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Article

Examining the relationship between U.S. incarceration rates and population health at the county level

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ABSTRACT

A collateral consequence of mass incarceration in the United States is its negative effects on population health. Using data from 2015, this study examines the relationship between incarceration rates and population health for a national sample of U.S. counties. To obtain unbiased estimates of the effect of incarceration on health, we use multivariate models which account for the endogeneity of incarceration rates when determining their effect on population health by employing an instrumental variable approach where the robust instrumental (exogenous) variable per capita corrections expenditures is used to predict incarceration rate. We then estimate population health outcomes as a function of predicted incarceration rate alongside factors such as public health spending, indicators of health behavior and control variables in models explaining county-level population health. Consistent with findings from prior research on individuals, families and at the state level, results of our analyses indicate that higher levels of incarceration are associated with higher levels of both morbidity (percentage reporting fair or poor health) and mortality (life expectancy). Implications of these findings for health and criminal justice policy, as well as research, are considered.

Introduction

The United States has the highest incarceration rate in the world (Sentencing Project, 2018). For the better part of the twentieth century – from the 1920s to the early 1970s – the U.S. incarceration rate was steady, averaging 110 per 100,000 persons in the population (Sampson & Loeffler, 2010, p. 20). However, in the mid-1970s, the number of people incarcerated in prison or jail began to rise dramatically. By 1980, the nation's incarceration rate had increased to 220 per 100,000 (or about 503,000 individuals). By 2016, the rate was 670 per 100,000 (more than 2,162,000) – an increase of about 330 percent (Bureau of Justice Statistics, 2018). This unprecedented long and large increase in the number of people behind bars is now commonly referred to as mass incarceration. It has been driven not by higher crime rates but by increased use of prison and jail and increased lengths of stay, especially in regard to the enforcement of drug laws (Clear, 2008).

Incarceration rates disaggregated by gender and race vary widely from the aggregate. Regarding gender, as of 2017, males' rate of incarceration was more than 13 times as high as females'. As for race, the racial disparity associated with mass incarceration is starkly evident: African Americans were incarcerated in state and federal prisons at a rate almost six times that of Whites, and almost double the rate for Hispanics (Bronson & Carson, 2019, p. 9).

As steep as the rise in the level of incarceration in the U.S. has been over the last several decades, aggregate national rates obscure substantial geographic variations in the level of incarceration – across states, cities and especially communities within cities (Sampson & Loeffler, 2010). This dramatic expansion of the American penal system has disproportionately affected a small segment of the population comprised of young minority men with very low levels of education (Western & Pettit, 2010). These individuals reside in a relatively small number of local communities, which bear the brunt of the phenomenon of mass incarceration (Clear, 2007). Within such communities, the prevalence of incarceration has made it a normal life event for many disadvantaged young men (Sampson & Loeffler, 2010).

The collateral consequences of mass incarceration are myriad. There has been extensive research on the negative effects of incarceration on one's subsequent prospects in life (e.g. Massoglia, 2008; Pager, 2007; Schnittker & John, 2007). Because some members of society (i.e., young under-educated African American males who reside in the poorest neighborhoods) are much more likely to be incarcerated than others, the United States' penal system has emerged as a mechanism of stratification and inequality (Massoglia & Pridemore, 2015). The individual-level effects of incarceration ripple outward, from those incarcerated to their family members, including spouses/romantic partners, children, siblings and parents. Reduced life opportunities of ever-incarcerated

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men "spill over" to negatively affect their loved ones and family members, including children; as a consequence, the effects of mass incarceration are almost certainly inter-generational (Murray & Farrington, 2008; Turney, 2014a; Tyler & Brockman, 2017; Wildeman, 2012a). High levels of incarceration also can have negative effects on communities. Approximately seven million people cycle between jail systems and their communities annually, while approximately 700,000 are released from prison each year (Cloud, Parsons, Delany-Rumsey, & Ayesha, 2014, p. 389). Research has demonstrated that the spatial concentration of incarceration has negative effects on phenomena ranging from community-level social dynamics (e.g., rate of female-headed households) to public safety (Clear, 2007).

Among the collateral consequences of incarceration is its negative effect on health (Fazel & Baillargeon, 2011; Massoglia & Pridemore, 2015; Wildeman & Wang, 2017). Prior research has consistently found that incarceration exacerbates societal health disparities (Iguchi, Bell, & Ramchand, 2005; Massoglia, 2008; Wildeman, 2011). A small but growing body of research has examined the relationship between level of incarceration and aggregate population health outcomes. Studies have examined this issue comparing nations (Stuckler, Basu, McKee, & King, 2008; Wildeman, 2016) and states (Johnson & Raphael, 2009; Wildeman, 2012a, 2012b; Wildeman et al., 2014) as well as intercounty differences within a single state (Thomas & Sampson, 2005; Thomas & Torrone, 2009). Even smaller jurisdictions have been the focus of analysis. For example, studies have examined the relationship between incarceration and health outcomes at the community (operationalized as ZIP codes) level (Ojikutu, Srinivasan, Borgart, Subramanian, & Mayer, 2018; Toppel et al., 2018). Studies using very small geographic areas such as census tracts (e.g., Porter, Thomas, & Emch, 2010; Thomas et al., 2007) are best suited to examine the relationship between incarceration and health outcomes at the neighborhood level.

This paper contributes to this area of research by examining the impact of mass incarceration on public health at the county level. It examines the relationships between county-level rates of incarceration and health outcomes on a national scale. It also accounts for the endogenous relationship between prison use and health outcomes (i.e., many of the same factors predict both) by using an exogenous factor (public spending on corrections) to produce an unbiased estimate of prison and jail use in models explaining indicators of morbidity and mortality at the county level.

Literature review

A significant body of research has examined the effect of incarceration on both morbidity and mortality, on individuals and families, as well as population health (Massoglia & Pridemore, 2015), including racial disparities in health (Massoglia, 2008). Research has variously considered the health of those who are or have been imprisoned, those with whom prisoners' lives intersect (i.e., family members and significant others) and the communities and neighborhoods to which they return, as well as the health of the general population (Massoglia & Pridemore, 2015). This review of the literature presents a succinct overview of the health effects of incarceration on the formerly incarcerated, followed in turn by an overview of the research on the effects of incarceration on the health of the families and romantic partners of the currently and formerly incarcerated, and their communities and neighborhoods. It then summarizes findings from research on the relationship between incarceration and public health outcomes at the county, state and national levels.

Effects on the formerly incarcerated. Those in prisons and jails have much higher rates of chronic and infectious diseases than the general population (Cloud et al., 2014), and research shows that incarceration has long-term health consequences as well (Schnittker & John, 2007). The formerly incarcerated face many maladies that are partially the product of their time behind bars, including both physical and mental health problems (Massoglia, 2008; Schnittker & John, 2007), as well as increased rates of mortality (Dumont, Bradley, Samuel, Nicole, & Rich, 2012; Pridemore, 2014). Schnittker and John (2007) found, based on their analysis of 1979–2000 data from National Longitudinal Survey of Youth (NLSY) that a history of incarceration strongly increases the likelihood of severe health limitations, and that any contact with prison is generally more important than the degree of contact. Massoglia (2008) using NLSY data, found a significant relationship between incarceration and later health status, especially health functioning at midlife, and that racial differences in midlife physical health are due primarily to disproportionate levels of incarceration. Massoglia, Pare, Schnittker, and Gagnon (2014) found that ever-incarcerated women were more likely to die than women without such a history, after controlling for the availability of health insurance, criminal behavior and health status prior to incarceration; by comparison, they found no relationship between incarceration and mortality among men.

Inmates are unable to develop a work history or marketable skills or social capital while imprisoned, and incarceration itself is a stigma that is more challenging to surmount than time out of the labor force or a deficit in skills (Schnittker & John, 2007, p. 117). Former prisoners, especially Black men, have great difficulty finding employment (Pager, 2007). As a result, the formerly incarcerated commonly deal with poverty, long periods of unemployment and marital instability – some of the best-known risk factors for poor health (Massoglia & Schnittker, 2009, p. 40). Partly as a consequence of decreased likelihood of having employer-based coverage, the formerly incarcerated are more likely than not to lack health insurance (Dumont, Allen Scott, Brockmann Bradley, Alexander Nicole, & Rich Josiah, 2013).

Former inmates' diminished social position, the result of the stigma of being an "ex con," contributes to high rates of discrimination, which studies have in turn linked to high blood pressure and forms of mental illness such as major depression and anxiety (Massoglia & Schnittker, 2009). Incarceration decreases the ability of former inmates to find stable housing, representing another major hurdle to overcome. Homelessness is much higher among former prisoners than in the general population (Dumont et al., 2013). Because Blacks and Latinos are disproportionately incarcerated, especially through the war on drugs, the cumulative effects of incarceration will be greater on them than on non-Hispanic Whites (Dumont et al., 2013).

Effects on the families and romantic partners of the incarcerated. Incarceration affects not only those who have or are serving time, but also those close to them such as their children, romantic partners and parents (Hatzenbuehler, Keyes, Hamilton, Uddin, & Galea, 2015; Wildeman & Muller, 2012). Research has shown that families of former inmates may suffer as much as the offender, in very much similar ways.

There are many avenues by which high concentrations of incarceration in a geographic area can negatively affect health, including stigmatizing and criminalizing the medically underserved, worsening educational achievement gaps, depriving the children of incarcerated parents familial and economic support (Cloud et al., 2014). For example, incarceration can affect a family's access to health care. Given the prevalence of employer-provided health insurance, and that many women receive health insurance through their spouse, many families of the incarcerated are more likely to be uninsured (Massoglia & Schnittker, 2009). Lee and Wildeman (2013) suggest processes by which mass imprisonment may harm the physical health of African American women by increasing their likelihood for risk factors including obesity, diabetes, hypertension, and cardiovascular disease – a result of the financial, familial and stress burdens placed on those connected to incarcerated men.

High rates of parental incarceration likely add to the instability of family life among poor children (Western & Pettit, 2010). More than half of all prisoners have children under the age of 18, and approximately 45 percent of those children were living with their parents before they were sent to prison (Western & Pettit, 2010, p. 14). Because parents of black children are much more likely to be imprisoned than parents of white children, incarceration can contribute to racial disparities in health (Wildeman, 2009). Also, many families suffer the simultaneous incarceration of multiple members of their kin network (Wildeman & Wakefield, 2014), thereby exacerbating incarceration's negative effects.

Turney (2014b), presents evidence that the many stressors experienced by incarcerated parents and their spouses or romantic partners (e.g., relationship dissolution, unstable family finances) might negatively affect the health of their children. Upon analyzing data from the 2011–2012 National Survey of Children's Health, she found that children of incarcerated parents experience an array of negative health outcomes, including attention deficit hyperactivity disorder, developmental delays, speech or language problems and behavioral or conduct problems (Turney, 2014). Parental separation is traumatic for children and parents alike, and this effect maybe especially acute among the families of female inmates, because of women's disproportionate role in childcare in many families (Massoglia & Schnittker, 2009).

Effects on communities and neighborhoods. The effects of incarceration also extend to the communities that those who are or have been incarcerated come from (Dumont et al., 2012; Massoglia & Pridemore, 2015; Wildeman & Wang, 2017). Those released from prisons and jails return to their communities, bringing with them the negative health consequences of incarceration. A disproportionate percentage return to poor communities of color – a phenomenon that exacerbates existing social inequalities and health disparities (Cloud et al., 2014, p. 389). Moreover, research has supported the idea that at a certain threshold, incarceration becomes criminogenic rather than deterrent, increasing the likelihood of victimization and associated stressors among members of high-incarceration communities (Clear, 2007; Sampson & Loeffler, 2010).

A large body of community research looks at the relationship between incarceration (e.g., living in a high-incarceration community) and the risk of contracting HIV and other STIs. At the community level, incarceration alters the social networks of which people are a part, increasing the rates of STI and HIV transmission. It does so by reducing the male to female ratio, thereby increasing concurrent sexual partnerships (Ojikutu et al., 2018; Porter et al., 2010; Thomas et al., 2007). Ojikutu et al. (2018) using communities (i.e., ZIP codes) for nine cities and metropolitan areas in the South, found prison release to be significantly related to HIV incidence. Stoltey, Li, Bernstein, and Philip (2015) based on analyses of census tracts in San Francisco found a positive association between level of incarceration and reported chlamydia incidence among female adolescents and young adults. Thomas, Levandowski, Malika, Torrone, and Wilson (2007) found a relationship between rates of incarceration and rates of gonorrhea at the census tract level in Durham, North Carolina. Potter et al. (2010) found a relationship between incarceration and gonorrhea at the census tract level in Guilford County, North Carolina. Toppel et al. (2018) and Taylor and Quyyumi (2018) examined the relationship between neighborhood (i.e., ZIP code) prison admission rates and cardiometabolic disease among non-incarcerated Blacks in Atlanta. They found that those living in neighborhoods with high rates of incarceration have worse cardiometabolic health profiles, including an increased likelihood of having dyslipidemia, hypertension and metabolic syndrome.

Public health outcomes at the county, state and national levels. The emerging literature of the effects of high levels of incarceration on families and communities indicates negative health outcomes on the families of those who are incarcerated, and prompts concerns that high levels of incarceration are harmful to entire communities, and therefore might partly explain health disparities in the population. A burgeoning area of research examines the relationship between level of incarceration and population health at the aggregate level. The indirect effects of incarceration rates on geographic areas are most readily measured at the population level (Wildeman & Wang, 2017).

Within the United States, the examination of the relationship between incarceration rates and population health would benefit from analyses conducted with counties as the unit of analysis. While it is the case that criminal justice law and policy is set primarily at the state level, there is wide variation in how a state's criminal justice policy is carried out across its counties (Weidner & Frase, 2003), including the fact that jails are county-level entities in the vast majority of jurisdictions. To date, research in this area using counties as the unit of analysis has been limited, and has focused only on specific states. For example, in their county-level studies based in North Carolina, Thomas and Sampson (2005) found moderately strong correlations between incarceration rate and the rates of chlamydia and gonorrhea, and Thomas and Torrone (2009) found that rates of teenage pregnancies and sexually transmitted infections increased consistently with increasing incarceration rates. In general, however, there is a relative dearth of research examining the relationship between level of incarceration and population health across the U.S. at the county level.

Aggregate-level studies of the relationship between incarceration rates and public health have more commonly used states as their unit of analysis. For example, Wildeman (2012a), using state-level panel data, found a positive relationship between imprisonment rate and population health operationalized as the total infant mortality rate, black-white inequality in the infant mortality rate, and the black infant mortality rate. In a separate state-level study Wildeman (2012b) found imprisonment to be associated with a substantial increase in the black-white gap in life expectancy at birth. Johnson and Raphael (2009) using state-level data from 1982 to 1996 found a strong effect of male incarceration rates on the rate of AIDS infection for both men and women, and concluded that higher incarceration rates over this time span accounted for most of the racial disparity in AIDS infection among women.

Regarding research on the relationship between incarceration rates and health across nations, in an analysis of European and central Asian countries for the years 1991–2002, Stuckler et al. (2008) found that mass incarceration explained increases in tuberculosis and multidrug-resistant tuberculosis. Wildeman (2016) examined the relationship between incarceration rates and health across 21 wealthy democratic nations. He found that population health consequences – i.e., increased infant mortality and decreased life expectancy at birth – of increases in incarceration rates are much worse in the United States than other countries, largely because its absolute levels of incarceration are so much higher. In sum, prior research suggests that mass incarceration could contribute to both between- and within-country differences in population health.

The aim of the present study is to contribute to this area of research by examining the relationship between incarceration rates and the health of their populations across a national sample of U.S. counties. More specifically, its purpose is to provide new insights about the adverse effect of incarceration rates on county-level population health, operationalized as life expectancy and quality of life. To do so, we use multivariate models which account for the endogenous nature of incarceration rate when determining its effect on population health. We employ an instrumental variable approach where the robust instrumental (exogenous) variable per capita corrections expenditures is considered alongside county-level measures of crime rate, and several pertinent sociodemographic factors such as racial composition and percent unemployed. We then use predicted incarceration rate as an independent variable in regression models alongside factors such as public health spending and indicators of health behavior and access to health care in models explaining county-level population health.

Methods

Analytic strategy

A challenge for researchers is to establish whether high levels of incarceration, as opposed to the factors that lead to these high levels, is a cause of poor health outcomes (Wildeman & Wang, 2017). It is almost certainly the case that many factors affecting incarceration level – e.g., poverty, low educational level – also affect population health. The dearth of sources of exogenous variation in incarceration rates has been cited as a limitation to research on the effects of incarceration rates on health

(Wildeman & Muller, 2012). Thus, to examine the effect of level of incarceration on health, we first must address the endogenous nature of incarceration rate. If endogeneity is not accounted for, the resultant parameter estimates will be biased – overestimating the effect of incarceration rates on population health (Schultz, O'Brien, & Tadesse, 2008).

The present study calculates parameter estimates by employing a two-stage least squares (2SLS) model. In the first model, it uses an exogenous variable, correctional expenditures, to estimate incarceration rate. Some assume that state spending on incarceration will constrain state spending in other areas, including health. If this inverse relationship existed, then correctional spending would be endogenous, and not useful as an instrumental variable. On the assumption that health spending is positively related to population health outcomes, an increase in correctional spending would negatively affect health outcomes. However, Ellwood and Guetzkow (2009) stress that there is little systematic empirical evidence of this budgetary tradeoff between spending on corrections and health. They examined whether correctional spending is an inverse function of state expenditures on other types of spending (i.e., transportation, education, health and welfare), and found this "crowding-out effect" existed in relation only to welfare (Ellwood & Guetzkow, 2009, p. 208). Ellwood and Guetzkow (2009, p. 229) conclude, based on their state-level longitudinal analyses, that although "spending on prisons has increased dramatically, it still does not garner a large enough share of the budget to make a big dent in programs other than welfare."

While welfare spending is indeed related to population health outcomes (Shahidi, Ramraj, Sod-Erdene, Hildebrand, & Siddiqi, 2019), it is important to recognize that because a large percentage of welfare spending is derived from federal (as opposed to state) dollars, the crowding-out effect of corrections spending will be tempered accordingly. By comparison, public health spending is more evenly split between the coffers of the federal government and the states. Moreover, in the county-level cross-sectional data on which this study is based, there is a non-significant relationship between spending on corrections and public health, and a weak *positive* association ($r = .075$, $p < .001$) between expenditures on corrections and welfare.

We estimate incarceration rate as a function of corrections expenditures, alongside county-level measures of index crime rate, and sociodemographic factors such as racial composition. We then estimate population health outcomes as a function of predicted incarceration rate along with social determinants of health in models evaluating county-level population health outcomes.

Data

County-level analyses were conducted using data from three sources. First, we use the Vera Institute of Justice's In-Our-Backyards (IOB) data set from 2015 for information on county-level rates of incarceration in prison and jails, as well as urbanicity (i.e., rural) and crime rate, from the FBI's Uniform Crime Report (UCR) Index (Vera Institute of Justice, 2018). Second, we use data on county health factors and outcomes for 2015 from County Health Rankings & Roadmaps (CHR&R), a collaboration between the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute (CHR&R, 2018). These data provide information on U.S. counties, compiled from different sources and intended to be cross-sectional, although the various sources from which it compiles information come from different years (2006–2012). Nonetheless, most of the variables considered are unlikely to change significantly from year to year, so the bias caused by heterogeneity in sampling time is likely to be small (Rettenmaier & Wang, 2013). Third, we used U.S. Census Bureau data on county-level expenditures to determine per capita spending on community and population health and corrections. These census data were from 2012; we selected a three-year lag period to account for the hypothesized effects on correctional populations, and health outcomes are likely to accrue over a few years, as opposed to a single year (McCullough & Leider, 2016). Lagging these variables also serves to preclude potential endogeneity.

Data coding and analyses are performed using SPSS statistical software. As mentioned previously, this research uses a 2-stage least squares (2SLS) approach. In the first stage, to account for the endogeneity of incarceration rate, we use ordinary least squares (OLS) regression to estimate predicted incarceration rate (i.e., a continuous variable), using the exogenous variable per capita correctional expenditures as an independent variable in this first model. In the second-stage OLS model, we use predicted incarceration rate alongside several health and sociodemographic factors to examine their effects on two continuous indicators of county population health. A more detailed explanation of the specification of models is offered below.

Stage One: Estimating Predicted Incarceration Rate. Predicted incarceration rates for each case were estimated based on a model with the exogenous or instrumental variable correctional spending, alongside seven other independent variables. The numerator of incarceration rate is comprised of the sum of the average daily county jail population for the calendar year and the number of people sent to prison from a given county as of December 31 of that same year. This number is divided by the census estimate of county population, and then multiplied by 100,000 to obtain the rate.

Correctional spending is a per capita measure which encompasses the money spent by a given county on residential institutions or facilities for the confinement of juveniles and adults (McCullough & Leider, 2016; U.S. Census Bureau, 2006). We used the natural log of this variable to account for its positive skew (Refer to Appendix A for more detailed information concerning how this measure was constructed.). This instrumental variable was hypothesized to be highly correlated with incarceration rate and uncorrelated with unobserved variables that may affect health. We conducted Wu-Hausman tests for endogeneity (Greene, 2012), the results of which confirmed that the instruments met exclusion restriction criteria ($p < .001$).

We estimate incarceration rate as a function of corrections expenditures, alongside county-level measures of UCR Index crime rate (logged to account for its positive skew [Neter, Wasserman, & Kutner, 1989]), urbanicity (i.e., whether a county was rural) and the following sociodemographic factors, which are commonly examined in research that attempts to explain variations in prison and jail use (e.g., Weidner & Frase, 2003): racial composition (percent Black), percent unemployed, median household income, percent of children in single-parent households, and the number of social associations (an indicator of social capital). An OLS model using these factors to predict incarceration rate produced the predicted incarceration rate which was, in turn, used as an independent variable in the health outcomes models, described below.

Stage-two models: health outcomes

Independent Variables. In the second stage of this 2SLS procedure, the following factors are considered alongside predicted incarceration rate in two separate OLS models explaining two health outcomes (described below). Descriptive statistics for these variables are presented in Table 1 (See Appendix B for a correlation matrix of the model variables.). To account for state-level fixed effects, state dummy variables were included as well. The inclusion of these dummy variables is especially important given that the level of incarceration in a given county is a function of both the number of individuals sent to locally-funded county jails and the number sent to prisons, which are funded by states.

Spending on Community Health Care and Public Health. Prior research has demonstrated per capita public health spending to be associated with a reduction in per capita Medicare expenses (Mays & Mamaril, 2017) and positive health outcomes (McCullough & Leider, 2016). To account for this factor, we use information from the 2012 Census of Governments on government expenditures for community health care and public health to create a per capita public health spending indicator. This measure encompasses spending for the provision of services for the conservation and improvement of public health, excluding hospital care and financial support of other governments' health programs (McCullough & Leider, 2016; U.S. Census Bureau, 2006). Because

Table 1
Descriptive statistics for the sample.

Variable	N	Mean	Median	SD
Premature death (YPLL)	2990	7996.294	7692.915	2399.795
Fair or poor health (%)	2732	17.262	16.500	6.125
Adult smoking (%)	2703	21.277	20.800	6.302
Adult obesity (%)	3132	30.693	30.900	4.336
Glucose testing (%)	3083	84.277	85.324	6.347
Uninsured (%)	3131	17.567	17.4222	5.375
Single parent households (%)	3131	32.090	31.278	10.354
Unemployed (%)	3131	7.247	7.043	2.646
Children in poverty (%)	3131	24.568	23.900	9.556
Black (%)	3132	8.888	2.100	14.301
Rural county (1 = yes)	3139	62.980	–	–
Public health spending ($ per capita)	3003	81.946	57.900	74.217
Predicted Incarceration rate (per 100 k)	2574	751.714	770.030	252.122

this variable is positively skewed, we used the its natural log in multivariate models; refer to Appendix A for more detailed information concerning how this measure was constructed.

Rural County. This factor is a dichotomous recode of the urbanicity variable in the IOB data set. The U.S. Census Bureau's urban areas represent densely developed territory, and encompass residential, commercial, and other non-residential urban land uses. “Rural” encompasses all population, housing, and territory not included within an urban area. Prior research (Hale, Beatty, & Smith, 2018) has found health outcomes to be worse in rural areas.

Health Factors. We used five indicators – each of which has been found to be a salient predictor of health outcomes – from County Health Rankings & Roadmaps (CHR&R). All of these were used to calculate CHR&R's 2015 County Health Rankings. First is an indicator of tobacco use, adult smoking, which is the percentage of the adult population that currently smokes every day or most days and has smoked at least 100 cigarettes in their lifetime. This item is from the U.S. Center for Disease Control's Behavioral Risk Factor Surveillance System (BRFSS), a state-based random digit dial telephone survey that is conducted annually in all states, the District of Columbia, and U.S. territories. In the CHR&R category of Diet and Exercise is adult obesity (also from the BRFSS), defined as the percentage of the adult population (age 20 and older) that reports a body mass index (BMI) greater than or equal to 30 kg/m2. An indicator for access to care, uninsured, is the percentage of the population under age 65 that has no health insurance coverage. This information is from the U.S. Census Bureau's Small Area Health Insurance Estimates program, which produces estimates of health insurance coverage for all states and counties. Percentage glucose tested, an indicator of quality of care, is the percentage of diabetic fee-for-service Medicare patients ages 65–75 whose blood sugar control was monitored in the past year using a test of their glycated hemoglobin (HbA1c) levels. This information is from the Centers for Medicare and Medicaid Services (CMS), the federal agency that collects data for every person and provider using Medicare health insurance, via the Dartmouth Atlas of Health Care Project.

Also included is a poverty index comprised of the following: unemployed, children in poverty, children in single-parent households and Black. All four of these are available at the county-level from CHR&R. Each of these is a percentage; because of issues related to multicollinearity in preliminary models in which they were included separately, we combined these indicators into a single measure by first standardizing them and then summing their standardized values (Wildeman, 2012b). The Cronbach's α for this four-item composite measure is 0.827.

Dependent Variables. This research uses two health outcome variables, both of which are available through County Health Rankings & Roadmaps (CHR&R). First is premature death – years of potential life lost (YPLL), which is based on all deaths occurring before the age of 75. Each of these deaths contributes to the total number of years of potential life lost. For example, a person dying at age 50 would contribute 25 years of life lost to the YPLL index. The YPLL is reported as a rate per 100,000 people. These data are from the National Center for Health Statistics and drawn from the National Vital Statistics System. The second health outcome variable we consider is fair or poor health, which is a measure derived from survey responses to the question: “In general, would you say that your health is excellent, very good, good, fair, or poor?” The value reported is the percentage of adult respondents who rate their health “fair” or “poor.” This item is from BRFSS.

Histograms of both of these outcome measures indicate that the distribution for each is approximately normal. Additionally, skewness and kurtosis values for each variable's distribution are within acceptable thresholds for normality (Field, 2013). Thus, we confirmed that OLS is indeed methodologically appropriate. Additionally, both of these health outcome indicators are very weakly correlated with the exogenous variable correctional expenditures; it was essentially unrelated to premature death ($r = 0.008$, n.s.) and very weakly related to fair/poor health ($r = 0.053$, $p < .05$).

Results

Descriptive statistics for the variables that comprise the two health outcome models are presented in Table 1.The preponderance of variables are measured as percentages (i.e., have a range of 0–100) with the exception of premature death, rural county, public health spending, and predicted incarceration rate.

Tables 2a and 2b presents the findings of multivariate analyses with the identical set of independent variables and the two health outcome measures. Note that for both outcome measures, higher values are indicative of worse outcomes (i.e., higher years of potential life lost, higher percentage reporting fair or poor health), so positive model coefficients are associated with worse health outcomes. Consistent with bivariate analyses (see Appendix B) that show that predicted incarceration rate is positively associated with worse health outcomes, one can see that in each of these multivariate models, higher predicted incarceration rates are associated with higher levels of both morbidity and mortality.

Table 2a presents the findings of the OLS model explaining the indicator of premature death (i.e., years of potential life lost). The unstandardized coefficient for predicted incarceration ($b = 0.823$, $p < .001$) in this model shows that for each 10-point increase in this factor, the value of a county's years of potential life lost increases by 8.23, controlling for other model variables. By comparison, the coefficient for glucose testing, the model's indicator of quality of care ($b = -41.458$, $p < .001$) indicates that a one-point increase in this factor is associated with a 41.458-point decrease in years of potential life lost, holding other model variables constant. The standardized coefficients (under the column headed “B”) provide a gauge of the relative influence of the model variables controlling for the scales at which they were measured – specifically, each B value represents the change in standard deviation units of years of potential life lost associated with a one-standard deviation change in a given independent variable. This common metric indicates that the effects of predicted incarceration ($B = 0.088$) and glucose testing ($B = -0.108$) are very similar, albeit in different directions of influence.

Table 2b presents the results pertaining to the OLS model explaining fair or poor health. The unstandardized coefficient for predicted incarceration rate ($b = 0.002$, $p < .001$) indicates that for each 50-point increase in this factor, holding other model variables constant, the percentage reporting fair or poor health increases by 0.1. By comparison, the coefficient for percent uninsured ($b = 0.236$, $p < .001$) indicates that a four-point increase in a jurisdiction's percent uninsured is associated with a 0.944-point increase in the percentage reporting fair or poor health, controlling for other model variables. In terms of the relative effect of the factors considered in this model, the standardized coefficients show, for example, that predicted incarceration ($B = 0.090$) has roughly half the effect of the health factors adult obesity ($B = 0.172$) and percent uninsured ($B = 0.190$).

Table 2a
OLS regression modela explaining years of potential life lost per 100,000.

Variable	B	SE	Β	t	Sig.
Adult smoking	89.380	5.779	0.240	15.468	0.000
Adult obesity	81.462	9.986	0.157	8.158	0.000
Glucose testing	−41.458	5.715	−0.108	−7.254	0.000
Uninsured	7.789	12.288	0.017	0.634	0.526
Poverty index	968.348	72.872	0.324	13.288	0.000
Rural county	472.201	65.068	0.102	7.257	0.000
Public health spending (logged)	−23.003	24.806	−0.014	−0.927	0.354
Predicted incarceration rate	0.823	0.211	0.088	3.895	0.000

[a]Coefficients for state dummy variables are not presented herein; CT, DE, HI and RI are excluded because of missing data.
R^2 = .685
$F_{(53,\ 2,176)}$ = 89.471 ($p < .001$)
N = 2229

Table 2b
OLS regression model[a] explaining percentage reporting fair or poor health.

Variable	B	SE	Β	t	Sig.
Adult smoking	0.256	0.017	0.260	15.22	0.000
Adult obesity	0.235	0.029	0.172	8.233	0.000
Glucose testing	0.018	0.016	0.017	1.082	0.279
Uninsured	0.236	0.035	0.190	6.793	0.000
Poverty index	0.013	0.002	0.168	6.367	0.000
Rural county	0.009	0.002	0.071	4.641	0.000
Public health spending (logged)	−0.001	0.001	−0.032	−1.899	0.058
Predicted incarceration rate	0.002	0.000	0.090	3.694	0.000

[a]Coefficients for state dummy variables not presented herein; CT, DE, HI, MA and RI are excluded because of missing data.
R^2 = .639
$F_{(53,\ 2,119)}$ = 70.916 ($p < .001$)
N = 2172

Discussion

This study used counties as the unit of analysis and employed the instrumental variable correctional expenditures to examine the effect of level of incarceration on two indicators of health outcomes – a measure of morbidity (fair or poor health) and a measure of mortality (years of potential life lost). Consistent with prior research that examined the relationship between incarceration rates and population health across countries and states, we found rate of incarceration to have a negative effect on health as indicated by both of our health outcome measures.

Research in this area manifests an increased focus on the intersection of epidemiological and social scientific research efforts to examine how political systems and priorities affect health inequities (Akers & Lanier, 2009; Beckfield & Krieger, 2009). The present study contributes to this area of research in its use of a national sample of counties (as opposed to states) as the unit of analysis, and an exogenous variable to account for the issue of endogeneity between incarceration rates and health outcomes, in order to provide an unbiased estimate of the effects of incarceration rates on the health of counties' populations. Regarding the latter, it is recognized that the dearth of sources of exogenous variation in incarceration rates has been a limitation to research on the effects of incarceration rates on health (Wildeman & Muller, 2012). Establishing whether high levels of incarceration, independent of the factors that lead to these high levels, is a cause of poor health outcomes has been a challenge (Wildeman & Wang, 2017). It is almost certainly the case that many factors affecting incarceration level – e.g., poverty, low educational level – also affect population health. Endogeneity must be addressed in order to avoid biased parameter estimates (Schultz et al., 2008).

Regarding the former, the novel county-level incarceration data made available by the Vera Institute of Justice allow for a more refined examination of the relationship between incarceration rates and population health on a national scale. There are distinct advantages to focusing on counties, as opposed to states, when considering the effect of incarceration rate. While it is the case that criminal justice law and policy are set predominantly at the state level, there is wide variation in how policy is carried out (i.e., by actors such as prosecutors and judges) across a state's counties and municipalities. Moreover, given that jails and courts are based in counties, it is very likely that state-level analyses will mask such variation (Weidner & Frase, 2003).

A key limitation of this study is that it is cross-sectional. Although some variables (i.e., logged transformations of government expenditures and crime rate) were temporally lagged, available data do not allow for the examination of the effect of *changes* in incarceration level on health outcomes over time. Also, especially given the aggregate nature of this study, the exact mechanisms through which incarceration rate affects population health are unclear (Wildeman & Muller, 2012). A longitudinal version of this study which uses an instrumental (exogenous) variable to produce unbiased estimates of incarceration rate's effect on health at the county level would enhance our understanding of the causal relationship between incarceration rates and population health.

Mass incarceration is a distinctly American phenomenon. The high rates of incarceration in the U.S. also makes it an outlier in terms of how incarceration rates affect population health (Wildeman, 2016). Moreover, because of the uneven distribution of incarceration rates, the negative health effects associated with incarceration rates could be a major factor in racial health disparities (Wildeman & Wang, 2017). This study adds to the research documenting the expanding collateral consequences of mass incarceration, and supports the assessment that overuse of prisons and jails is a significant social determinant of health disparities (Dumont et al., 2013).

For this reason, addressing the phenomenon of mass incarceration represents a significant community health opportunity (Toppel et al., 2018). Yet, there is no well-established or proven strategy for combating the effects of concentrated incarceration on communities (Clear, 2008) nor, by extension, on larger geographic areas such as counties. Major changes in sentencing practices that significantly reduce the number of custodial sentences and the increased use of diversion programs are two measures that – if implemented on a sufficiently large scale – could over time reduce mass incarceration and its deleterious effects on health. The idea of "therapeutic jurisprudence" – instituting programs designed to divert those with histories of addiction or serious mental illness to community-based treatment services in lieu of incarceration – could serve as an underpinning for such changes (Cloud et al., 2014, p. 390). Also along these lines, correctional officials and judges could consider the implications of individuals health, and formulate their sentencing and confinement decisions accordingly (Massoglia & Schnittker, 2009). Research that evaluates the effects of such approaches will be crucial.

Policymakers and politicians should use research that studies the effects of strategies to address drug addiction not just in terms of reducing arrests, but also in terms of criminal justice policies and laws on both the health of individuals and the impact on the communities in which they live (Cloud et al., 2014, p. 391). For those transitioning from jail or prison, a multidimensional approach that considers the inmates themselves along with the broader social context should be considered. Such an approach could incorporate assistance with housing and job training for the soon-to-be-released, so as to smooth their transition (Massoglia & Schnittker, 2009). Of course, reintegration of the formerly incarcerated is predicated on the existence of good opportunities for former inmates. In sum, the clear implication of this research for politicians and policymakers is that reducing the use of jails and prisons could have the benefit of improving their population's health, as well as racial disparities in population health.

Appendix A. Information on Government Expenditure Data

The U.S. Census Bureau's quinquennial Census of Governments includes expenditure data from all of the 87,000 local governments in the United States (U.S. Census, 2006). Using this information, we aggregated expenditures for all government entities within a county according to spending categories defined by the Census Bureau. These measures exclude expenditures made by state governments themselves. The two government spending variables we used in our analyses were operationalized as follows, and divided by census population estimates to derive per capita measures:

- ***Community Health Care and Public Health.*** This encompassed the census item "Current Operations – Health – Other." It is a conservative indicator in that it is exclusive of construction and capital outlays in the "Health – Other" category, on the assumption that these latter two do not directly affect health. It is also exclusive of any expenditures on public hospitals, which is a distinct expenditure category.
- ***Corrections.*** This expenditure category includes all item codes in the Census Bureau-defined "Corrections" category: "Residential institutions or facilities for the confinement, correction, and rehabilitation of convicted adults, or juveniles adjudicated delinquent or in need of supervision, and for the detention of adults and juveniles charged with a crime and awaiting trial" (U.S. Census, 2006).

As both of these measures are positively skewed, we made natural log transformations of both (Neter et al., 1989). The logged versions of these variables are used in the multivariate analyses described herein.

Appendix B. Pearson's r correlations among the observed variables

	Variables	Y1	Y2	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y1	Premature death	1												
Y2	Fair or poor health	.637**	1											
X1	Adult smoking	.558**	.555**	1										
X2	Adult obesity	.538**	.462**	.415**	1									
X3	Glucose testing	-.324**	-.193**	-.129**	-.091**	1								
X4	Uninsured	.410**	.455**	.250**	.112**	-.358**	1							
X5	Single parent hslds	.517**	.455**	.292**	.388**	-.196**	.271**	1						
X6	Unemployed	.398**	.512**	.357**	.250**	-.089**	.185**	.485**	1					
X7	Children in poverty	.689**	.678**	.453**	.456**	-.246**	.542**	.681**	.588**	1				
X8	Black	.320**	.291**	.044*	.410**	-.059**	.152**	.660**	.349**	.502**	1			
X9	Rural county	.254**	.176**	.159**	.160**	-.102**	.203**	.010	.036*	.244**	-.105**	1		
X10	Public health spending	-.111**	-.087**	-.062**	-.132**	.051**	-.075**	-.012	.076**	-.039*	-.056**	.020	1	
X11	ˆIncarceration rate	.565**	.560**	.339**	.406**	-.193**	.495**	.631**	.420**	.782**	.526**	.209**	-.054**	1

*p < .05; **p < .01.

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