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From Punitive Governance to Transformative Justice: Rethinking Criminal Justice Reform

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ABSTRACT: Punitive governance determines not only liberty but access to cooling, water, energy, and other environmental determinants of health. This ecological secondary-data study with deterministic policy simulation examined 4,078 populated carceral facilities in the contiguous United States. Facility population and mean annual days during 2016-2020 with modeled indoor maximum wet-bulb globe temperature above 28 degrees C were linked to 2019 state prison-and-jail incarceration rates in 48 states and the District of Columbia. Outcomes were population-weighted hazardous-heat days, annual person-days, facility-state exposure disparity, burden concentration, and person-days avoided under alternative population-reduction strategies. Facilities housed 2.03 million people and generated 41.25 million hazardous-heat person-days annually. State incarceration intensity correlated with weighted heat exposure (Spearman rho=0.541, $p<0.001$). Each additional 100 incarcerated people per 100,000 residents was associated with 3.09 more hazardous-heat days in the unadjusted model (95% CI 2.12-4.06) and 2.52 days after Census-region adjustment (95% CI 0.87-4.18); Census-division adjustment attenuated the estimate to 2.06 days (95% CI -0.14-4.25). Within-state exposure disparity was not associated with incarceration intensity. The highest-incarceration quartile accounted for 58.6% of person-days while housing 33.1% of the facility population. A 10% proportional population reduction avoided 10.0% of person-days, compared with 19.8% under heat prioritization within states and 36.6% under a national upper-bound strategy. Transformative reform should pair enforceable environmental-health protections with population reduction, community reinvestment, and safeguards against transfers and net-widening.

1. INTRODUCTION

The legal process, sentence proportionality, institutional order, rehabilitation and recidivism are all common ways to measure criminal justice reform. These domains are relevant, but do not fully reflect the impact of confinement on health. The prevalence of chronic disease, mental distress, disability, infectious disease and premature mortality is high in incarcerated populations, and the effects of incarceration reach out to families and communities (Fazel and Baillargeon, 2011; Massoglia and Pridemore, 2015; Wildeman and Wang, 2017; Cloud et al., 2023). A public-health analysis should therefore consider not just the legality of a sanction, but the distribution of exposure, protection and life sustaining resources by the institutions that operate it.

Punitive governance refers to a policy approach that is mainly based on criminalisation, incarceration, monitoring, exclusion and the deprivation or provision of material support to deal with insecurity and social harm. The carceral environment is one in which the state or its carceral contractor regulates access to potable water, ventilation, health and sanitation, electricity, temperature control, food, sunlight, shade, mobility and health care. A person that is confined is not normally able to escape from an overheated cell, to choose another water supply, to go to a cooling center, or to get reliable information about the environmental risk by himself. Confinement thus transforms environmental conditions into background circumstances to administered exposures.

Of particular interest as an informative tracer of this governance relationship is hazardous heat. Protection from the heat is influenced by built infrastructure and natural resources, while risk is influenced by climate and location, including safe water for hydration, reliable energy for cooling, shade and vegetation, clean air to breathe, space to retreat and clinical capacity. Wet-bulb globe temperature is a combination of heat and humidity and is a measure of physiological heat stress. The National Institute for Occupational Safety and Health (NIOSH) recommends 28 degrees C WBGT as a safe temperature for acclimatized workers doing moderate work under specific work/rest schedules (Jacklitsch et al., 2016). Individuals in custody could be at further risk due to age, cardiovascular or renal disease, taking psychotropic or other heat sensitive medications, lack of access to water, and lack of ability to change activity or location.

Carceral heat has been the subject of recent research that reveals the extent and health impacts of heat in prisons. Tuholske et al. (2024) estimated exposures for all 4,078 operational and populated facilities in the continental United States, and found that there were ~41.3 million hazardous-heat person-days each year in 2016-2020. Ovienmhada et al. (2024) identified patterns of summer heat exposure, vulnerability and risk at the facility-level. Extreme heat has been associated with risk of death in national and Texas-specific epidemiological studies, and air conditioning has been shown to significantly reduce this risk (Skarha et al., 2022; Skarha et al., 2023). This is part of a larger body of research on environmental justice and the environmental conditions of incarcerated people, which includes exposure to unsafe drinking water, air-quality hazards, contaminated watersheds, and poor local environmental quality (Nigra and Navas-Acien, 2020; Pellow, 2021; Poirier et al., 2024; Moran et al., 2024).

Environmental justice offers three dimensions which are relevant. Distributional Justice is about who is exposed to harm and who has the resources to be protected. Procedural justice issues include access to information, decision-making power, monitoring, complaints procedures and remedies. Recognitional justice is about the legitimacy of the knowledge, dignity and vulnerability of those affected by the institutions (Brulle and Pellow, 2006; Mohai et al., 2009; Pellow, 2021). In carceral environments, these dimensions are typically compressed, with exposure potentially great, exit options limited, and the population at risk with little formal budgetary or siting control, infrastructure, or emergency response.

While the current heat literature addresses the question of whether the existing heat of facilities is a risk to incarcerated persons, the question of how much overlap in the scale of incarceration there is with hazardous environmental exposure, beyond the heat of facility location, has not been fully answered. A jurisdiction can have a high national burden for any—or all—of the following reasons: 1) incarcerates a high proportion of individuals in a hot region of the state, 2) facilities are disproportionately located in hotter regions of the state, 3) both of the above. It is important to differentiate between overall exposure and intra-state variability. The first is a combined effect of punitive scale and climatic geography, the second more specifically is an effect of facility location with respect to the surrounding state.

Transformative justice throws in a second distinction. Good humane conditions and structure reduction goals are not mutually exclusive. Cooling, safe water, medical protection and enforceable thermal standards are a pressing need for all those who are trapped right now. Meanwhile, infrastructure-only reform could be a form of normalization or expansion of confinement, absent reductions in admissions, length of stay, and meaningful release review, and investment in non-carceral safety.

Transformative justice is about safety, accountability, repair and change – defined by the survivors – in the conditions that produce harm, not just punishment (Kim, 2018; Kim, 2021; Rossner and Taylor, 2024). It also needs to include safeguards against net-widening, including the use of intrusive monitoring of individuals who would have been unconditionally released (Phelps, 2013; Kubrin and Tublitz, 2022). The conceptual pathway discussed in this paper is shown in Figure 1.

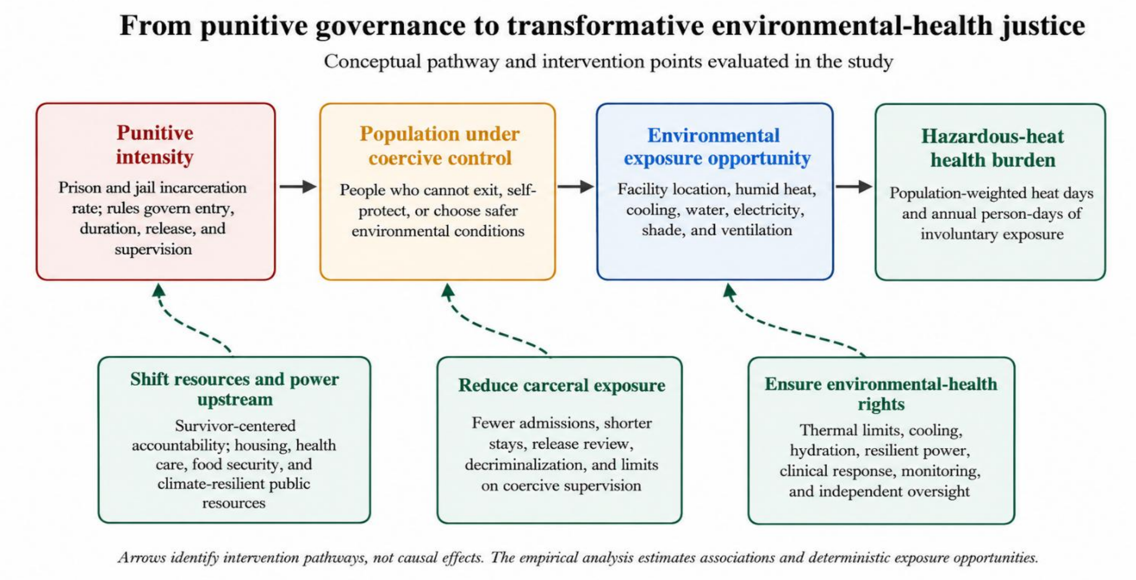

Figure 1. Conceptual pathway linking punitive intensity, the population under coercive control, environmental exposure opportunity, and hazardous-heat health burden. Dashed arrows identify three transformative intervention points. The diagram guides interpretation but does not assert causal effects.

This research was designed to answer four questions accordingly. First, do the intensity of state prison-and-jail incarceration and population-weighted hazardous-heat exposure in contiguous jurisdictions in the United States vary? Second, does incarceration intensity correlate with excess heat at facility sites, compared to the rest of the state? Third, what is the level of national exposure by facility, population, facility type, and state? Fourth, what benefits would accrue in terms of exposure avoidance if there were population reduction proportional to exposure or prioritized by heat? We hypothesized that the total exposure would be correlated with the intensity of incarceration but that this correlation would be decreased when accounting for broad geographic divisions due to the spatial pattern of climate and penal policy

2. MATERIALS AND METHODS

2.1 Study design and setting

A secondary data ecological cross-sectional study was performed with a deterministic counterfactual policy simulation. The analytic population included prisons, jails, immigration detention facilities, and other carceral facilities that were both operational and populated in the 48 contiguous states and the District of Columbia. The facility was the unit used in burden and scenario analyses and the state or jurisdiction was the unit used in association models. This study was exploratory, and not preregistered. All associations were considered as patterns at the jurisdiction level and not as individual or causal effects, due to the aggregation of exposure and policy measures.

2.2 Data sources and analytic sample

The open source data and code repository that accompanies Tuholske et al. (2024) was used to obtain facility-level heat and population data. A source file was created containing 4,078 operational and populated facilities, a facility type, the 2018 population, and the mean number of days in 2016-2020 during which the modeled maximum wet-bulb globe temperature (WBGTmax) was > 28 degrees C. Original investigators calculated WBGTmax using temperature and vapor-pressure-deficit estimates from 4-km PRISM data, transforming the data using a fixed low wind speed assumption and no radiant heat, and correlating these estimates to Homeland Infrastructure Foundation-Level Data facility locations (Tuholske et al., 2024). The

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source data for Figure 2a was also used to compute the population-weighted difference between the number of hazardous-heat days at facility locations and the number of hazardous-heat days at other locations in the state, on average for the 2016-2020 period.

State incarceration rates are from the Vera Institute of Justice Incarceration Trends dataset (Vera Institute of Justice, 2026), version 3.1. We chose 2019 because it is close to the midpoint of the 2016-2020 exposure window and prior to pandemic-related changes in jail and prison populations. The main policy exposure was the overall state prison-and-jail incarceration rate per 100,000 state residents aged 15-64. The Vera file also supplied Census region and division classifications. Alaska and Hawaii were not included in the heat data set, and the District of Columbia was kept as a jurisdiction for a total of 49 analytic units. The data sources, measures and limitations are summarized in Table 1.

Table 1. Data sources, measures, and analytic roles

Source	Unit and period	Variables	Role and principal limitation
Tuholske et al. (2024), Figure 1b source data	Facility; 2018 population and 2016-2020 mean exposure	Facility type, population, annual days with modeled indoor/shaded WBGTmax >28 degrees C	Primary burden and concentration analysis; no facility-specific cooling or direct indoor sensors
Tuholske et al. (2024), Figure 2a source data	State-year, 1982-2020; averaged for 2016-2020	Population-weighted facility-versus-state difference in hazardous-heat days	Secondary relative-siting outcome; state averages can mask within-state heterogeneity
Vera Incarceration Trends v3.1	State/jurisdiction; 2019	Prison-and-jail incarceration rate per 100,000 residents aged 15-64; Census region and division	Punitive-intensity measure and geographic adjustment; denominator does not map exactly to all facility types
Derived analytic files and code	Facility and jurisdiction	Person-days, weighted heat, quartiles, regression models, concentration curve, counterfactual scenarios	Fully reproducible from cited source files; simulation is deterministic, static, and non-causal

2.3 Measures

The main outcome was the number of hazardous-heat days weighted by population. To calculate the person-days of hazardous-heat exposure, for each jurisdiction we multiplied the number of people at each facility in 2018 by the average number of days with hazardous heat in that jurisdiction, and divided by the total population of facilities in the jurisdiction. Annual hazardous-heat person days were the product of the number of people unable to leave the environment and the number of days the environment was hazardous, and thus represented a combination of the severity of the environment and the number of people exposed. The national weighted mean was computed in the same way.

Within-state heat disparity was the 2016-2020 mean difference in number of hazardous-heat days that a facility experienced compared to the rest of the state, weighted by population, as provided in the source data from Tuholske et al. Positive values means that the facility locations were hotter than the background of the state. This was done separately from total exposure to differentiate the relative facility siting from the total climatic burden faced by incarcerated individuals.

We reported burden by facility type and in terms of three thresholds of at least 30, 60, and 90 hazardous-heat days per year. Sorting facilities were ranked from most to fewest hazardous-heat days and cumulative person-days were plotted against cumulative facility population for exposure concentration assessment. This curve was used to compute a population-weighted Gini coefficient, which is a measure of equality of annual heat days (a value of zero means the number of annual heat days is equal for all people in the facility population, while a value closer to one means the number of annual heat days is concentrated in the population). We also estimated the proportion of person-days in the country that could be attributed to the top 2, 5 and 10 jurisdictions by burden.

2.4 Statistical analysis

The jurisdictions were ranked in quartiles based on their 2019 incarceration rate. Median and mean population-weighted heat days were summarized and quartiles were compared with a Kruskal-Wallis test. Spearman's rho was used to determine monotonic association between incarceration rate and total heat, and Pearson's correlation was provided as a descriptive sensitivity value. The 95% interval for Spearman's rho was obtained using a percentile bootstrap with 10,000 resamples and a fixed random seed. Leave-one-jurisdiction-out estimates were used to determine if the correlation was influenced by any one jurisdiction.

Ordinary least-squares models were used to estimate the change in population-weighted hazardous-heat days due to a 100-per-100,000 increase in incarcerated persons. The small sample size and possible differences in residual variance across jurisdictions warranted the use of heteroskedasticity consistent HC3 standard errors. The main model was uncorrected. Two models of geographic confounding, a Census-region model and a Census-division model, were used. In the parallel models, within-state heat disparity was the outcome, with and without region adjustment. Two-sided p values < 0.05 were deemed statistically significant, but focus was placed on effect estimates, confidence intervals, and geography sensitivity. Analyses used Python 3.13.5, pandas 2.2.3, NumPy 2.3.5, SciPy 1.17.0, and statsmodels 0.14.6.

2.5 Counterfactual exposure-reduction scenarios

This study simulated three allocation rules for 5%, 10%, 20%, and 25% reductions in the number of facilities in the country. The proportional approach resulted in the same proportion of reduction for each facility and the proportion of person-days avoided was the same as the proportion of persons reduced. The within-state heat-prioritized approach involved each jurisdiction cutting the same percentage of its facilities, starting with the facilities in each jurisdiction with the highest exposures. The national heat-prioritized approach assigned the entire target to facilities with the most hazardous-heat days per year, and interpreted the target as an upper bound for exposure-reduction. The simulation estimated continuous person-day opportunities and not discrete legal decisions and therefore fractional persons were allowed.

The simulation assumed constant climate, facility conditions, and per-person exposure, and no replacement admissions or transfers to other carceral facilities. It did not reflect legal eligibility, sentence structure, reentry resources, survivor safety, community capacity, or public-safety outcomes. As such, the scenarios are not release recommendations or forecasts. They separate out the effect on the quantity of involuntary heat exposure that can be eliminated by the change in population location.

3. RESULTS

3.1 Extraction yield

3.1 National burden and facility composition

The analytic sample included 4,078 facilities in 49 jurisdictions, and 2,032,647 persons. The facilities accounted for an estimated 41,249,637 hazardous-heat person-days per year, which is a population-weighted mean of 20.3 days per year. These totals reflect the national scale as reported by Tuholske et al. (2024) and take the source data further to explore punitive intensity, concentration and counterfactual reform strategies.

59.2% of the sample population were housed in state facilities and 60.8% of person-days were spent in state facilities. Of the population, 29.7% was in county facilities and 26.9% was in federal facilities (Table 2). The population-weighted mean was 20.8 hazardous-heat days in state facilities, 18.3 in county facilities, and 23.2 in federal facilities. Type should not be interpreted as an effect of facility governance as it is confounded by geography, facility age, construction, and population characteristics. However, they suggest that the burden is not limited to a single sector of the institutions – prison, jail, and federal.

Exposure was highly skewed towards levels above policy-relevant thresholds. The facilities with an average of at least 30 hazardous-heat days had 603,421 people (29.7% of the population) and 79.5% of the person-days across the nation. The facilities with a mean stay of 60 days or more held 10.1% of the population and 37.0% of burden. 1.1% of the population lived in a smaller group of 44 facilities with an average of at least 90 days. The concentration implies that a universal minimum

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standard is still required, but a relatively small number of high exposure settings should be monitored, cooled and population reduced immediately.

Table 2. National hazardous-heat burden by facility type

Facility type	Facilities	Population	Population (%)	Person-days (million)	Burden (%)	Weighted days
State	1,606	1,202,930	59.2	25.07	60.8	20.8
County	2,142	604,699	29.7	11.09	26.9	18.3
Federal	232	187,847	9.2	4.36	10.6	23.2
Other/local/multi	98	37,171	1.8	0.74	1.8	19.8
Total	4,078	2,032,647	100.0	41.25	100.0	20.3

3.2 Punitive intensity and total hazardous-heat exposure

The population-weighted hazardous-heat days were positively associated with state incarceration intensity (Figure 2). Spearman's rho was 0.541 ($p<0.001$), with a 95% bootstrap interval of 0.287 to 0.716. Leave-one-jurisdiction-out correlation ranged from 0.515 to 0.583, suggesting that the result was not due to any one state or the District of Columbia. Pearson's r was 0.639 ($p<0.001$).

The quartile analysis revealed a significant gradient, and significant variation within the quartiles. The lowest quartile in terms of incarceration had a median weighted exposure of 0.91 days, and represented 2.5% of national person-days and 14.9% of the facility population. The highest quartile of incarceration had a median of 29.58 days and housed 33.1% of the population and 58.6% of person days (Table 3). Results of the Kruskal-Wallis test suggested differences among quartiles ($H=18.79$, $p<0.001$). The non-monotonic median in the middle quartiles is an example of the fact that incarceration rate should not be used as an alternative to direct environmental measurement.

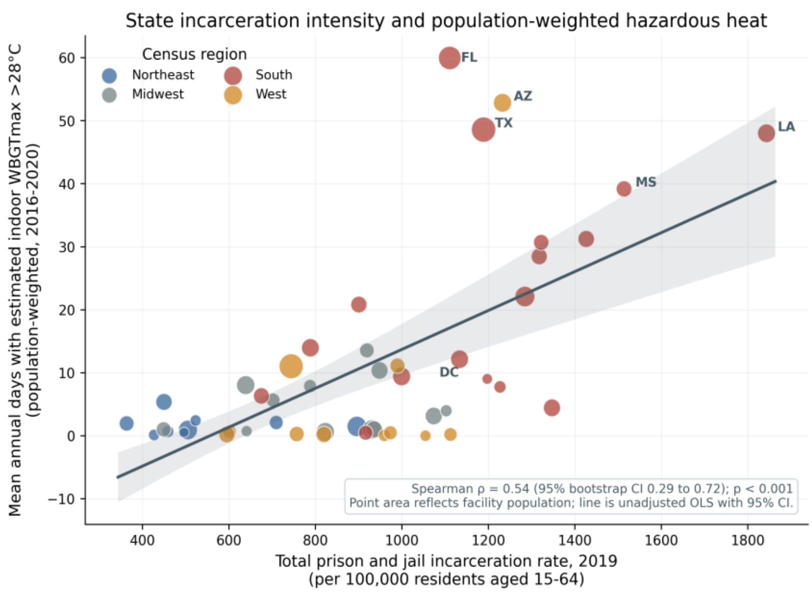

Figure 2. State prison-and-jail incarceration intensity in 2019 and population-weighted annual hazardous-heat days during 2016-2020 across 48 contiguous states and the District of Columbia. Point area reflects facility population and color denotes Census region. The line and shaded band show the unadjusted ordinary least-squares fit and 95% confidence interval. Spearman rho=0.541 (95% bootstrap interval 0.287-0.716; $p<0.001$).

The unadjusted HC3 model showed that every 100 people incarcerated per 100,000 residents was correlated with an additional 3.09 population-weighted hazardous-heat days (95% CI 2.12-4.06; $p<0.001$; R-squared=0.409). After Census-region adjustment, the estimate was still positive, but after Census-division adjustment, the estimate was no longer different from the null (Table 4).

This pattern is not a simple causal statement, but it is an interpretation of a joint-structure. High incarceration rates are concentrated in areas with more dangerous heat and the population incarcerated in those areas contributes to the overall exposure opportunity. A positive estimate remains after accounting for region, indicating that this is not solely a regional effect. But after adjusting for division attenuation, conclusions are subject to more specific geographic controls. 49 ecological units are not sufficient to definitively separate penal policy, climate, urbanization, location of facilities and building infrastructure, which are all spatially clustered.

Table 3. Hazardous-heat exposure by quartile of state incarceration intensity

Incarceration quartile	n	Median rate	Median weighted heat days	Population share (%)	Person-day share (%)
Q1 lowest	13	505.0	0.91	14.9	2.5
Q2	12	804.0	3.87	28.5	10.9
Q3	12	994.5	2.07	23.5	28.1
Q4 highest	12	1301.0	29.58	33.1	58.6

3.3 Total burden is distinct from within-state siting disparity

The heat difference between facility and state was not statistically related to incarceration intensity. Spearman's rho was 0.194 ($p=0.181$). The unadjusted regression estimate was 0.24 additional disparity days per 100-person increase in the incarceration rate (95% CI -0.04-0.51; $p=0.097$), and the region-adjusted estimate was 0.33 (95% CI -0.13-0.79; $p=0.157$) (Table 4).

The difference between total exposure and disparity is in substance. A state can generate a very heavy load, by locking up lots of people in a hot climate, even if its facilities are not significantly hotter than the rest of the state. This process is exemplified in Florida, which had the highest weighted facility exposure and the facility-versus-state gap was negative. However, a state could have a positive siting disparity, and a smaller national burden due to a smaller incarcerated population or background heat. Hence, the absolute burden and the relative siting should be reported in reform evaluation. Focusing on disparity alone can mask the health impacts of the magnitude of confinement; focusing on the total burden alone can mask the environmental injustice at a local level.

Table 4. Association between incarceration intensity and hazardous-heat outcomes

Model	Estimate	95% CI	p	R-squared
Unadjusted total exposure	3.09	2.12 to 4.06	<0.001	0.409
Census-region adjusted	2.52	0.87 to 4.18	0.003	0.464
Census-division adjusted	2.06	-0.14 to 4.25	0.067	0.524
Unadjusted within-state disparity	0.24	-0.04 to 0.51	0.097	0.046
Region-adjusted within-state disparity	0.33	-0.13 to 0.79	0.157	0.113

3.4 Geographic and population concentration of exposure

Texas and Florida combined for 52.0% of the total person-days with 19.8% of the facility population. The top five jurisdictions had 72.1% of person-days and 36.4% of population; the top 10 jurisdictions had 86.7% of person-days and 46.9% of population.

This finding aligns with the concentration reported by Tuholske et al. (2024), and the current calculation incorporates all facility types present in the source data.

The concentration was also high at the facility level. When people were ordered from the highest- to lowest-heat facilities, the highest-exposure 10% of the population accounted for 36.6% of person-days, the top 20% accounted for 61.7%, and the top 30% accounted for 80.0% (Figure 3). The population-weighted exposure Gini was 0.63. The curve is not an index of income inequality or a causal index; it simply represents the distribution of annual heat days among the nation's facility population.

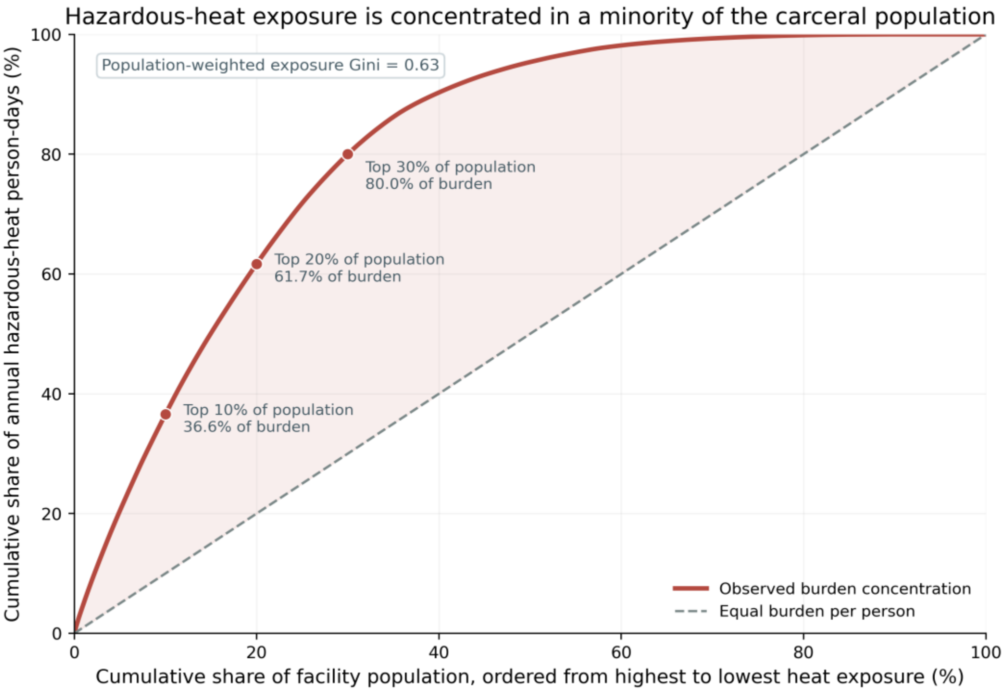

Figure 3. Concentration curve for annual hazardous-heat person-days. Facilities are ordered from highest to lowest annual hazardous-heat days; the x-axis accumulates facility population and the y-axis accumulates person-days. The dashed line represents equal heat exposure per person. The population-weighted exposure Gini was 0.63.

Concentration has two policy implications. First, people in all facilities have environmental-health rights, and climate change can change risk quickly outside of the current hot spots. Second, direct measurement and prompt intervention can be the focus and not every setting has to be considered a crisis. Facilities that have high exposures should have ongoing indoor sensors, public reporting, cooling audits, power-resilience audits, medication and disability protocols, emergency release review, and external inspection. This targeting should be in addition to, not a substitute for, universal enforceable standards.

3.5 Counterfactual exposure opportunities

The estimated exposure benefit was significantly affected by the allocation of population reduction (Table 5 and Figure 4). A proportional reduction of 5% prevented 2.06 million person-days of burden, which is 5.0% of the national burden. The state-by-state same-fraction reduction approach resulted in a savings of 4.55 million person-days (11.0%) as compared to the national upper-bound strategy that resulted in a savings of 8.44 million person-days (20.5%).

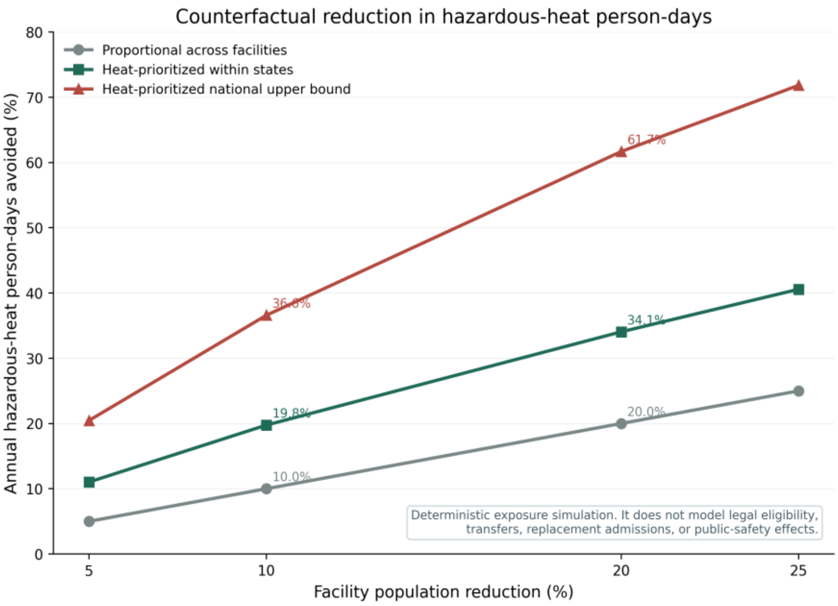

Figure 4. Deterministic counterfactual share of annual hazardous-heat person-days avoided under proportional, heat-prioritized within-state, and heat-prioritized national upper-bound population reductions. The analysis does not model legal eligibility, transfers, replacement admissions, reentry capacity, or public-safety effects.

The proportional, within state and national upper-bound strategies prevented 4.12 million (10.0%), 8.15 million (19.8%) and 15.09 million (36.6%) person days, respectively, at a 10% population reduction. The within-state strategy was able to reach its target by accessing 405 facilities, while the national strategy accessed 282 facilities and a proportional strategy accessed all 4,078 facilities. At a 20% reduction, the corresponding estimates were 8.25 million (20.0%), 14.05 million (34.1%), and 25.45 million (61.7%) person-days.

These scenarios represent opportunity to be exposed, not an entire justice policy. Ethically, heat prioritization may be appropriate if a facility is unable to keep the environment at a safe temperature, but heat is not the only consideration in determining who should be released and how. Other factors, such as individual liberty interests, sentence review, age, medical vulnerability, disability, family responsibilities, pretrial status, legal entitlements, survivor safety, and community supports also are relevant. A national ranking is especially out of the question, as release authority, legal regulations and re-entry systems vary by jurisdiction. The within-state strategy is more institutionally feasible, but even then, it assumes that there are no transfers or new admissions to replace the reductions.

The simulation, however, helps to shed light on the rationale for population reduction in environmental-health planning. Cooling retrofits change the intensity of exposure to persons who continue to be in the facility, while decarceration changes the amount of person-time in a facility where self-protection is limited. The two methods are complementary. Decarceration alone is not sufficient to ensure the safety of current residents, and infrastructure alone can safeguard health and maintain unnecessary coercive exposure or incentivize the maintenance of capacity.

Table 5. Annual hazardous-heat person-days avoided under population-reduction scenarios

Population reduction	Proportional	Heat-prioritized within states	National heat-prioritized upper bound
5% (101,632)	2.06 (5.0%)	4.55 (11.0%)	8.44 (20.5%)
10% (203,265)	4.12 (10.0%)	8.15 (19.8%)	15.09 (36.6%)
20% (406,529)	8.25 (20.0%)	14.05 (34.1%)	25.45 (61.7%)

3.6 The RESTORE framework for transformative reform

The empirical results suggest that there is a two-track reform structure: first, environmental-health protection and second, measurable steps to move away from punitive governance. We implemented this architecture in the RESTORE framework (Table 6). RESTORE is not offered as a validated scale. A policy and evaluation framework that translates the exposure results of the study into audit-able decision making.

Reduce carceral exposure by limiting access, duration and intensity of control including through pretrial release, decriminalisation, sentence review, compassionate and medical release and restrictions on technical violation incarceration. Ensuring environmental-health rights includes enforceable thermal limits, safe water, ventilation, sanitation, nutritious food, disability access, independent inspection, confidential complaints and remedies. Shifting resources upstream involves tangible movement of resources from carceral expansion to housing, voluntary health care, education, food security, transport, violence prevention, survivor services and climate-resilient public space.

Compensated authority for incarcerated and formerly incarcerated people, survivors, families, workers and affected communities in monitoring, budgets, closure, facility reuse, and evaluation, which are all required for transfer of decision-making power. Organizing for survivor-centered accountability involves providing choices for safety, separation, reparation, behaviour change and relational repair, rather than coerced forgiveness or denial of due process. Remediating ecological damage involves testing and cleaning up contaminated land and water, providing for workers' transition and community-led reuse of closed facilities, and minimizing waste and emissions. Outcomes for evaluation of equity, safety, exposure and non-recurrence are more than just arrests or recidivism and include illness, environmental measures, survivor defined safety, system reach, material security, budget redistribution, legitimacy and adverse events.

This is a purposefully anti-entrenchment system. Capacity expansion, unconditional release to surveillance, and the exclusion of affected people from decision-making, or the use of health data for law enforcement, are all potential ways in which a reform can enhance conditions and yet also be a form of punitive governance. Evaluation should thus include assessment of total controlled population, admissions, length of stay, electronic monitoring, technical violations and new construction as well as environmental and clinical outcomes.

Table 6. RESTORE framework linking empirical findings to transformative policy and evaluation

Dimension	Empirical or ethical trigger	Policy direction	Indicator or safeguard
R - Reduce carceral exposure	Burden rises with the number of people held in hot jurisdictions	Reduce admissions and duration; expand release review; limit technical-violation custody	Total controlled population, admissions, length of stay, unconditional release, transfers
E - Ensure environmental-health rights	41.25 million annual person-days and concentrated high-exposure facilities	Thermal standards, sensors, cooling, hydration, resilient power, clinical protocols, independent remedies	Indoor heat and humidity, outages, water access, heat illness, complaint resolution
S - Shift resources upstream	Infrastructure alone does not prevent unnecessary exposure	Invest in housing, voluntary care, food security, education, transport, survivor services, and resilient public space	Verified budget transfers and community coverage; no simultaneous carceral expansion
T - Transfer decision-making power	People subject to exposure have little control over monitoring or response	Compensated authority for incarcerated/formerly incarcerated people, survivors, families, and host communities	Voting and agenda-setting power, data access, retaliation safeguards, accessibility

O - Organize survivor-centered accountability	Exposure reduction is not a complete definition of safety	Voluntary safety planning, separation, reparation, behavior change, and relational repair where desired	Survivor-defined safety, voluntariness, due process, adverse events, repeat harm
R - Remediate ecological harms	Facility sites and operations can burden land, water, air, and nearby communities	Test and clean sites; reduce waste and emissions; plan worker transition and community-led reuse	Contaminants, remediation milestones, emissions, community ownership, worker outcomes
E - Evaluate equity and non-recurrence	Associations are geographic and reforms may widen control	Measure health, exposure, safety, system reach, material security, legitimacy, and distribution	Disaggregated outcomes, electronic monitoring, technical violations, net-widening, public reporting

3.7 Implications for natural-resource and public-health governance

The results suggest that carceral settings should be viewed as priority environmental-health settings, rather than special places that are exempt from routine environmental-health regulation. Direct measurement of temperature inside, maximum temperature or heat index rules, humidity limits, ready drinking water, shade, rest, medication check, clinical escalation, cooling access and resilient electricity. Public-health authorities should be independent, and there should be inspection powers, and facility-level data should be public but in ways that don't compromise individuals and allow for accountability. The Nelson Mandela Rules call for equivalence in health care and respect the dignity of persons in custody, and the human right to a clean, healthy, and sustainable environment bolsters the normative underpinning of these rights (United Nations General Assembly, 2015; United Nations General Assembly, 2022).

Heat should be a factor in population management, emergency planning, bail and pretrial review, medical and compassionate release, parole, and facility closure decisions for justice agencies. There is an international foundation for non-custodial measures, the Tokyo Rules (United Nations General Assembly, 1990). However, emergency release must go hand in hand with voluntary housing, health care, continuity of medications, transportation, identification papers, income assistance and communication with families and providers of services. With these resources removed, the risk is transferred to homelessness, unsafe work, or to interrupted care.

The distinction total versus disparity should be maintained for the use of researchers. Future studies should connect continuous indoor sensor data, cooling and ventilation inventories, water reliability, power outages, medical vulnerability, mortality, heat illness, self-harm and facility policy. Retrofits, closures, court orders, and release policy changes can be used to improve causal inference in a design. Additionally, co-produced research should include measures of survivor and community outcomes, rather than only considering a decrease in exposure to carceral involvement as a measure of safety.

3.8 Strengths and limitations

This study has a number of strengths. It compared an exhaustive list of operational and populated carceral facilities across the continental United States with a transparent state incarceration dataset, distinguished between total burden and within-state disparity, accounted for person-time meaning of exposure by using population weighting, tested sensitivity to broad and fine geographic categories, quantified burden concentration, and provided reproducible counterfactual calculations. Leave-one-out and bootstrap analyses indicated that the rank correlation was not driven by one jurisdiction and the division adjusted model captured uncertainty properly.

There are big restrictions. First, the ecological design does not allow for the conclusion that the punitive policy led to heat exposure and state-level results are not statements of individual risk. Second, the population of facilities was counted in 2018, exposure was calculated for the average of the 2016-2020 period, and incarceration intensity was counted in 2019. These decisions enhance temporal alignment but fail to account for policy changes within periods, as well as seasonal changes or daily turnover in the population. Third, the WBGTmax measure was not measured in the facility but modeled, and does not account for facility-specific air conditioning, radiant heat, building materials, ventilation, crowding, water access, work assignment or adaptive behavior.

Fourth, the Vera rate includes both prison and jail populations, and the facility inventory includes federal, immigration, and other settings, and uses an age-specific denominator. The rate is thus a punitive-intensity indicator for the jurisdiction level, not a direct match for the denominator for each facility. Fifth, the region and division are coarse controls; there is still some spatial dependence and other political, economic and climatic factors that are not measured. A more complex spatial model would need to make more assumptions or a larger and more detailed policy data set. Sixth, the difference in outcomes is an average across facilities and states, so it might not reflect variation within states.

Last but not least, the counterfactual analysis is static and knowingly limited. It assumes there will be no transfers or replacement admissions, and it does not estimate costs, time for implementation, community capacity, health outcomes, or public safety. Without due process, individual choice, survivor safeguards and reentry investment, prioritized exposure reduction could be inequitable. The upper-bound scenario should therefore be interpreted as a mathematical reference, rather than an operational plan.

CONCLUSION

The total burden of hazardous heat was strongly associated with punitive intensity across the 4,078 carceral facilities, but the association was less evident at more refined levels of geographic adjustment, and was not clearly associated with within-state siting disparity. The top jurisdictions with the highest numbers of incarcerated persons disproportionately accounted for 41.25 million person-days of exposure, and exposure was highly concentrated in a small number of facilities and individuals. The counterfactual analysis revealed that the health opportunity from population reduction is very much location specific.

The results help to move from punitive governance to transformative environmental-health justice. Safe temperatures, water, air, energy, sanitation, health care and independent remedies are immediate rights not benefits depending on institutional convenience. These protections should be coupled with a gradual transition to fewer admissions and shorter stays, survivor-centered accountability, community control, ecological remediation and upstream investment. Future evaluation should not only measure increased efficiency of a facility, but also decreased involuntary exposure, increased safety for survivors and communities, increased distribution of life-sustaining resources and reduced likelihood of recurrence of harm.

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