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The contingent effect of incarceration on state health outcomes

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ABSTRACT

Introduction: This study examines how growth in the population of former prisoners affects rates of communicable diseases such as tuberculosis, syphilis, chlamydia, and HIV.
Methods: We estimate state-level fixed effects count models showing how the former prisoner population affected communicable disease in U.S. states from 1987 to 2010, a period of dramatic growth in incarceration.
Results: We find contingent effects, based on how specific diseases are recognized, tested, and treated in prisons. The rate of former prisoners increases diseases that are poorly addressed in the prison health care system (e.g., chlamydia), but decreases diseases that are routinely tested and treated (e.g., tuberculosis). For HIV, the relationship has shifted in response to specific treatment mandates and protocols. Data on prison healthcare spending tracks these contingencies.
Discussion: Improving the health of prisoners can improve the health of the communities to which they return. We consider these results in light of the relative quality of detection and treatment available to underserved populations within and outside prisons.

1. Introduction

This study considers the effects of incarceration on state-level public health outcomes. We ask whether growth in the population of former prisoners affects rates of communicable diseases such as tuberculosis, syphilis, chlamydia, and HIV in the broader community. There are reasons to expect negative consequences of incarceration, given that prisons are well-suited for the spread of infectious disease (Massoglia and Pridemore 2015) and the potential for spillover effects from prison to the community (Charles & Luoh, 2011; Nowotny et al., 2020; Schnittker et al., 2022; Wildeman and Wang 2017).

Alternatively, the health care provided in prisons may also benefit communities outside of prisons. Although there is considerable debate regarding the quality of prison care and the neglect of certain medical conditions, prisons clearly provide some degree of care for underserved populations. As we discuss below, prisons are legally obligated to provide care for "serious medical need" and must not act with "deliberate indifference" that could constitute cruel and unusual punishment (Greifinger, 2022). It is therefore reasonable to expect some improvement in detection and treatment as people move through prisons, at least relative to the low baseline level of detection and treatment available to them in the community. This, in turn, might prevent the spread of communicable disease once these individuals are released.

Communicable disease thus provides a prism for understanding contingencies, particularly when the prison system is considered alongside a health care system that systematically underserves marginalized communities. The literature on correctional care highlights both opportunities and challenges. The prison system oversees a medically underserved population with a relatively high burden of illness and provides opportunities for the direct observation of therapy, which is especially important in treating some communicable diseases (Skolnick, 1998). Yet an equally strong strain in this literature questions these opportunities, highlighting the noxious context of the prison itself (Barnert et al., 2020), variation in the quality of services (Reverby, 2019), the legal ambiguity surrounding treatment responsibilities (Headworth & Zaborenko, 2021), and the inconsistency between the command-control organization model of prisons and the collaborative model of health care (Heckman, 2013; Schnittker et al., 2022).

Understanding the balance of these influences, as well as their legal and structural antecedents, is important for science and policy. We will argue that the effects of incarceration on community health are neither uniformly positive nor uniformly negative; they are instead contingent

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on how specific diseases are recognized, tested, and treated in prisons. By tracing these countervailing influences, this study seeks to untangle the complex relationship between correctional care and population health. We analyze the period from 1987 to 2010, during which the state and federal prison incarceration rate more than doubled, rising from 230 per 100,000 U.S. residents to 500 per 100,000 U.S. residents (Carson, 2021).

1.1. Background

Understanding how incarceration affects the spread of infectious disease begins with understanding the infections prisons must test for, the diseases they treat upon detection, and how prisons both draw from and shape epidemiological environments outside prison walls. This background section highlights literature on the general spillover effects of incarceration on population health, as well as literature on carceral healthcare and the reasons why such settings are distinctive sites for the provision of care.

1.1.1. A. *Potential spillovers*

With regard to potential spillovers, there are clear reasons to expect a positive correlation between the number of former prisoners and deleterious state health outcomes, most notably evidence regarding the long-term effects of incarceration on individual health (Massoglia & Remster, 2019; Schnittker & John, 2007). Incarceration exposes people to stress and infectious disease and, after release, increases the risk of chronic conditions stemming from discrimination and the difficulties of reentry and reintegration. The possibility of community effects is magnified for infectious diseases such as STIs (Nowotny et al., 2020), given the ease of contagion within segregated social networks. Most released prisoners are drawn from and return to a relatively small number of disadvantaged communities (Morenoff & Harding, 2014). In the short term, this concentration lowers the male-to-female sex ratio and harms pre-existing relationships (Dauria et al., 2015; Pouget, 2017). In the long term, it fosters contagion given the dynamics of a population returning to the community with potentially high rates of infection.

Yet there is also a case for beneficial community effects, and these, too, can be understood from literature on the effects of incarceration on individuals. For instance, Patterson (2010) demonstrates that the mortality rate of Black men in prison is lower than that among Black men outside of prison. Although firearms and motor vehicle accidents account for some of this difference, these causes of death cannot wholly explain the gap, suggesting some role for prison health care. Consistent with this claim, there is direct evidence for the high use of medical diagnostic and treatment services among people in prison. Many incarcerated people resume treatments that lapsed prior to incarceration, whether because they lacked access to care, lacked health insurance, or decided to forego care (Wilper et al., 2009). At least 70% of state prisoners with medical problems report seeing medical professionals while incarcerated. Slightly more report receiving a medical exam or blood test, suggesting a vigorous detection program (Maruschak, 2010).

The balance between positive and negative spillovers rests partly on care outside prisons and partly on prison care. Any contingent effects on health will thus reflect the specific legal mandate behind care in each setting. Outside prison settings, the populations most likely to be criminalized are often uninsured and underserved (Winkelman et al., 2017), although the Affordable Care Act (ACA) has helped reduce the rate of uninsurance among formerly incarcerated men and (Gutierrez and Pettit 2020).

1.1.2. B. *Care in carceral settings*

The literature on carceral healthcare provides clear reasons to examine such settings as distinctive sites for care. Most notably, prisons are legally compelled to provide medical treatment, but the force of litigation does not produce a nimble or forward-looking system. Variation in detection and treatment between diseases is guided less by their prevalence—as would be the case if treatment reflected simple need—than by the legal consequences of failing to provide adequate treatment, given the mandate to care. Indeed, the legal mandate to care has produced a structured ignorance from which prisons can systematically overlook the medical needs of those in their care.

In Estelle vs. Gamble 429 U.S. 97 [Marshall and Supreme Court of The United States 1976], the Supreme Court ruled that "deliberate indifference to serious medical needs" violated the Eighth Amendment's cruel and unusual punishment clause (Greifinger, 2022). Rold (2008) refers to the thirty years since Estelle as a success in terms of the rights it conferred and the standards it spawned. Yet the ruling created an uncertain legal mandate and its ambiguities forestalled further progress. For one, a "serious" medical need is difficult to define, although working definitions (employed by managed care organizations and likely by prisons as well) identify conditions that, in absence of timely treatment, deteriorate and result in unnecessary pain, death, or risk to public health (Greifinger, 2022). This definition is limiting, obligating prisons to treat only diseases of significant effect and only those amenable to treatment. Furthermore, it does not necessitate testing or treatment for conditions deemed inconsequential to "public" health within the confines of a custodial setting.

Subsequent rulings have hewed closely to Estelle's initial parameters, as litigation has focused less on wholesale improvements in care than on addressing specific aspects of treatment or inadequacies regarding specific diseases or illnesses. Cases are usually brought by individuals in prison with specific problems or, in some cases, by classes of people with similar unmet needs (Wool, 2007). Prisons must avoid cruel and unusual punishment, but this is hardly an affirmative duty to care in a robust, preventive, and wholesale fashion (Genty, 1996). In this regard, courts consider evidence of the intention of correctional care, such as whether a prison has an active protocol for treating HIV or testing for TB, rather than the observed effectiveness of the care provided (Genty, 1996). Furthermore, federal courts have largely maintained a sphere of discretion around the decisions of medical professionals within prison settings, allowing them to employ their own definition of a serious condition (Rold, 2008).

1.2. Specific conditions: tuberculosis, HIV, syphilis, and chlamydia

Reflecting this model of care and its implied specificity, detection and treatment varies across medical conditions and is more likely to be reactive than proactive (Dolovich, 2009; Headworth & Zaborenko, 2021). The vast majority of people in prison are screened for tuberculosis, HIV, and syphilis (Maruschak, 2010). All three diseases are serious, treatable, and well-embedded in standard prison medical procedures across jurisdictions (Brodsky et al., 2013; Rich et al., 2016). TB, in particular, has been a long-standing concern (Lambert et al., 2016; Stewart et al., 2022). Syphilis, too, rises to the level of a serious concern, despite its low prevalence in the general population (Brodsky et al., 2013; Nowotny et al., 2020). The treatment of both TB and syphilis is effective and feasible in prison settings, in part because surveillance that would seem unnatural in non-prison settings is relatively normalized (Chuck et al., 2016). Directly observed therapy of TB, for instance, is effective both for treating infected people and for preventing infection to others: it greatly reduces infectivity and almost always leads to a cure (Parvez, 2022).

The case of HIV has been more dynamic, reflecting the rapid evolution of treatment, testing, and standards of care (Iroh et al., 2015; Maruschak, 2022). Indeed, studies of mortality suggest that prisons have shifted dramatically, though in ways that reinforce the contingent nature of prison care. Early analyses implicated prisons in the spread of HIV, highlighting the ease with which the virus could spread, especially where risky sexual behavior is common (Johnson & Raphael, 2009). In an analysis of the 1982–1996 period, for example, Johnson and Raphael (2009) find strong effects of the male incarceration rate on male and female AIDS rates. Other evidence is similarly suggestive. In 1995, a

third of all deaths in state prisons were AIDS related, suggesting both high prevalence and inadequate treatment (Maruschak, 2001). Since the 1990s, however, prison systems have adjusted their policies and procedures, usually in response to litigation and new testing guidelines (Pope, 2009).

Between 2001 and 2010 AIDS-related deaths in prison declined sharply, as did AIDS-related deaths among prison residents with HIV (Maruschak, 2022). In 2009, the AIDS mortality rate in state prisons fell slightly below the rate for the U.S. general population. This is not only a matter of better treatment for existing conditions. Testing also became much broader, such that more newly identified HIV-infected persons learned of their infection while incarcerated (see Dixon et al., 1993; Solomon et al., 2014). Many states initiated mandatory HIV testing or "opt-out" testing, which is equally effective (Lyons et al., 2014; Pope, 2009). Others provided testing based on a clinical indication of need or upon request. In addition, effective antiretroviral treatments became less costly and perhaps more effective in prison settings where direct observational therapy is more achievable (Haley et al., 2014; Spaulding et al., 2002).

Although these therapeutic effects reflect the provision of health care, the impact of prisons on reducing HIV infections does not end at release. These effects are at least partly behavioral. For instance, there is some evidence that people change their sexual behavior after learning of their HIV infection in prison, reducing the likelihood of spreading infection after release (Jafa et al., 2009; Underhill et al., 2014). Risk-reduction programs further reduce the likelihood of transmission (Spaulding et al., 2002; Valera et al., 2017), as do prison-based HIV prevention programs (White et al., 2008).

The broad response of the prison system to TB, syphilis, and, more recently, HIV does not apply to all communicable diseases, as shown in the national survey data for 2004–2005 presented in Table 1. A full 95% of U.S. state and federal prison residents reported they had been tested for TB (Maruschak, 2010). A national survey puts the figure somewhat lower for syphilis, but 76% of state prisons reported either mandatory or routine screening for syphilis (Hammett et al., 2007). The rate of HIV testing has changed over time, but 73% of those in state prisons (and 84% of those in federal prisons) said they had been tested for HIV in 2004 (Maruschak, 2010).

In contrast, only 20% of people in prison reported mandatory or routine screening for gonorrhea or chlamydia (Hammett et al., 2007). This low rate of testing is surprising if one regards need as the basis for services — the prevalence of these infections is high in prison and ought to compel commensurate levels of treatment (Centers for Disease Control and Prevention, 2011). It is less surprising, however, if the implied obligation to treat is stronger for conditions regarded as severe, or if the obligation to treat is only apparent when infections are known (and the obligation to test is weaker than the obligation to treat, especially for conditions not deemed serious). Chlamydia and gonorrhea can certainly have serious long-term complications, but these are most severe in women (who, despite recent increases, make up less than 10% of state and federal prison populations (Carson, 2021)). Complications can include pelvic inflammatory disease and other reproductive sequelae for women (LeFevre 2014), but some men with gonorrhea have no symptoms. These disproportionate impacts are consequential. In the general population, screening efforts for chlamydia and gonorrhea focus on women, both in fact and by U.S. Preventive Services Task Force recommendations (LeFevre 2014). If prisons fail to regularly test for chlamydia, they are following practices found in the general population and considering very narrowly the composition of the population in their care.

Table 1
Prison Health Screening Practices.

	Prisoners[a]	Prisons	
Disease		Mandatory or Routine[b]	Mandatory, Routine, or Regularly Offered[b]
Tuberculosis	95.1%	–	–
HIV	73.1%	39%	84%
Syphilis	–	76%	83%
Chlamydia	–	20%	40%
Gonorrhea		17%	37%

[a] Percentage of state prisoners who reported having their skin ever pricked to test for TB or their blood ever tested for HIV. Source: Maruschak (2010:20)

[b] Percentage of prison facilities that reported having mandatory, routine, or regularly offered testing for these diseases. Source: Hammett et al. (2007:8-11).

1.3. Hypotheses

The above research suggests both general and conditional hypotheses for the effect of former prisoners on state health outcomes. A general health-worsening hypothesis would predict that a high rate of former prisoners in a state would raise the incidence of infectious diseases ranging from tuberculosis to chlamydia. The mechanisms undergirding this hypothesis are intra-prison spread and subsequent transmission between former prisoners and others (Johnson & Raphael, 2009; Khan et al., 2005). A general ameliorative hypothesis, in contrast, would predict that a high rate of former prisoners would decrease the incidence of infectious diseases, largely through the provision of prison health care. Extant research on the attention to different conditions in prisons, however, suggests that both models may be oversimplified. We therefore propose a conditional hypothesis, stemming from the observation that different conditions receive very different treatment in prison settings. Under the conditional hypothesis, that a high rate of former prisoners in a state will only increase incidence for conditions that are not routinely tested and treated in prisons. The strongest version of the conditional hypothesis goes further, suggesting that a high rate of former prisoners will decrease rates of those diseases that are rigorously tested and treated in prisons.

2. Methods

2.1. Analytic strategy

To test these hypotheses, the number of formerly incarcerated people is more relevant to overall population health than the number currently in prison. This is because the formerly incarcerated will have received whatever detriment or benefit prison imparts and will be present to infect others in the community, if spillovers of this sort occur. Such spillovers most directly affect the partners and children of former prisoners, but they may also impact larger communities, in part due to the social and spatial concentration of people with incarceration histories (Morenoff & Harding, 2014; Wildeman & Wang, 2017). The current prison population, in contrast, has far less contact with the general population, which limits the impact of contemporaneous imprisonment on such community spillovers. Previous state-level research has also linked the rate of former prisoners to overall access to health care and the quality of care provided (Schnittker et al., 2015). We therefore estimate state-level fixed-effects count models (described below) that assess the effects of changes in the rate of former prisoners on changes in population health, as well as time-varying control variables plausibly related to incarceration and health.

Our analysis also attends to the challenge of distinguishing changes in disease detection from changes in infection. For instance, scholars recognize that observed increases in chlamydia case rates since 1996 are due, in part, to improved reporting, increased screening, and more sensitive diagnostic tests (Centers for Disease Control and Prevention, 2022). We disentangle these effects in two ways. First, we adjust for trends using a granular model specification. Detection effects are likely to change in a stepwise fashion as new diagnostic methods are introduced, whereas changes in incidence will likely occur more continuously. We model time using year fixed-effects, to be maximally sensitive to these influences, though some of the communicable diseases we

explore exhibit relatively straightforward trends. Second, we explore incidence rates by sex (except for TB, where sex-specific data are unavailable). Given the larger size of the male prison population and the more routine testing of chlamydia and gonorrhea in women outside of prison, the detection effects of incarceration should be much larger for men. For this reason, incarceration effects that are similar for males and females point to something more than detection. Of course, interpretations regarding detection also depend on the direction of the estimated effect; should we find that incarceration reduces the incidence of a communicable disease, our estimate of this negative relationship will be conservative.

2.2. Formerly incarcerated populations

The number of former prisoners is taken from demographic life table estimates for each state from 1987 to 2010, using the publicly available supplementary data reported in Shannon et al. (2017). These figures are based on life tables for successive prison release cohorts from 1948 to 2010, adjusted for recidivism, mortality, mobility, and deportation each year (Shannon et al., 2017). These data show a sharp rise in the estimated percentage of the adult population that are former prisoners but considerable variation across states. By 2010, the last year data are available for former prisoners, the rate exceeded 2% of the adult population in 27 states. Unfortunately, state-specific estimates of this key independent variable are not yet available for more recent years.

2.3. Disease incidence and HIV/AIDS deaths

Our dependent variables are based on state-level reports of communicable disease incidence and deaths attributable to HIV/AIDS. For each state and year, we model the number of new reported cases of TB, chlamydia, gonorrhea, and syphilis. With the exception of TB, where sex-specific reports are unavailable, the models are stratified by sex, a feature important to our design. Case counts are based on reports submitted to the CDC by state and local health departments. Chlamydia reporting before 1996 was voluntary and, therefore, sporadic. By 1988, however, at least 40 states were consistently reporting on chlamydia. Gonorrhea has been reported consistently since 1984, although Georgia did not provide a report in 1994. For sensitivity testing, we estimate models that include the full series and the series from 1996 forward. Reports are more uniform for other diseases, including TB, which has been reported since 1993. Deaths from HIV/AIDs are based on vital statistics. Reporting began in 1987, although early years contain unreliable values, as identified by the CDC. We address the discontinuous quality of the data by comparing models for the entire series against models that eliminate unreliable reports. As a further check, we limit analysis to the 1993–2010 period, reflecting the significant 1993 revisions in the surveillance case definition of AIDS (Klevens et al., 2001).

2.4. Independent variables

Our models include key variables related to both punishment and health, compiled from U.S. government sources for the 50 states. Table 2 shows descriptive statistics, including health outcomes and the former prisoner percentage. Other independent variables are taken from standard government sources, including racial demographics, unemployment, the party affiliation of the governor, the percent uninsured, the poverty rate, and the sexual assault rate. These variables were selected to reflect dynamic influences likely to affect the outcomes and unlikely to be captured through fixed state effects. The covariates also reflect influences correlated with incarceration, health care infrastructure, and health care access in the state. Governor's political affiliation, for instance, is correlated with spending and policy priorities (Altman & Morgan, 1983), including policies related to health (Rocco et al., 2020). Adjusting for state-specific shifts in economic conditions and racial demographics helps to distinguish the effects of shifts in the total rate of prison exposure from the effects of systematic group inequities in care and punishment. The state and year fixed-effects are important to our estimation strategy, providing statistical leverage beyond these time-varying control variables. Even over the extended series represented here, states differ consistently in incarceration and health, for reasons that predate but anticipate the rise in incarceration.

Table 2
Variable Means and Standard Deviations across US States and Years.

Variables	Years	Mean	SD
Health Outcomes			
Tuberculosis Reported Annual Incident Cases	1993–2010	333.97	617.38
Male Syphilis Reported Annual Incident Cases	1987–2010	708.58	1395.46
Female Syphilis Reported Annual Incident Cases	1987–2010	542.78	1163.58
Male Chlamydia Reported Annual Incident Cases	1987–2010	3023.03	4960.68
Female Chlamydia Reported Annual Incident Cases	1987–2010	11028.87	14648.41
Male Gonorrhea Reported Annual Incident Cases	1987–2010	4471.10	6368.83
Female Gonorrhea Reported Annual Incident Cases	1987–2010	4099.94	4923.94
Male HIV Annual Deaths	1987–2010	316.45	703.69
Female HIV Annual Deaths	1987–2010	71.38	164.07
State Ex-Prison Population			
Percent Former Prisoners	1987–2010	1.26	.65
Other State Characteristics			
Percent Below Poverty	1987–2010	12.58	3.67
Percent Uninsured	1987–2010	12.67	4.23
Percent Unemployed	1987–2010	5.46	1.72
Percent Black	1987–2010	10.21	9.52
Republican Governor (vs. non-Republican Governor)	1987–2010	.57	.49
Rape/Sexual Assault Rate per 100,000	1987–2010	35.87	13.03
State Prison Healthcare Spending			
Total (in $1000 of 2011 dollars)	2007–2010	$174,860	$423,245

2.5. Estimation

The data consist of state-years. We estimate negative binomial regression models of the count of incident cases (or, for HIV/AIDS, the number of deaths) on our independent variables. With time and state fixed-effects in place, our models assess the effects of change in the percent of state residents who are formerly incarcerated on change in the incidence of infectious disease and deaths from HIV/AIDS. Fig. 1 presents yearly grand means of the key variables over time. These include former prisoners as a percentage of state adult population, and reported incident cases for TB (Tuberculosis), male chlamydia, female chlamydia (shown in the top row of the figure), male gonorrhea, female gonorrhea, male syphilis, and female syphilis (shown in the second row of the figure), and male HIV deaths and female HIV Deaths (in the bottom row of the figure).

Our dependent variables are counts and we estimate negative binomial models to adjust for overdispersion (Cameron & Trivedi, 2013). The models include an exposure effect based on the size of the relevant underlying at-risk population for the particular model (men, women, or total population). The ex-prison population is specified with a 1-year lag.

To examine whether and how prisons respond to infections in their residents, we also consider prison healthcare spending. Although we cannot observe treatment behavior directly, spending patterns provide evidence suggesting variation in treatment. These models use Pew data on prison healthcare spending for 2007–2010 (Pew Charitable Trusts, 2014) in constant 2011 dollars. We estimate the log of state-level spending on prison health care as a function of the burden of infectious disease in the year prior. We then use the strength of the relationship with different types of infection in the year prior, in tandem

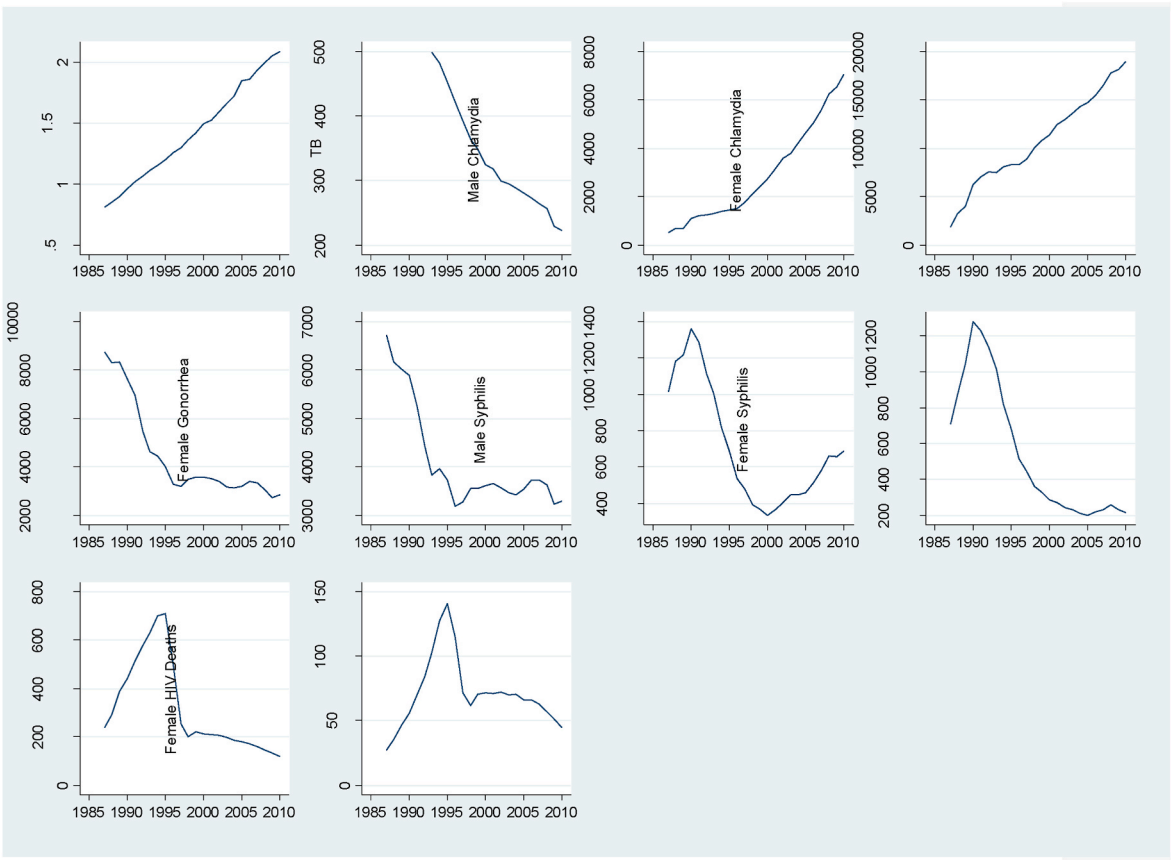

Fig. 1. Yearly grand means of key state-level variables. Note — Detailed Y-Axis Labels for Fig. 1. Row 1: Ex-prisoners as Percentage of State Adult Population; TB (Tuberculosis) Cases; Male Chlamydia Cases; Female Chlamydia Cases. Row 2: Male Gonorrhea Cases; Female Gonorrhea Cases; Male Syphilis Cases; Female Syphilis Cases. Row 3: Male HIV Deaths; Female HIV Deaths.

with information on the unit cost of treating these infections, to assess the extent to which prisons are addressing the specific infections among those in their custody.

3. Results

The state-level average effects we report are limited to the period from 1987 to 2010 (and from 1993 to 2010 for tuberculosis), when data on the key independent variable (the rate of former prisoners) and the key health outcomes are available. Table 3 presents negative binomial regression estimates predicting annual incident tuberculosis cases for 1993–2010. Two models are presented, the first without controls for time-varying covariates and the second including them. Both indicate that state-specific increases in the former prisoner population are associated with reductions in the number of TB cases. The inclusion of time-varying covariates reduces this magnitude of association but does not eliminate it. Interpreting the coefficients as incidence rate ratios, for each percentage-point increase in the number former prisoners in a state, the expected number of TB cases decreases by over 8% (i.e., exp (-0.092) = 0.912). Since TB is almost universally tested and treated in prisons, a negative effect provides evidence supporting the conditional hypothesis—that incarceration has a net negative association with state tuberculosis rates, likely attributable to comprehensive diagnosis paired with effective treatment.

Table 3
Negative Binomial Models Predicting Annual Tuberculosis Incidence.

Variables		
State Former Prisoner Population		
% Former Prisoners (1-Year Lag)	−.102***	−.092***
	(.027)	(.027)
Other Controls		
Time-varying Control Variables		✓
Year Fixed-Effects	✓	✓
State Fixed-Effects	✓	✓
Observations	900	900
Pseudo R-squared	.24	.24
States	50	50
Years	1993–2010	1993–2010

*p < .05; **p < .01; ***p < .001.
Note: Standard errors in parentheses. Time-varying control variables include percent below poverty, percent uninsured, percent unemployed, percent Black, Republican governor, and sexual assault rate.

Table 4 considers a spectrum of communicable diseases that vary in the degree to which they are treated in prisons, presenting sex-specific results to help disentangle detection and transmission. The general intra-prison transmission hypothesis predicts positive incarceration effects for all three outcomes, but the conditional hypothesis predicts positive effects only for chlamydia and perhaps gonorrhea (the more symptomatic of the two). Again, we find greater support for the conditional hypothesis. As the former prisoner population rises, rates of chlamydia increase substantially for both men and women. Among men, a percentage-point increase in former prisoners increases the incidence of chlamydia by 44% (exp(0.367) = 1.443), whereas among women it increases the incidence by 58% (exp(0.454) = 1.575). Because detection of chlamydia is less strongly tied to incarceration for women than men, this pattern implies transmission rather than detection. Gonorrhea presents a different pattern. The rate of former prisoners is unrelated to gonorrhea in men, but positively related to gonorrhea in women. One potential explanation for this pattern involves offsetting transmission and treatment effects, leading to a neutral effect among men but a rise

Table 4
Negative Binomial Models Predicting Annual Chlamydia, Gonorrhea, and Syphilis Incidence.

Panel A. Male Incidence	Chlamydia	Chlamydia	Gonorrhea	Gonorrhea	Syphilis	Syphilis
State Former Prisoner Population	.408***	.367***	.022	−.002	−.105^{+}	−.094
% Former Prison (1-Year Lag)	(.065)	(.065)	(.032)	(.030)	(.058)	(.058)
Other Controls						
Time-varying Control Variables		✓		✓		✓
Year Fixed-Effects	✓	✓	✓	✓	✓	✓
State Fixed-Effects	✓	✓	✓	✓	✓	✓
Observations	1137	1137	1199	1199	1200	1200
Pseudo R-squared	.07	.07	.16	.17	.16	.16
States per year	36–50	36–50	49–50	49–50	50	50
Years	1987–2010	1987–2010	1987–2010	1987–2010	1987–2010	1987–2010
Panel B. Female Incidence	Chlamydia	Chlamydia	Gonorrhea	Gonorrhea	Syphilis	Syphilis
State Former Prisoner Population	.470***	.454***	.140***	.133***	.048	.065
% Former Prisoners (1-Yr Lag)	(.070)	(.070)	(.032)	(.031)	(.065)	(.063)
Other Controls						
Time-varying Control Variables		✓		✓		✓
Year Fixed-Effects	✓	✓	✓	✓	✓	✓
State Fixed-Effects	✓	✓	✓	✓	✓	✓
Observations	1146	1146	1199	1199	1200	1200
Pseudo R-squared	.03	.04	.15	.16	.18	.18
States	36–50	36–50	49–50	49–50	50	50
Years	1987–2010	1987–2010	1987–2010	1987–2010	1987–2010	1987–2010

$^{+}$ p < .10; *p < .05; **p < .01; ***p < .001.
Note: Standard errors in parentheses. Gonorrhea was not reported by Georgia in 1994. Chlamydia reporting was not mandated until 1996.

among women. With regard to syphilis, which is more likely to be tested and treated in prisons, state incidence rates may decline somewhat for men as the former prisoner population increases (p < .10).

Table 5 shows HIV mortality for men and women alongside several sensitivity tests. It estimates models over the entire available series (1987–2010; over the later series when more uniform reporting practices were in place (1993–2010); and before and after eliminating reports regarded by the CDC as unreliable. All models yield similar conclusions, albeit with different magnitudes. Table 5 also includes models with an interaction between year and the percentage of former prisoners. Because the series for this model begins in 2003 and the interaction is with a year variable beginning at zero in 2003, the main effect can be interpreted as the relationship between the percent former prisoner and HIV/AIDS deaths in 2003.

In all specifications, incarceration increases deaths from HIV/AIDS. The relationship is strongest (for men) in models for years 1993–2010 that eliminate unreliable reports, but holds across all models. Among men, a percentage-point increase in the percent former prisoner leads to anywhere from a 12% (exp(0.109) = 1.115) increase in deaths from HIV/AIDS using all available data to a 21% (exp(0.191) = 1.210) increase using 1993–2010 data that exclude unreliable reports. Among women, the associations are somewhat larger: from a 27% to a 37%

Table 5
Negative Binomial Models Predicting Annual HIV Deaths.

Panel A. Male Deaths					
State Former Prisoner Population					
% Former Prisoners (1-Year Lag)	.171***	.185***	.109*	.191***	.308***
	(.032)	(.031)	(.031)	(.031)	(.078)
% Ex-Prison (1-Yr Lag) × (Year-2003)					−.013**
					(.005)
Other Controls					
Time-varying Control Variables		✓	✓	✓	✓
Year Fixed-Effects	✓	✓	✓	✓	✓
State Fixed-Effects	✓	✓	✓	✓	✓
Eliminating Unreliable Reports				✓	
Observations	900	900	1200	823	400
Pseudo R-squared	.28	.28	.24	.28	.33
States	50	50	50	44–50	50
Years	1993–2010	1993–2010	1987–2010	1993–2010	2003–2010
Panel B. Female Deaths					
State Former Prisoner Population					
% Former Prisoners (1-Year Lag)	.271***	.317***	.240***	.298***	.293*
	(.044)	(.043)	(.041)	(.045)	(.122)
% Ex-Prison (1-Yr Lag) × (Year-2003)					.006
					(.008)
Other Controls					
Time-varying Control Variables		✓	✓	✓	✓
Year Fixed-Effects	✓	✓	✓	✓	✓
State Fixed-Effects	✓	✓	✓	✓	✓
Eliminating Unreliable Reports				✓	
Observations	900	900	1200	766	400
Pseudo R-squared	.28	.29	.26	.29	.34
States	50	50	50	39–50	50
Years	1993–2010	1993–2010	1987–2010	1993–2010	2003–2010

*p < .05; **p < .01; ***p < .001.
Note: Standard errors in parentheses.

increase. This association, however, is contingent on time, as shown in the final model that interacts year and the percent former prisoner. From 2003 on, the relationship declined somewhat among men from 36% (exp (0.308) = 1.361) to about 24% (exp(0.308–0.013*7) = 1.242). These results are consistent with reports of improved HIV treatment in prisons over this period (Maruschak, 2010; Pope, 2009).

Table 6 provides summary information that helps convey the impact of the predicted effects for each condition, showing expected incident yearly counts across the models. It presents three hypothetical scenarios: predicted counts at the overall mean for the former prisoner percent (1.258), at one within-state standard deviation below the mean (−0.528), and at one within-state standard deviation above the mean (+0.528). For HIV, it presents deaths in 2003 and 2010, reflecting the bookends of the multiplicative interaction between the former prisoner percent and year. The standard deviation change is useful for evaluating magnitude, though it is conservative relative to the total amount of change. The overall mean for the former prisoner percent increased by 1.278 percentage points, from 0.809 to 2.087, between 1987 and 2010. TB infections have declined over time, on average by about 15 cases within states per year, which is approximately the same expected decrease for a standard deviation increase in the former prisoner percent. These absolute numbers are small, though the baseline TB incidence is quite low and decreasing. On balance, the prison system produces far more infections than it prevents given the high overall prevalence of STDs, though it does prevent a number of new TB infections relative to the baseline.

Table 7 examines prison healthcare spending by state from 2007 to 2010. The dependent variable is the natural log of spending on healthcare in prisons. The independent variables include the one-year lag of the number of former prisoners in the state, the one-year lag of the infection variables (all male-specific except for TB), the control variables used in other models, and year fixed-effects. The infections are, in this case, divided by 100 to scale the coefficients. The patterns are consistent with the idea that prisons spend a good deal on HIV infections, somewhat less on TB, and very little on chlamydia and gonorrhea. With a logged dependent variable, the exponentiated coefficients can be interpreted as the percent change in spending for every 100 additional cases of infection. Every 100 cases of TB results in 5% more prison healthcare spending (exp(0.051) = 1.052 or 5.2%), and every 100 deaths from HIV results in 9% more spending. Both chlamydia and gonorrhea, by contrast, result in less than 1% more spending. Because incident cases and deaths are not limited to those currently incarcerated, the actual increase associated with an incident case in prison is almost certainly higher. Yet the rank ordering of the coefficients is consistent with the implied emphasis of treating these specific infections in prison combined with the expected unit cost of treating each infection (see Chesson et al., 2008). Within this set of infections, the primary drivers of prison healthcare spending are HIV and TB, followed distantly by syphilis.

Table 6
Predicted Yearly Incident Cases/Deaths Under Alternative Scenarios.

	Former Prison Percentage		
	Minus One Within-State Standard Deviation	At Overall Mean	Plus One Within-State Standard Deviation
TB	369	351	334
Male			
Chlamydia	2077	2522	3062
Gonorrhea	4457	4451	4445
Syphilis	756	719	684
Female			
Chlamydia	7124	9054	11508
Gonorrhea	3753	4025	4317
Syphilis	503	520	538
Male HIV Deaths			
In 2003	142	167	197
In 2010	82	92	103
Female HIV Deaths			
In 2003	53	63	74
In 2010	30	35	42

Note: All expected values from models with complete set of control variables.

4. Discussion: the context and contingencies of prison health care

We began this study with the widely accepted idea that mass incarceration has compromised social welfare and health. Like other researchers (e.g., Mariner, 2001), we anticipated that prisons represented a potent locus for the transmission of infectious disease, given the conditions of confinement in U.S. prisons and the many pains of imprisonment cataloged in prior research. In this light, our results run counter to conventional expectations, particularly our evidence that incarcerating at scale has yielded a net public health benefit for certain disease outcomes. Although this finding reveals much about the prison system and its mandate to care, it perhaps says more about the health care system generally. The populations most likely to be criminalized—young, Black, and lower-income—are likely to be uninsured and underserved. Are levels of care so low that incarceration improves diagnosis and treatment for marginalized citizens?

This is a disturbing prospect, but our analysis indicates it is only half true. We find evidence for a conditional effect of incarceration on health outcomes, with the contingencies reflecting the ambivalent mandate of Estelle and the intersection of incarceration with other systems of inequality. The rate of former prisoners is negatively correlated with diseases that are routinely tested and treated in prisons, such as tuberculosis. Prisons thus appear to be somewhat effective in diagnosing and treating serious diseases that are difficult to identify in underserved populations, as well as diseases that, should they spread or be left untreated, would be tantamount to cruel and unusual punishment. Estelle mandates that prisons address serious medical concerns. Both TB and HIV are serious in consequence, and treatments exist to either eliminate the infections or greatly reduce the risk of death. By contrast, incarceration increases the incidence of chlamydia and (for women) gonorrhea. From the standpoint of Estelle, neither condition is regarded as particularly serious, even if prisons are implicated in their spread.

The most robust effect of prisons on improving public health is for TB, the one disease that is not sexually transmitted. This highlights another facet of the prison system's institutional neglect of health, and another paradox derived from the twin mission of care and punishment. Our results for chlamydia and gonorrhea point in part to the unrecognized importance of sex and sexuality in prison administration. There are numerous ways to prevent their spread, but most efforts of the public health system focus on women rather than men. The focus, then, is on those who suffer the most when infected rather than the parties implicated in transmission. Prisons appear to respond to these infectious diseases in much the same fashion, disregarding the bulk of those in their care, even as the carceral environment engenders intra-prison transmission.

Several institutional factors produce this neglect. For one, sexual contact between people in prison is generally illegal. Issues surrounding sexuality, including rape, have historically been ignored or minimized by prison authorities (Najdowski, 2011). In addition, people in prison are often reticent to talk about sexuality and especially rape. In this light, and combined with the asymptomatic nature of some sexually transmitted infections, it is perhaps unsurprising that prisons might overlook chlamydia. TB is very different in this regard. Whereas treating chlamydia and gonorrhea requires prisons to grapple with sexuality, recognizing TB transmission merely requires acknowledging its presence and its spread through coughs, sneezes, or vocalizations. In our study, prisons were largely unrelated to the incidence of syphilis, though this might reflect the convergence of some intra-prison transmission

Table 7
Least Squares Regression Models Predicting Log of Prison Healthcare Spending.

Variables	TB	Male Chlamydia	Male Gonorrhea	Male Syphilis	Male HIV Deaths
State Infections (1-Year Lag)					
Infections or Deaths/100	.051***	.003***	.007***	.021***	.089***
	(.011)	(.001)	(.002)	(.004)	(.022)
Observations	200	200	200	200	200
Pseudo R-squared	.863	.864	.860	.862	.859
States	50	50	50	50	50
Years	2007–2010	2007–2010	2007–2010	2007–2010	2007–2010

*p < .05; **p < .01; ***p < .001.
Note: Standard errors in parentheses. All models include year fixed-effects. Time-varying control variables include state former prisoner population, percent below poverty, percent uninsured, percent unemployed, percent Black, Republican governor, and sexual assault rate.

balanced out by testing and treatment. Although correctional officials and institutions are capable of mounting tailored and effective responses to some diseases that fit their standard of seriousness and their understanding of prison behavior, they lack the appropriate legal mandate, the resources, and the comprehensive ethic of care needed to bring about wholesale improvements in treatment.

4.1. Litigation and contingent effects

Although the Supreme Court's Estelle decision led to improvements in correctional care, it also paved the way for the contingent effects observed in this study. For one, Estelle makes further improvements in care difficult and tapers the path to enhanced care (Wool, 2007). When jurors evaluate whether officials intentionally neglected care, they are asked to identify with prison administrators charged with multiple responsibilities, rather than with the prisoners who are denied care (Pope, 2009). Proving ill-intent, consistent with Estelle's "deliberate indifference" standard, has also become especially burdensome. Moreover, the Prison Litigation Reform Act increased barriers to filings, making it difficult for people in prison to prevail at all (Schlanger, 2003). Estelle also funnels successful lawsuits toward narrow and specific enhancements. Successful class-action suits tend to focus on a single aspect of correctional care or a specific disease, such as HIV (Wool, 2007). The burden of proof required to document more systemic differences in the quality of care is considerably higher. Furthermore, litigation has emphasized the denial of treatment more than the failure to test. In aligning denial of services with cruel and unusual punishment, Estelle obligates prisons to treat serious disease associated with lingering death, but imposes little obligation to detect asymptomatic conditions or those unlikely to significantly impact individuals during their prison stay, regardless of the consequences for the community.

The ACA expanded access to affordable insurance and improved continuity of care between prison and release (Bainbridge, 2012), but it is unlikely to completely disrupt the incarceration effects observed here. If improvements in community care are robust and the uptake among criminal justice populations is high, the prison system might no longer represent an improvement in access to care, and infectious disease might be detected before incarceration. In this idealized case, the newly admitted might enter prison with treatment and medication plans already in place, increasing the responsibility of prison administrators to continue these plans. Yet the ACA does not obviate the obstacles and processes documented in this study, and political decisions can blunt its impact. For instance, the ACA encouraged states to expand Medicaid but did not obligate them to do so, and several states that have not expanded Medicaid have especially high incarceration rates (e.g., Louisiana and Mississippi).

4.2. Limitations and opportunities

Some caveats to the foregoing analysis include the absence of direct measures of prison practices and the absence of pre-1987 and post-2010 data to address recent patterns and the COVID-19 era. Our analysis is thus limited to the period of rapidly rising incarceration rates from the late 1980s to the turn of the twenty-first century. Further research is also needed to explore more granular race-specific and intersectional prison effects on the health of different groups. The state-level average effects we find are informative, given that states face a similar legal mandate based on federal law. Yet it is important to note that our analysis cannot compare pre-post time periods for either Estelle, which was decided in 1976, or the 2010 Affordable Care Act. Instead, we have compared different health outcomes that have been differentially affected by the former ruling. Because prisons vary in the quality of care they deliver, future studies that identify best practices among prisons in the post-ACA era are urgently needed. Our findings suggest that the potential for prison care has yet to be fully realized in practice or fully considered empirically. Nevertheless, none of our results obviate the opportunities available in the correctional care system. The effects we find would not be possible if prison care failed altogether, that is, if it did not provide services to populations with strong care needs. In this respect, our estimates, and their implications for health inequality, run counter to much of the literature on the social impacts of incarceration.

Our results also leave some uncertainty surrounding detection versus contagion. We have made a logical and partly empirical case for contagion, but future research might benefit from investigating diseases for which detection is more uniform. Such research would also benefit from considering consequences over varying geographies. The state is an appropriate level of analysis, given the overwhelming role of state prison systems in mass incarceration and in health care policies within (and outside) prisons. But local processes also matter. When released from prison, people return to a relatively small number of communities, disproportionately in urban areas. If geographic dispersion deflates the effects of incarceration on communicable disease, some of the results presented would be conservative. The concentrated nature of incarceration also suggests that municipal policies are relevant for health outcomes. We have made the case for contingent effects, but prison effects are also contingent on additional factors arrayed at varying levels of geography.

We find that testing in prison can improve population health, but this practice raises major ethical questions. Many states have moved toward mandatory HIV testing in prisons, for example, recognizing the opportunities for treatment and for intra-prison transmission (Pope, 2009). Although mandatory testing might be justified on public health grounds, it is not consistent with ordinary medical practice. Instead, public health organizations favor routine voluntary testing. In some cases, they recommend voluntary opt-out testing, wherein people in prison are provided with pre-test counseling and are tested unless they explicitly refuse. Future research is needed to assess the relative effects of mandatory and opt-out testing for population health. In the same context, it is important to evaluate resident perceptions in inherently coercive prison environments. Opt-out testing shifts the burden from those who choose testing to those who refuse it, but we know little about how people with drastically diminished agency view the burden of

choice regarding decisions to be tested for conditions like HIV.

5. Conclusion

Much research has shown how incarceration creates and reinforces inequality, yet prisons also have the capacity to address health problems and to improve prospects for people inside and outside prisons. This study finds that the effects of incarceration on community health are contingent on how specific diseases are recognized, tested, and treated in prisons. The different institutional responses to TB and HIV, relative to other STIs, are due in part to their seriousness, their symptoms, and the availability of treatment. We also draw attention, however, to the legal mandate in Estelle that imposes little obligation on correctional authorities to detect and treat asymptomatic conditions – even when such detection and treatment would greatly benefit the community. For the 1987–2010 period examined here, a high rate of former prisoners increased the incidence of diseases that are poorly addressed in the prison health care system (e.g., chlamydia), but decreased those that are routinely tested and treated (e.g., tuberculosis). For HIV, the relationship has shifted with treatment mandates and protocols. Improving the health of prisoners can thus improve the health of the communities to which they return. If prisons are helping to curtail the spread of communicable diseases outside prisons, however, this is more an indictment of the inequities of community care than a justification of the prison system. As our results indicate, such improvements hinge on what prisons regard as their central mission, the parameters of the legal mandate to care that they operate under, and the relative level of testing and care available to underserved populations outside prison walls.

Ethical statement

All authors have participated in the drafting and editing of this manuscript, have approved the work for publication in SSM – Population Health and accept full responsibility for its content. The work described has not been published previously, is not currently under review elsewhere, and if accepted, it will not be published elsewhere in the same form. The authors have no interest or conflict that might bias this work.

Author Statement

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Christopher Uggen: Conceptualization, Methodology, Writing – Original Draft; Writing – Reviewing and Editing; Project Administration; **Jason Schnittker**: Conceptualization, Methodology, Writing – Original Draft; Writing – Reviewing and Editing; Project Administration; **Michael Massoglia**: Conceptualization, Writing – Original Draft; Data Analysis, Methodology; **Sarah Shannon:** Writing – Original Draft; Data Curation; Data Analysis; Methodology.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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