County Jail Incarceration Rates and County Mortality Rates in the United States, 1987–2016

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Objectives. To evaluate the relationship between changes in county jail incarceration rates and subsequent county mortality rates across the United States.

Methods. We analyzed county jail incarceration rates from the Bureau of Justice Statistics from 1987 to 2016 for 1884 counties and mortality rates from the National Vital Statistics System. We fit 1-year-lagged quasi-Poisson 2-way fixed-effects models, controlling for unmeasured stable county characteristics, and measured time-varying confounders, including county poverty and crime rates.

Results. A within-county increase in jail incarceration rates from the first to second quartile was associated with a 2.5% increase in mortality rates, adjusting for confounders (risk ratio [RR] = 1.03; 95% confidence interval [CI] = 1.02, 1.03). This association followed a dose–response relationship and was stronger for mortality among those aged 15 to 34 years (RR = 1.07; 95% CI = 1.06, 1.09).

Conclusions. Within-county increases in jail incarceration rates are associated with increases in subsequent mortality rates after adjusting for important confounders.

Public Health Implications. Our findings add to the growing body of empirical evidence of the harms of mass incarceration. The criminal justice reform and decarceration movements can use these findings as they develop strategies to end mass incarceration. (*Am J Public Health.* 2020;110:S109–S115. doi:10.2105/AJPH.2019.305413)

Mass incarceration is hypothesized to have collateral health consequences not only for incarcerated individuals[1–3] but also for their families and communities.[4–10] This phenomenon is often described as a "spillover" effect of mass incarceration.[10] For example, incarceration of a family member has adverse intergenerational health consequences, including a high risk of learning disabilities, mental health conditions, behavioral problems, and developmental delays in children.[4,5] Women with incarcerated partners have elevated rates of cardiovascular risk factors, anxiety, depression, and overall poor health.[6–8] Furthermore, given the extensively documented structural racism inherent in and reproduced by mass incarceration,[11] its collateral consequences contribute to and exacerbate racialized health inequities.

Most research concerning the spillover effects of mass incarceration defines incarceration as an individual-level exposure.[4–9] Few studies consider incarceration as a community-level contextual exposure, but there are strong theoretical reasons to do so. Multiple pathways link incarceration to negative health effects that operate at the community level through the destruction of community social and economic resources.[2] The cycle of imprisonment and reentry disrupts local economies and housing markets and increases the strain on social service systems.[12–14] Furthermore, incarceration impedes social integration, an important community-level protective factor against morbidity and mortality.[2] As mass incarceration erodes these crucial social and economic resources, it threatens the ability of communities to collectively build safe and healthy environments.[15] Jail incarceration, in particular, threatens social ties and local economies through what has been described as "coercive mobility," or the disruptive effects of individuals cycling in and out of the criminal justice system.[15,16]

Emerging empirical literature supports the hypothesis that community-level exposure to high incarceration rates affects community health. Living in a community with high incarceration rates is associated with a higher risk of cardiometabolic disease, major depressive disorder, and generalized anxiety disorder, after adjusting for community-level risk factors such as poverty and crime rates.[10,17] However, studies have been conducted primarily among local samples using cross-sectional data, with the exception of a recent study examining the association between incarceration and drug-related mortality nationally.[18] We build on the literature and address previous study design limitations; our study is among the first, to our knowledge, to analyze the association between jail incarceration as a contextual exposure and an essential indicator of county health—mortality—drawing on a longitudinal national data set.

METHODS

We conducted retrospective longitudinal county-level analyses to evaluate the relationship between lagged county jail incarceration rates and all-cause mortality rates in the United States from 1987 to 2016. We included all US counties with available data

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in the analyses. We treated the 5 counties in New York City as 1 because of their unique jailing structure.

Data Sources and Measures

We obtained all data from public sources, and data can be accessed via the referenced Web sites.

Jail incarceration. The exposure of interest was jail incarceration rate, calculated by dividing the average daily population of each county jail by the total county population. In counties with multiple jails, data were aggregated. Average daily population reflects an estimation of prevalence and not the total incidence of jail incarceration over a year. We obtained average daily population counts from 2 sources: the Bureau of Justice Statistics' (BJS) Census of Jails[19] and the Annual Survey of Jails (ASJ).[20] The Census of Jails is fielded every 5 to 8 years and captures data for all local jails in the United States. The ASJ collects data from a nationwide sample of several hundred local jails. The ASJ is fielded every year, except years when the Census of Jails is fielded. The sample of jails drawn for each ASJ is based on information collected from the most recent Census of Jails.

All US jails are grouped into 10 strata based on average daily population. In 8 of the 10 strata, a random sample of jails is selected. For the remaining 2 strata, all jails are selected for the survey based on BJS policy, primarily because they are operated by multiple jurisdictions or have large populations. As a result, the sample is skewed toward larger jails. We included Census of Jails data if the county was represented at any point in the ASJ data set. Thus, each county in the analysis had data for a minimum of 2 years (n = 6) and a maximum of the full 30-year period (n = 202). On average, a county was represented in the analysis for 15.5 years.

County population totals were obtained from the Census Bureau's Intercensal Estimates of the Resident Population for Counties and States (Intercensal Estimates).[21] Population data were missing for 3 county-year units, leaving 29 266 county-years available for analysis. We modeled jail incarceration rates both continuously and as quartiles.

Mortality. The outcome of interest was all-cause mortality rate. We first modeled total county mortality rates, followed by an analysis of age-specific mortality using mortality rates for the following 5 age groups: younger than 15, 15 to 34, 35 to 54, 55 to 74, and 75 years and older. We obtained all mortality rate data (1988–2017) from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research Underlying Cause of Death database,[22] which provides a count of total number of deaths per county per year per age group and an estimate of total population to calculate crude mortality rates. We treated mortality rates continuously in the analyses. Mortality data were missing for 25 county-year units, leaving 29 241 county-years remaining for final analysis.

Potential confounders. Because the fixed-effects regression models we employed control for all unobserved time-invariant confounders, we identified potential time-varying confounders based on their hypothesized relationships with jail incarceration and mortality. The first set of potential time-varying confounders included county median age, poverty rate, crime rate, and Black resident population as a percentage of total population. We selected median age because younger adults have a higher prevalence of criminal justice involvement and incarceration[23] and lower mortality than do older adults. We selected county poverty rate and Black resident population percentage as potential confounders because of the well-documented criminalization of low-income communities and communities of color[11,13,24] and the demonstrated mortality disparities among these groups. We selected county crime rate as a potential confounder because of the direct link between crime and incarceration and the role of crime in influencing safety and mortality. We adjusted for county median age using an 18-level variable with an indicator for the 5-year category containing the median age based on the Intercensal Estimates.[21]

We obtained county poverty rates for 1989 through 2015 from the Census Bureau's Small Area Income and Poverty Estimates system.[25] The county poverty rates reflect the percentage of all ages below the federal poverty level. For early years with missing data (1986–1988), we carried last observations backward. For years with missing poverty data for some counties (1990, 1991, 1992, 1994, 1996), we carried the closest previous data available for each county forward. We obtained county crime data from the Federal Bureau of Investigation (FBI) Uniform Crime Reporting Program,[26] and these data reflect all recorded part I offenses (murder, rape, robbery, aggravated assault, burglary, larceny, auto theft, and arson). We divided total crime estimates by county population from the Intercensal Estimates[21] to obtain county-level crime rates. Crime data were missing for 1993 and 2015 and were replaced with the corresponding county's crime data from the preceding year. Finally, we calculated the Black resident population in each county as a percentage of the county population using data from the Intercensal Estimates.[21]

We included a second set of potential time-varying confounders in additional models: county unemployment rate, state incarceration rate, and political party control of state legislature. We selected county unemployment rate as an additional measure of economic well-being, hypothesized to be associated with incarceration and mortality. We obtained county unemployment rates for 1990 through 2015 from the Bureau of Labor Statistics' Local Area Unemployment Statistics program.[27] For early years with missing data (1986–1989), we carried last observations backward.

We selected state incarceration rate and party control of state legislature as potential confounders that may reflect state-level differences in political climate or specific policies concerning criminal justice and health care. We obtained state incarceration rate data for all years from the BJS National Prisoner Statistics program,[28] and these data reflect the total population under custody in each state divided by state population. We obtained party control of state legislature data for all years from the National Conference of State Legislatures[29] and categorized them as Democrat, Republican, or split. We assessed multicollinearity by calculating correlation coefficients for all variables in the model and found that no 2 variables were highly correlated (Figure A, available as a supplement to the online version of this article at http://www.ajph.org).

Statistical Analyses

First, we calculated descriptive statistics for all variables of interest. To ensure the correct

temporal order of the hypothesized association between jail incarceration rates and subsequent county mortality rates, we employed a time-lag in our analyses (Figure B, available as a supplement to the online version of this article at http://www.ajph.org). To predict county mortality rate in a given year (t_2), we included county jail incarceration rate for the previous year (t_1). To ensure that potential time-varying confounders in adjusted analyses were not mediators on the causal pathway between the exposure and outcome, we lagged these covariate data by 2 years (t_0).

Using this time-lag, we conducted 2 sets of analyses. First, we modeled changes in total mortality. Second, we modeled changes in age-specific mortality. All analyses employed quasi-Poisson regression models with county and year fixed effects to account for all un–observed stable differences between counties and over time that may confound the relationship between jail incarceration and mortality. We employed quasi-Poisson models to account for the overdispersion that was apparent in initial Poisson models.[30]

In all models, we estimated county fixed effects by including $k - 1$ dummy variables for k counties.[31] The inclusion of the county dummy variable removes all between-county variance from the estimation of the association between jail incarceration rates and mortality rates, leaving only within-county variance to account for any observed association. As a result, only counties whose jail incarceration rates vary over time contribute to model estimation; those with no within-county variation are "differenced out" of the estimation. By essentially using each county as its own control, the fixed-effects approach rules out any observed or unobserved stable selection or confounding factors that render high incarceration counties unexchangeable (on all other causes of mortality) with low incarceration counties, assuming that the effects of those stable county characteristics are also time invariant.[31] We used the same dummy variable method for year fixed effects.

Total mortality analysis. First, we modeled jail incarceration rate as a continuous exposure. Model 1 included county jail incarceration rate and county and year fixed effects. Model 2 included the variables in model 1 plus the first set of potential time-varying confounders. Model 3, the fully adjusted model, included the variables in model 2 plus

the second set of potential time-varying confounders. We repeated these 3 models but split the distribution of jail incarceration rates into quartiles to aid in interpreting the association in relative rather than absolute terms. As a result, only counties with quartile changes in jail incarceration rates contributed to estimation in this set of models. We calculated quartiles across all years to account for national changes in jail incarceration rate over time.

Age-specific mortality analysis. Given the important role of age distribution in shaping a county's mortality and incarceration rates, we also conducted an age-specific analysis. We fit the fully adjusted model (model 3), excluding county median age as a covariate, with the outcomes of age-specific mortality rate for the 5 age groups described. These models included jail incarceration rate, county and year fixed effects, plus all time-varying confounders.

Sensitivity analyses. We conducted 3 sensitivity analyses using the described methods with the following changes: (1) using jail incarceration data compiled by the Vera Institute of Justice, which uses linear interpolation for counties missing from the ASJ,[32] (2) including county random effects rather than fixed effects, and (3) lagging the party control of state legislature data by 3 and 4 years as opposed to 2 years.

We limited analyses to county-years with complete data and performed analysis in R version 3.6 (R Foundation for Statistical Computing, Vienna, Austria) using the *dplyr*, *ggplot2*, *gtools*, and *lme4* packages.

RESULTS

The sociodemographic characteristics of the 29 241 county-year units in the study, representing 1884 unique counties and county equivalents (60% of all US counties and county equivalents), are presented in Table 1 by jail incarceration rate quartiles. Table 2 presents the number of counties represented in the data set by geography and year.

Total Mortality Analysis

Jail incarceration rate as a continuous exposure. The results from the 3 models treating jail incarceration rate as a continuous

exposure are presented in Table A (available as a supplement to the online version of this article at http://www.ajph.org). The results demonstrated that small increases in jail incarceration rate were associated with small increases in total mortality at the county level. In the fully adjusted model (model 3), a percentage point increase in jail incarceration rate was associated with a 0.4% increase in total mortality rate (risk ratio [RR] = 1.0038; 95% confidence interval [CI] = 1.0034, 1.0042).

Jail incarceration rate in quartiles. Seventy-five percent of counties experienced a quartile-level change in jail incarceration rate over the study period. Figure 1 presents the observed within-county associations between jail incarceration rate quartile and total mortality rates in the fully adjusted model (model 3). The numerical findings are presented in Table B (available as a supplement to the online version of this article at http://www.ajph.org). In the fully adjusted model, a within-county change in jail incarceration rate from the first to second quartile was associated with a 2.5% increase in total mortality rate (RR = 1.03; 95% CI = 1.02, 1.03). Additionally, we observed a dose–response relationship: change in jail incarceration rate from the first to third and first to fourth quartiles was associated with stepwise increases in mortality rates (RR = 1.06; 95% CI = 1.05, 1.06; RR = 1.06; 95% CI = 1.06, 1.07; respectively).

Age-Specific Mortality Analysis

Figure 1 also presents the associations between quartiled within-county change in jail incarceration rate and age-specific mortality rates from the fully adjusted model (model 3). Figure 2 presents the model-predicted age-specific mortality rate as a function of within-county change in jail incarceration rate from the fully adjusted model. The numerical findings are presented in Tables B and C (available as a supplement to the online version of this article at http://www.ajph.org). The association between change in jail incarceration rate and subsequent mortality rate was more pronounced among individuals younger than 75 years. The association was strongest with respect to the mortality of those aged 15 to 34 years. In the fully adjusted model, a change in jail

TABLE 1—Sociodemographic Characteristics of 29 241 US County-Years: 1987–2016

Characteristic	Total (n = 29 241), Median (IQR)	Jail Incarceration Rate Quartiles[a]			
		First Quartile (n = 7311), Median (IQR)	Second Quartile (n = 7310), Median (IQR)	Third Quartile (n = 7310), Median (IQR)	Fourth Quartile (n = 7310), Median (IQR)
Age-adjusted mortality rate (per 100 000)	883.7 (789.9–976.4)	873.3 (782.6–959.9)	884.1 (793.3–976.8)	881.9 (793.8–971.7)	897.6 (789.8–996.3)
Total county population (in 1000s)	73.3 (27.1–206.5)	40.4 (17.2–100.6)	64 (25.8–162.2)	102.8 (38.6–293.3)	124.2 (36.4–409)
% of population in poverty	13.9 (10.3–18.3)	12.4 (9.4–16.2)	13.4 (10.0–17.8)	13.9 (10.1–17.9)	16.1 (12.3–20.6)
Total crime rate (per 10 000)	304.3 (185.5–452.3)	226.2 (115.6–354.5)	274.4 (172.7–409.5)	335.2 (225.9–471.3)	392.0 (253.5–556.4)
% Black residents in county	5.3 (1.2–17.4)	1.3 (0.3–5.2)	3.9 (1.0–11.8)	8.2 (2.7–18.6)	14.4 (4.1–30.3)
% of population unemployed	5.8 (4.4–7.7)	5.6 (4.2–7.4)	5.8 (4.4–7.6)	5.7 (4.4–7.4)	6.3 (4.8–8.7)
State incarceration rate (per 10 000)	34.8 (24.7–44.0)	26.2 (18.3–36.4)	34.4 (25.1–44.2)	37.2 (27.9–46.7)	39.5 (31.5–46.2)

Note. IQR = interquartile range.
[a]First quartile: 0, 0.26; second quartile: 0.26, 0.58; third quartile: 0.58, 1.44; fourth quartile: > 1.44.

incarceration rate from the first to second quartile was associated with a 7.4% increase in the mortality rate of those aged 15 to 34 years (RR = 1.07; 95% CI = 1.06, 1.09). Again, we observed a dose–response relationship for all age groups.

Sensitivity Analyses

The findings from our sensitivity analyses were not meaningfully different from our reported findings with 1 exception: the change in mortality rate associated with a percentage point change in jail incarceration was larger when using the data set compiled by the Vera Institute of Justice.[32] Because the Vera Institute of Justice used linear interpolation to fill in missing data from smaller jail jurisdictions, a percentage point change reflects a more extreme change in this data set. The results from all sensitivity analyses are presented in Table D (available as a supplement to the online version of this article at http://www.ajph.org).

DISCUSSION

Our findings support the hypothesis that increases in county jail incarceration rates are associated with increases in county mortality rates, after controlling for all unobserved stable county characteristics and observed time-varying confounders. Specifically, a change in jail incarceration rate from the first

to second quartile was associated with a 2.5% increase in total mortality and a change from first to fourth quartile was associated with a 6.4% increase in total mortality. We also found that the association between jail incarceration and county mortality was stronger among younger individuals (< 75 years); a change in jail incarceration rate from the first to second quartile was associated with a 7.4% increase in the mortality of those aged 15 to 34 years. This finding suggests that county-level jail incarceration may be influencing premature mortality at the county level.

These findings are consistent with emerging research concerning the community-level collateral health consequences of mass incarceration. In their prospective analysis of data from the Detroit Neighborhood Health Study, Hatzenbuehler et al. found that individuals living in neighborhoods with high prison incarceration rates were more likely to meet criteria for current and lifetime major depressive disorder and generalized anxiety disorder than were individuals living in neighborhoods with low prison rates.[10] Using cohort data from Atlanta, Georgia, Topel et al. found that individuals living in neighborhoods with high incarceration rates were more likely to have dyslipidemia and metabolic syndrome than were individuals in neighborhoods with low incarceration rates.[17] Furthermore, race-stratified analyses showed that these associations were stronger among Black individuals.[17] Finally,

Nosrati et al. found that 1 SD increase in jail incarceration rates was associated with a 1.5% increase in drug use disorder mortality at the county level.[18] This study builds on this existing evidence by identifying an additional association with the basic health indicator of overall mortality. Together, these studies provide strong evidence of the widespread negative health outcomes associated with mass incarceration in the general population.

There are many plausible mechanisms that may underlie the observed association between change in county jail incarceration and county mortality, operating via material and psychosocial pathways. Materially, incarceration disrupts local economies by removing working-age individuals from the labor market.[33] Stigma and institutionalized discrimination introduce barriers to gaining employment and reintegrating into society that contribute to intergenerational cycles of poverty.[13] The lack of adequate reentry supports also places strain on communities' social service systems.[13] From a psychosocial perspective, the disruption caused by the revolving doors of the criminal justice system impedes a community's ability to build social ties and maintain social integration.[2,15,16] Social impediments such as these may contribute to community mistrust and perceived safety, which can affect the psychological health of community members.[10] These compounded stressors strip

TABLE 2—Number of Counties Represented in Data Set by Geographic Division and Year: United States, 1987–2016

Years	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
1987	21	77	118	85	191	105	110	62	66
1988[a]	35	124	275	239	369	247	297	152	111
1989	20	84	117	57	190	73	111	57	73
1990	20	84	117	57	189	72	110	57	73
1991	20	84	117	57	188	71	110	57	72
1992	20	84	116	57	187	71	110	56	71
1993[a]	35	123	273	243	368	240	299	155	112
1994	14	73	118	74	193	70	132	52	68
1995	14	73	118	74	195	70	132	52	68
1996	14	73	118	74	195	70	132	52	68
1997	14	73	117	74	177	68	84	52	68
1998	14	73	118	74	193	70	131	52	68
1999[a]	35	123	275	246	360	241	298	153	112
2000	16	78	122	68	202	95	128	55	69
2001	16	79	126	69	206	96	131	58	70
2002	16	79	126	69	204	97	131	58	70
2003	16	79	126	69	205	100	131	58	70
2004	16	79	126	69	205	100	130	59	70
2005[a]	35	123	274	245	350	238	293	150	113
2006	17	65	114	81	198	112	133	63	70
2007	17	65	114	81	198	112	133	63	70
2008	18	64	114	81	196	112	129	60	70
2009	18	64	114	81	195	112	129	60	70
2010	18	65	114	81	194	112	131	61	70
2011	18	63	111	80	192	99	127	60	69
2012	16	63	108	74	189	99	122	59	70
2013[a]	28	117	260	231	293	210	262	143	109
2014	17	57	106	79	183	101	118	55	83
2015	14	65	100	71	148	105	122	60	75
2016	13	62	100	69	145	104	118	60	76

Note. Geographic division defined by the US Census regions and divisions.
[a]Indicates Census of Jails fielded this year.

communities of the economic and psycho–social resources needed to safeguard community health and, as a result, may be reflected in changes in mortality rates at the county level.

The stronger association observed among younger individuals may reflect impacts of direct exposure to incarceration, as opposed to community-level exposure, given that this population is more likely to be criminal justice-involved.[23] This stronger association may also reflect the role of community-level

incarceration in influencing premature death by unnatural causes as opposed to aging-associated diseases. More research concerning cause of death would be helpful in clarifying this issue and further elucidating the underlying mechanisms at play in this study. Furthermore, in future research we aim to examine the role of institutional and structural racism, given that mass incarceration is a racialized social policy that disproportionately harms communities of color and given the existing research demonstrating heightened

community health impacts of incarceration in Black communities.[17]

Strengths and Limitations

This study has a number of strengths, including the use of large, longitudinal data sets. Additionally, the inclusion of county and year fixed effects and adjustment for time-varying confounders addressed measured and unmeasured confounding. Further, we conducted multiple sensitivity
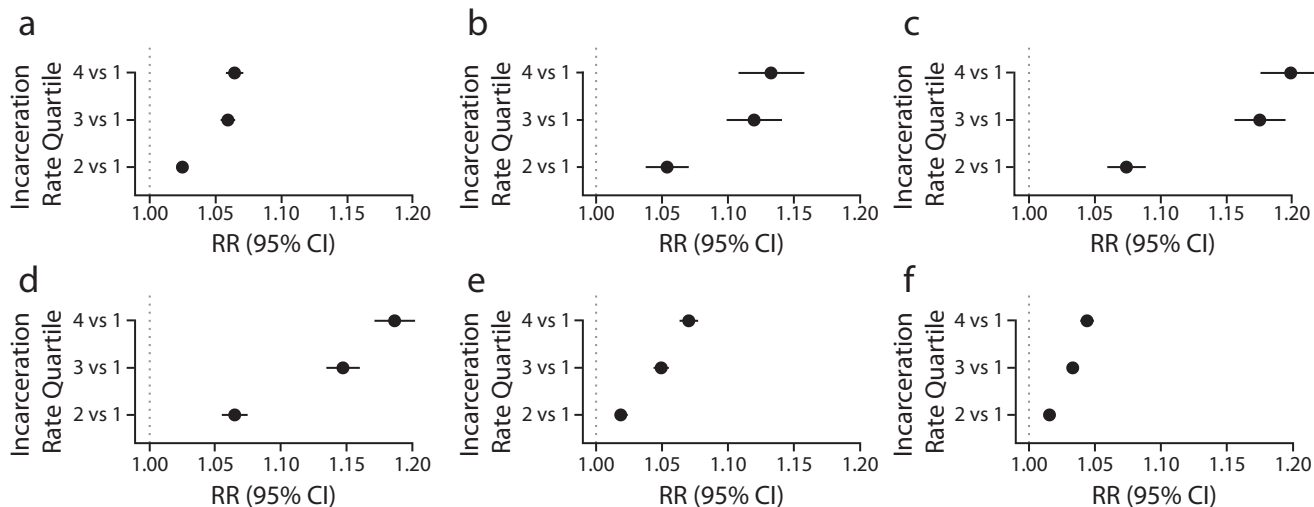
Note. CI = confidence interval; RR = risk ratio. Numerical findings are presented in Table B (available as a supplement to the online version of this article at http://www.ajph.org).

FIGURE 1—Associations Between Quartile Change in County Jail Incarceration Rate and Change in County Mortality Rates for (a) Total and Ages (b) < 15, (c) 15–34, (d) 35–54, (e) 55–74, and (f) ≥ 75 Years: United States, 1987–2016

analyses, all of which suggest that our findings are robust.

However, this study has important limitations. First, as with all observational data, there may be some unmeasured time-varying confounding that explains the observed relationship between county jail incarceration and mortality. For example, an additional measure of county economic well-being may be influencing this association. However, there was little change in county poverty and unemployment rates over the study period, suggesting that our inclusion of county and year fixed-effects controls for much of this potential confounding. Second, we did not have access to complete data for all jails in the United States. We also did not have complete data for all time-varying confounders for all years, and the accuracy of these data may vary by jurisdiction. For example, we cannot be certain of the reliability of the county crime data obtained from the FBI Uniform Crime Reporting Program.

Third, although the within-county analysis is robust in its adjustment for selection into counties, it limits the analysis to only those counties that experienced changes in jail incarceration rates over the study period. Fourth, counties represent large, heterogeneous geographic areas; the present analysis may lack the precision to capture more local effects of mass incarceration. Finally, although our time-lag approach ensures accurate temporal order of exposure, outcome, and confounders, there is likely autocorrelation between our confounders at different periods. Therefore, our results may be underestimating the true effect by adjusting for these confounders.

Public Health Implications

Our findings, which provide evidence of a county-level association between change in jail incarceration and mortality, are alarming: the jail system, ostensibly designed to protect the public while serving justice, may in fact harm communities. In particular, jail incarceration may have a stronger impact on premature mortality among younger populations. Given the inequitable distribution of incarceration, these spillover effects likely exacerbate socioeconomic and racialized health inequities at the community level. In addition to existing evidence of the wide-reaching health impact of mass incarceration at the community and individual levels, our findings provide further empirical
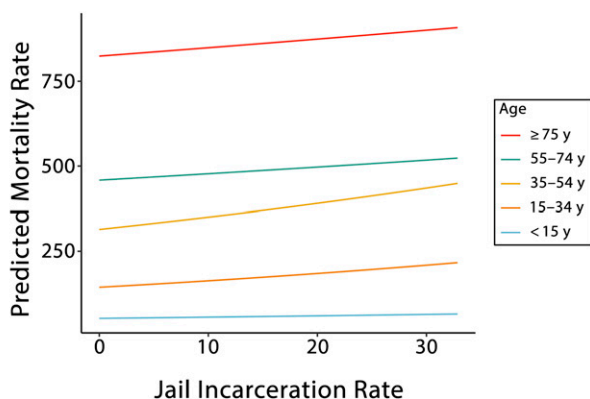

FIGURE 2—Model-Predicted Age-Specific Mortality Rates (per 100 000) as a Function of Within-County Change in Jail Incarceration Rate (per 100): United States, 1987–2016

evidence of the harms of current criminal justice policy. These findings can be used by criminal justice reform and de-carceration movements as they develop strategies and interventions to end mass incarceration. AJPH

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