.02	-.02	-.02	---	-.02
AFDC/TANF + Food Stamp	---	---	---	-.13	-.15	-.15	---	-.15
Percent Nonmarital Births	---	---	---	.01	.02	.02	---	.02
Percent in Poverty	---	---	---	-.01	-.01	-.01	---	-.01
Unemployment Rate	---	---	---	.00	.01	.01	---	.02
Doctors (per 1,000)	---	---	---	-.01	-.05	-.04	---	.00
Nurses (per 1,000)	---	---	---	-.26*	-.24*	-.25*	---	-.22
Percent Whose Mothers Smoked	---	---	---	.01	.02	.02	---	.02
Percent with No Prenatal Care	---	---	---	.06	.06	.06	---	.06
Percent of Births Premature	---	---	---	.27***	.21***	.28**	---	.28***
Percent of Births Low BW	---	---	---	.02	.02	.02	---	.01
Includes Random Effects?	YES	YES	YES	YES	YES	YES	YES	YES
Includes Fixed Effects?	YES	YES	YES	YES	YES	YES	YES	YES
Includes AR(1) Adjustment?	YES	YES	YES	YES	YES	YES	YES	YES
Intercept	10.59***	10.40***	10.36***	5.53	6.72	6.63	10.11***	8.20
<i>p</i>	.37	.45	.44	.16	.18	.18	.42	.19
R ²	.88	.87	.87	.92	.91	.91	.88	.91
N	663	663	663	663	663	663	663	663

Note: Significance levels are: *** <.001; ** <.01; * <.05. All t-tests are one-sided. Standard errors are omitted to conserve space.

Imprisonment and Infant Mortality

Table 5. Results from GLS Regression Models with Random and Fixed Effects and an AR(1) Adjustment Predicting State-Level Total, Black, and White Infant Mortality Rates and Inequality in the Infant Mortality Rate by State-Level Imprisonment Rates, 1990-2003

	M1 (All) ^a	M2 (Black) ^a	M3 (White) ^a	M4 (Inequality) ^a
Imprisonment Rate	.14**	.42**	.05	.34*
Includes Full Controls	YES	YES	YES	YES
Includes Random Effects?	YES	YES	YES	YES
Includes Fixed Effects?	YES	YES	YES	YES
Includes AR(1) Adjustment?	YES	YES	YES	YES
Intercept	-8.25	-24.69	6.18	-30.51
<i>p</i>	.24	.16	-.05	.11
R ²	.95	.71	.77	.62
N	429	429	429	429

Note: Significance levels are: *** <.001; ** <.01; * <.05. All t-tests are one-sided. All models include the full controls used in Table 4. Standard errors are omitted to conserve space.

^a These models include a smaller number of cases because they are based on states with a large enough number of Black and White births to compute the infant mortality rate for both groups.

Imprisonment and Infant Mortality

Table 6. Results from Logistic Regression Models with State and Year Dummies Predicting Early Infant Death by Parental Incarceration using PRAMS Data, 1990-2003

	M1	M2	M3	M4 ^a
Parental Incarceration	.33**	.24*	.28*	.40*
Abuse	---	---	---	.38*
Parental Incarceration * Abuse	---	---	---	-.68*
Months	.20*	.17	.21*	.12
Months ²	-.01	-.01	-.02*	-.00
Mother Married	---	-.20	-.02	-.09
Maternal Race				
Black	---	.65***	.13	.10
Hispanic	---	-.29	-.20	-.21
Other	---	-.03	-.01	.12
Maternal Education < HS	---	.00	-.17	-.27*
Maternal Age	---	-.00	-.03**	-.03**
Maternal Age ²	---	.00	.00	.00
Maternal BMI				
Underweight	---	---	-.25	-.11
Obese	---	---	.32**	.34*
Stressful Experiences	---	---	.30	.29
Stressful Experiences ²	---	---	-.15	-.19
Previous Births	---	---	.27*	.33*
Previous Low	---	---	-.45*	-.47*
Previous Preterm	---	---	.26	.30
Boy	---	---	-.03	.02
Mother Smoked	---	---	.29*	.27
Mother Drank	---	---	-.97	-.50
Prenatal Visits	---	---	-.13***	-.12***
Prenatal Visits ²	---	---	.00***	.00***
This Birth Low	---	---	1.43***	1.74***
This Birth Very Low	---	---	3.20***	3.53***
This Birth Preterm	---	---	.80***	.56***
Child in Intensive Care	---	---	-.83***	-1.17***
Includes State Dummies?	YES	YES	YES	YES
Includes Year Dummies?	YES	YES	YES	YES
Intercept	-6.22***	-6.24***	-6.29***	-6.38***
-2 Log Likelihood	6441	6367	4468	3264
N	134330	134330	134330	102898

Notes: Significance levels are: *** <.001; ** <.01; * <.05. All t-tests are one-sided. Standard errors are omitted to conserve space. All analyses are weighted and limited to women on WIC.

^a This model uses less cases because it is based only on years for which abuse was reported.

Imprisonment and Infant Mortality

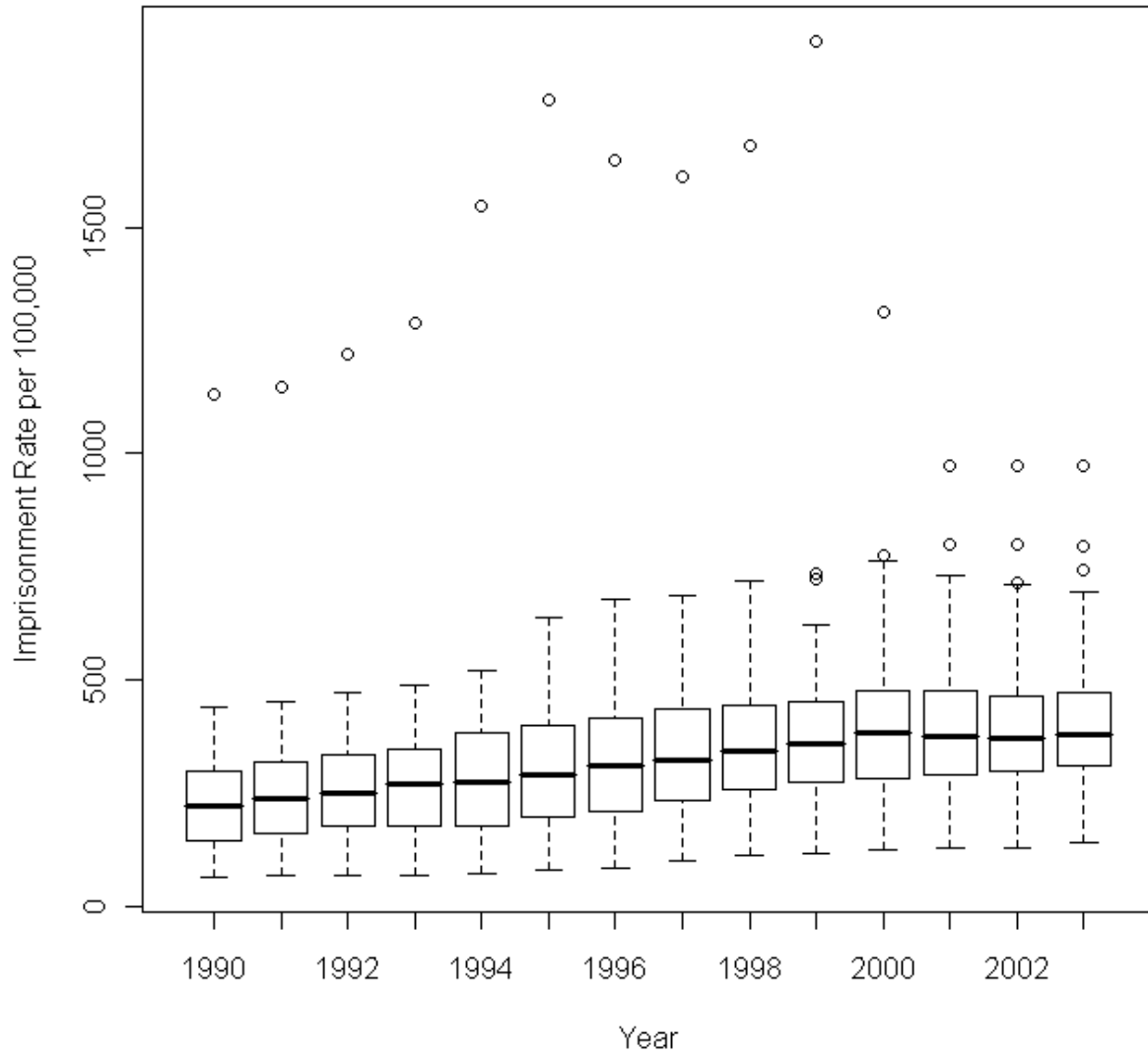
Table 7. Results from Multinomial Logistic Regression Models with State and Year Dummies Predicting Neonatal and Postneonatal Mortality Relative to Survival by Parental Incarceration using PRAMS Data, 1990-2003

	M1		M2		M3		M4 ^a	
	<1 Mon.	>1 Mon.	<1 Mon.	>1 Mon.	<1 Mon.	>1 Mon.	<1 Mon.	>1 Mon.
Parental Incarceration	-.03	.88***	-.11	.75***	-.02	.64**	-.19	.98**
Abuse	---	---	---	---	---	---	.35	.46
Parental Incarceration * Abuse	---	---	---	---	---	---	.00	-1.44**
Intercept	-5.95***	-9.00***	-6.11***	-8.78***	-6.55***	-8.64***	-6.12***	-9.82***
Includes State Dummies?	YES		YES		YES		YES	
Includes Year Dummies?	YES		YES		YES		YES	
Includes Months?	YES		YES		YES		YES	
Includes Basic Demographics?	NO		YES		YES		YES	
Includes Full Controls?	NO		NO		YES		YES	
-2 Log Likelihood	7005		6972		4849		3491	
N	134330		134330		134330		102898	

Notes: Significance levels are: *** <.001; ** <.01; * <.05. Standard errors are omitted to conserve space. All t-tests are one-sided. All models include state and year dummies. All analyses are weighted and limited to women on WIC.

^a This model includes a smaller number of cases because it is based only on years for which information on abuse was reported.

Figure 1: Box Plots of State Imprisonment Rates, 1990-2003



Imprisonment and Infant Mortality

Table A1. Availability of PRAMS and TEDS Data by State and Year (* = PRAMS; # = TEDS)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Alabama				* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
Alaska		*	*	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
Arizona									#	#	#	#	#	#
Arkansas				#	#	#	#	* #	* #	* #	* #	* #	* #	* #
California				#	#	#	#	#	#	#	#	#	#	#
Colorado				#	#	#	#	#	* #	* #	* #	* #	* #	* #
Connecticut				#	#	#	#	#	#	#	#	#	#	#
Delaware				#	#	#	#	#	#	#	#	#	#	#
D.C.														
Florida				* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
Georgia				* #	* #	* #	* #	* #	#	#	#	#	#	#
Hawaii				#	#	#	#	#	#	#	* #	* #	* #	* #
Idaho				#	#	#	#	#	#	#	#	#	#	#
Illinois				#	#	#	#	#	* #	* #	* #	* #	* #	* #
Indiana				#	#	#	#	#	#	#	#	#	#	#
Iowa				#	#	#	#	#	#	#	#	#	#	#
Kansas				#	#	#	#	#	#	#	#	#	#	#
Kentucky									#	#	#	#	#	#
Louisiana				#	#	#	#	#	* #	* #	* #	* #	* #	* #
Maine	*	*	*	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
Maryland				#	#	#	#	#	#	#	#	#	#	#
Massachusetts				#	#	#	#	#	#	#	#	#	#	#
Michigan				* #	* #	* #	* #	#	#	#	#	* #	* #	* #
Minnesota				#	#	#	#	#	#	#	#	#	* #	* #
Mississippi						#	#	#	#	#	#	#	#	* #
Missouri				#	#	#	#	#	#	#	#	#	#	#
Montana				#	#	#	#	#	#	#	#	#	#	#
Nebraska				#	#	#	#	#	#	#	#	#	* #	* #
Nevada				#	#	#	#	#	#	#	#	#	#	#
New Hampshire				#	#	#	#	#	#	#	#	#	#	#
New Jersey				#	#	#	#	#	#	#	#	#	* #	* #
New Mexico				#	#	#	#	#	* #	* #	* #	* #	* #	* #
New York				* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
North Carolina				#	#	#	#	* #	* #	* #	* #	* #	* #	* #
North Dakota				#	#	#	#	#	#	#	#	#	* #	* #
Ohio				#	#	#	#	#	#	* #	* #	* #	* #	* #
Oklahoma		*	*	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
Oregon				#	#	#	#	#	#	#	#	#	#	* #
Pennsylvania				#	#	#	#	#	#	#	#	#	#	#
Rhode Island				#	#	#	#	#	#	#	#	#	* #	* #
South Carolina				* #	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
South Dakota				#	#	#	#	#	#	#	#	#	#	#
Tennessee				#	#	#	#	#	#	#	#	#	#	#
Texas				#	#	#	#	#	#	#	#	#	#	#
Utah				#	#	#	#	#	#	* #	* #	* #	* #	* #
Vermont				#	#	#	#	#	#	#	#	* #	* #	* #
Virginia				#	#	#	#	#	#	#	#	#	#	#
Washington				#	* #	* #	* #	* #	* #	* #	* #	* #	* #	* #
West Virginia	*	*	*	* #	* #	* #	* #	*	*	* #	*	* #	* #	*
Wisconsin				#	#	#	#	#	#	#	#	#	#	#
Wyoming				#	#			#	#	#	#	#	#	#

Note: Data from Maryland not included because the state did not approve use of their data.