# The Association of Census Tract-Level Incarceration Rate and Life Expectancy in New York State

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## Abstract

**Background:** Jail incarceration rates are positively associated with mortality at the county level. However, incarceration rates vary within counties, limiting the generalizability of this finding to neighbourhoods, where incarceration may have the greatest effects.

**Methods:** We performed a cross-sectional analysis of census tract-level state imprisonment rates in New York State (2010) and life expectancy data from the United States Small-area Life Expectancy Estimates Project (2010–2015). We modelled fixed-effects for counties and controlled for tract-level poverty, racial makeup, education, population density and controlled for confounders from the American Community Survey (2010–2014), and violent crime data from the New York City Police Department (2010). We also examined interactions between incarceration rate and poverty, racial makeup, and population density on life expectancy.

**Results:** Life expectancy at the highest quintile of incarceration was 5.5 years lower than in the lowest quintile and 2 years lower in a fully-adjusted model. Census tract-level poverty and racial makeup both moderated the association between incarceration and life expectancy.

**Conclusion:** Census tract level incarceration is associated with lower life expectancy. Decarceration, including alternatives to incarceration, and release of those currently incarcerated, may help to improve life expectancy at the neighbourhood level.

## INTRODUCTION:

Social determinants of health, including poverty and structural racism, have a profound impact on life expectancy at a population level.[1] Communities with high rates of poverty and Black residents are also disproportionately affected by incarceration.[2] Higher rates of policing and arrests in these neighbourhoods[3,4] and longer correctional sentences for people of color[5] have disproportionately exposed Black people and their families to the carceral system and the consequences of having a criminal record thereafter.[6]

Incarceration has broad effects at a population level,[4] beyond the health of individuals who are incarcerated and their families.[6,7] High incarceration rates at the community level are associated with residential instability, unstable social networks, and decreased social capital.[4] These in turn can lead to negative health outcomes for non-incarcerated people living in those communities.

Living in a neighbourhood with high rates of incarceration is associated with worse mental health,[8] increased cardiovascular risk factors,[9] and higher rates of sexually transmitted infections (STIs).[10] At the county level, incarceration rates are associated with preterm birth,[11,12] higher rates of STIs,[13,14] and a small but significant association between rates of jail incarceration and mortality.[15]

Yet, incarceration rates vary significantly by neighbourhoods within counties,[3] thus county-level estimates obscure significant heterogeneity across neighbourhoods. Further, people's social networks may be more closely reflected in a smaller geographic area. To get a more accurate measure of the effect of incarceration rates on community health, we evaluated life expectancy at the census tract level in association with rates of incarceration in state prison, and estimated how tract-level poverty, racial makeup, and population density moderate that association. We hypothesize that incarceration rate will have a negative association with life expectancy, and that the aforementioned covariates will moderate the association.

## METHODS:

We conducted a cross-sectional analysis to evaluate the relationship between census tract prison incarceration rates (2010) and life expectancy in New York State (NYS) (2010–2015).

### Data Sources and Variables

Life expectancy estimates come from the U.S. Small-area Life Expectancy Estimates Project (USALEEP),[16] which estimates life expectancy at birth for 2010–2015 (appendix). State prison incarceration rates come from the Prison Policy Initiative, and assigned people with a usable NYS address in NYS prison during the 2010 census count (16.9% missing; (appendix)) to their residential census tract prior to incarceration. We obtained census tract poverty, education, and race data from the American Community Survey (2010–2015) (appendix) and population density from Rural-Urban Commuting Area Codes (2010). We included the percent of Black residents as an important indirect proxy of structural racism[17] and to name the disproportionate impact of mass incarceration in Black communities.[6] For education, we used percent of the population with less than highschool completion,

since this is associated with decreased life expectancy.[18] In order to adjust for the possible confounding of living in a high-crime area[3] and police contact,[19] we geocoded New York City Police Department data (2010; appendix) and created rates of violent crime by tract. Similar data do not exist for other NYS census tracts.

Our dependent variable was life expectancy in years, and independent variables were all measured continuously. To determine whether each independent variable was best modeled as a linear or non-linear relationship with life expectancy, a squared term was added and found to be significant for each. Thus, for ease of interpretation, we categorized incarceration rates, education, percent of Black residents, population density, and violent crime into quintiles, and categorized poverty based on grouping we observed in the continuous variable in association with life expectancy and incarceration (<15%, 15–35%, and >35%).

### Statistical Analysis

We calculated descriptive statistics on variables of interest and tested differences in these variables across quintiles of incarceration rate using ANOVA or the Kruskal-Wallis test of difference between mean ranks across groups. Next, we examined the association between quintile of incarceration and life expectancy using a linear regression model with a fixed effect for county. We compared models with fixed effect and random effect for county using the Hausman specification test, which demonstrated the fixed effect model was a better fit. Our multivariable model included poverty rate, percent of population with less than high school education, percent Black residents, and population density. In order to account for the potential moderating effect of neighbourhood poverty, racial composition, and population density on our findings, we tested three interaction terms with incarceration rate in the fully adjusted model. To adjust for violent crime, we ran the full model in New York City tracts, and then added violent crime rate.

### Sensitivity analyses

We performed five sensitivity analyses: first, we excluded tracts with life expectancies more than three standard deviations from the mean; second, we excluded tracts that had a prison or jail in 2010 (n=138) to ensure our tract-level variables for population density, racial makeup, and poverty rate reflected only non-incarcerated individuals; third, we ran the full model using the quadratic terms instead of categories; fourth, we tested incarceration rates categorized as deciles; fifth, we used total crime rate instead of violent crime in NYC. Statistical analyses were performed using Stata version 16.0 (StataCorp). This research did not meet the definition of human subject research and IRB review was not required.

## RESULTS:

The study sample comprised 4,547 census tracts after excluding 372 census tracts missing life expectancy data (Table S1; appendix). Life expectancy was normally distributed in the sample, with a mean of 80.3 years. In tracts in the lowest quintile of incarceration rates, life expectancy was 82.5 years; in the highest quintile, it was 76.7 years. Incarceration rates per

100,000 residents ranged from zero to 3,335 with a median of 119 residents per 100,000 (Table 1).

As incarceration rates increased, tracts had a greater percent of residents: living in poverty, with less than highschool education, who were Black, greater population density; and, within NYC (N=1967), higher violent crime. All of these characteristics were significantly different across groups with a *P* value of <0.001 (Table 1).

In our unadjusted model, life expectancy in census tracts in the highest quintile of incarceration rates was 5.5 years lower (confidence interval (CI): −5.7 to −5.2) than in the lowest quintile, and showed a dose-dependent relationship (Table 2).

After controlling for tract-level percent of residents living in poverty, percent less than highschool education, percent who were Black, and population density, life expectancy was 2.6 years lower (CI: −3.0 to −2.2) in tracts in the highest quintile of incarceration. In NYC, the model adjusted for all sociodemographics demonstrated that tracts in the highest quintile of incarceration had a 2.4 year lower life expectancy (CI: −2.9 to −1.8), and after adjustment for violent crime rate, 2.1 years lower (CI: −2.6 to −1.4) (Table 2). These findings were robust to removal of outliers, removal of census tracts with a prison or jail, using quadratic terms, categorizing incarceration into deciles, and using total crime rate (Table S3).

Our prespecified interaction terms, all tested in the model fully adjusted for sociodemographic variables (model 4), demonstrated that poverty moderated the association of incarceration rate and life expectancy, with a steeper slope as poverty rates increased (*P*=0.007) (Figure S1). Racial makeup also moderated the association of incarceration rate and life expectancy: tracts in the quintile with the greatest percentage of Black residents (>30% Black) had a lower life expectancy at the lowest quintile of incarceration and a flatter slope (*P*=0.004) (Figure S2). Population density did not interact significantly with incarceration.

## DISCUSSION:

Individuals living in census tracts with high incarceration rates have an over two-year lower life expectancy, even after controlling for census tract-level poverty, education level, racial makeup, population density, and violent crime. This supports previous findings that incarceration impacts the health of the community as a whole.[3,4,8,14,15,20] The mechanisms underlying this may include social network disruption and stress for community members without personal history of incarceration, and the known health effects on individuals directly impacted by incarceration returning to those neighbourhoods.

Individuals living in high incarceration census tracts are more likely to be poor and Black, suggesting incarceration may compound other social determinants of health like poverty and racism. Further, interaction analysis demonstrated that more impoverished census tracts are more vulnerable to the negative impacts of incarceration. Interestingly, interaction analysis also demonstrated that tracts with greater percentages of Black residents have a significantly lower life expectancy even at low rates of incarceration. This may reflect generations of

disinvestment in Black communities, segregation, and the negative effects of structural racism.

This study is limited in that our cross-sectional analysis does not allow us to fully address reverse causation; however, we did include many possible confounders in our model; we did not include jail or federal prison incarceration rates; however, the rate of incarceration in state prison is likely representative of the total incarceration rate in the tract; and we only had census tract data for violent crime in NYC, though we demonstrated this made only a small difference in outcomes.

Our findings indicate that incarceration rates have a strong association with neighbourhood health. Decarceration, including community-driven alternatives to incarceration and release of those currently incarcerated, may contribute to a reduction in disparities in life expectancy across communities, given the disproportionate prevalence of incarceration in Black communities, particularly in high-poverty neighbourhoods.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgements:

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**Summary Box**

**Section 1: What is already known on this subject:**

- For non-incarcerated individuals living in neighbourhoods with high rates of incarceration, cross-sectional studies have demonstrated higher risk of sexually transmitted infections, mental health diagnoses, and risk factors for cardiovascular disease.

- At the county level, higher jail incarceration rates are associated with a small but significantly higher mortality rate, and higher rates of preterm birth.

- Incarceration rates vary greatly at the neighbourhood level within counties; however, it is unknown whether life expectancy at the neighbourhood level is associated with incarceration rate.

**Section 2: What this study adds:**

- Our study demonstrates that living in a neighbourhood with high rates of incarceration is associated with a significantly lower life expectancy even after controlling for neighbourhood-level poverty, racial makeup, education level, population density, and violent crime.

- This suggests that decarceration may improve life expectancy at a population level.

**Table 1:**

Characteristics of New York State census tracts 2010–2015 (n=4,547) by quintiles of incarceration

| Characteristic | Total (n=4,547, 100%) Median (IQR) | First Quintile (n=919, 20.2%) Median (IQR) | Second Quintile (n=911, 20.0%) Median (IQR) | Third Quintile (n=899, 19.8%) Median (IQR) | Fourth Quintile (n=909, 20.0%) Median (IQR) | Fifth Quintile (n=909, 20.0%) Median (IQR) | P value* |
|---|---|---|---|---|---|---|---|
| Life expectancy in years Mean (SD)† | 80.3 (3.7) | 82.5 (2.8) | 81.7 (2.9) | 81.0 (2.9) | 79.6 (3.1) | 76.7 (3.4) | <0.001 |
| Incarceration rate per 100,000 Median (IQR)† | 119 (263) | 14 (27) | 60 (24) | 120 (37) | 245 (115) | 667 (473) | <0.001 |
| % of population in poverty Median (IQR)† | 12.0 (15.5) | 5.8 (7.1) | 8.1 (9.1) | 11.0 (9.4) | 14.9 (11.7) | 30.6 (19.2) | <0.001 |
| % of population with less than high school education Median (IQR)† | 12.2 (13.7) | 6.5 (8.0) | 9.0 (8.7) | 11.1 (8.8) | 14.5 (13.1) | 24.1 (16.8) | <0.001 |
| % of Black residents Median (IQR)† | 4.3 (20.0) | 1.4 (3.4) | 1.9 (4.2) | 2.8 (7.6) | 10.2 (25.4) | 39.3 (44.3) | <0.001 |
| Population density per square mile [rounded] Median (IQR)† | 8,218 (35,872) | 5,293 (20,931) | 4,712 (27,494) | 5,353 (31,906) | 10,692 (39,269) | 22,108 (54,888) | <0.001 |
| | | | | | | | |
| For census tracts within NYC | Total (n=1,986, 100%) | First Quintile (n=324, 16.3%) | Second Quintile (n=356, 17.9%) | Third Quintile (n=362, 18.2%) | Fourth Quintile (n=441, 22.2%) | Fifth Quintile (n=503, 25.3%) | |
| Violent crime rate per 1000 population Median (IQR)† | 3.5 (5.0) | 1.3 (2.0) | 1.8 (2.1) | 2.7 (3.2) | 4.5 (4.1) | 7.3 (5.1) | <0.001 |

*ANOVA used for normally distributed data, and Kruskal-Wallis test of difference between mean ranks across groups used for non-normally distributed data

†Mean (SD) reported for normally distributed data; Median (IQR) reported for non-normally distributed data

**Table 2:**

Adjusted associations between census tract incarceration rate quintile and census tract life expectancy[*]

| Incarceration Quintile | Life expectancy mean (difference in years from ref) | | | | NYC census tracts only | |
|---|---|---|---|---|---|---|
| | Model 1 Beta (95% CI) | Model 2 Beta (95% CI) | Model 3 Beta (95% CI) | Model 4 Beta (95% CI) | Model 5 Beta (95% CI) | Model 6 Beta (95% CI) |
| First Quintile | ref | ref | ref | ref | ref | ref |
| Second Quintile | −0.6 (−0.8 to −0.3) | −0.4 (−0.7 to −0.1) | −0.4 (−0.7 to −0.2) | −0.3 (−0.6 to −0.0) | −0.2 (−0.6 to 0.2) | −0.1 (−0.6 to 0.3) |
| Third Quintile | −1.3 (−1.5 to −1.0) | −0.9 (−1.1 to −0.6) | −0.9 (−1.2 to −0.7) | −0.6 (−0.9 to −0.4) | −0.3 (−0.7 to 0.1) | −0.2 (−0.6 to 0.3) |
| Fourth Quintile | −2.6 (−2.8 to −2.3) | −1.9 (−2.1 to −1.6) | −1.9 (−2.2 to −1.6) | −1.3 (−1.6 to −1.0) | −0.9 (−1.4 to −0.4) | −0.7 (−1.2 to −0.2) |
| Fifth Quintile | −5.5 (−5.7 to −5.2) | −3.7 (−4.0 to −3.3) | −4.3 (−4.7 to −3.9) | −2.6 (−3.0 to −2.2) | −2.4 (−2.9 to −1.8) | −2.1 (−2.7 to −1.5) |
| $P$ value[**] | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

Model 1: unadjusted

Model 2: adjusted for % living below poverty level in census tract (3 categories: <15%, 15–35%, >35), % less than highschool (quintiles)

Model 3: adjusted for % residents who identify as Black in census tract (quintiles)

Model 4: adjusted for poverty rate (3 categories), % less than highschool (quintiles), % Black residents (quintiles), and population density (quintiles)

Model 5: model 4 in NYC census tracts only (n=1986)

Model 6: model 5 adjusted for violent crime rate (quintiles) (n=1986)

[*] Full models with all covariates in Table S2 (appendix)

[**] F test for joint significance of incarceration rate