Impact of decarceration plus alcohol, substance use, and mental health screening on life expectancies of Black sexual minority men and Black transgender women (BSMM/BTW) living with HIV in the United States: A Simulation Study based on HPTN 061

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Abstract

Background—Given the disproportionate rates of incarceration and lower life expectancy (LE) among Black sexual minority men (BSMM) and Black transgender women (BTW) with HIV, we modeled the impact of decarceration and screening for psychiatric conditions and substance use on LE of US BSMM/BTW with HIV.

Methods—We augmented a microsimulation model previously validated to predict LE and leading causes of death in the US with estimates from the HPTN 061 cohort and the Veteran's Aging Cohort Studies. We estimated independent associations among psychiatric and substance use disorders, to simulate the influence of treatment of one condition on improvement on others. We used this augmented simulation to estimate LE for BSMM/BTW with HIV with a history of incarceration under alternative policies of decarceration (i.e., reducing the fraction exposed to incarceration), screening for psychiatric conditions and substance use, or both.

Results—Baseline LE was 61.3 years. Reducing incarceration by 25%, 33%, 50%, and 100% increased LE by 0.29 years, 0.31 years, 0.53 years, and 1.08 years, respectively, versus no reductions in incarceration. When reducing incarceration by 33% and implementing screening for alcohol, tobacco, substance use, and depression, in which a positive screen triggers diagnostic assessment for all psychiatric and substance use conditions and linkage to treatment, LE increased by 1.52 years compared to no screening or decarceration.

Discussion—LE among BSMM/BTW with HIV is short compared with other people with HIV. Reducing incarceration and improving screening and treatment of psychiatric conditions and substance use could substantially increase LE in this population.

Introduction

Black sexual minority men (BSMM) and Black transgender women (BTW) with HIV are at an elevated risk for morbidity and early mortality compared to those not part of these specific risk groups. [1,2] BSMM also have the highest rates of incarceration in the United States (US). [3] Black men have a one in three lifetime chance of incarceration, compared with a one in 11 chance among white men[4] and incarceration rates among sexual minorities is more than three times that of the US adult population. [5] Those at the intersection of being minoritized due to race and sexual or gender identity face disproportionate risk of incarceration; BSMM have twice the incarceration risk compared to their non- racial/ethnic sexual minority counterparts [6] and BTW have markedly higher rates of than BSMM. [7] Structural racism contributes greatly to these disparities in incarceration rates. [8,9]

Incarceration has been associated with several negative outcomes among BSMM including elevated risks of unhealthy alcohol and drug use, [10] violence, [11] mental disorders[12] and increased risk of HIV acquisition. [13] Additionally, it is well known that incarceration is associated with disruption in care or lack of care for different health related conditions. For instance, being incarcerated is associated with disruptions in care for HIV [14] and there is evidence that prisos in the United States have failed to provide adequate treatment services

for those with mental health illness. [15]Reducing incarceration (i.e., decarceration) may improve health and life expectancy (LE) while reducing negative HIV health outcomes for BSMM and BTW. [16] Current policy efforts have suggested reducing incarceration by 40% is feasible without affecting public safety. [17] Unfortunately, we have limited understanding of how reducing incarceration may influence morbidity and mortality risk among BSMM/BTW.

In addition to the potential reduction in incarceration being a health promotion strategy for BSMM/BTW with HIV, among persons in this group who cycle through the jail and prison systems, several approaches have been proposed to improve quality of life and overall LE including the use of screening and treatment tools for common diagnoses. Previous research suggests that screening co-occurring unhealthy alcohol use, substance use, and mental disorders (CASM), with linkage to diagnostic assessment and treatment for conditions diagnosed as positive, could have substantial health benefits among people without HIV and even larger benefits among people living with HIV (PLHIV) because of the way these conditions impact one another and, in PLHIV, impact adherence to treatment. [18] It is likely the benefits of CASM screening and treatment would be especially profound among BSMM/BTW with HIV with a risk of incarceration because of the high prevalence and strong interrelationships among these conditions and their impact on HIV treatment success. However, research on how improved screening for these conditions in the clinical setting and how they could influence LE for BSMM/BTW with a history of incarceration is limited.

The current study aims to address gaps in current research by utilizing microsimulation modeling to estimate the influence of decarceration and improved screening and treatment of CASM on the LE of BSMM/BTW with HIV. We hypothesized that incarceration itself poses a substantial health risk, and that systemic and structural interventions to reduce incarceration rates could provide health benefits and improve LE on par with, and synergistic with, CASM screening and treatment. We further hypothesized that the benefits of coupling decarceration with CASM screening and treatment will provide additional protection against mortality and early morbidity among BSMM/BTW with HIV, given the high prevalence of these conditions in this group and the strong interrelationships among these conditions and their impact on HIV treatment success.

Methods

The model for this study was built using a previously validated microsimulation model that had been used to predict the leading causes of death by gender and age in the US, examining 19 different causes accounting for approximately 90% of deaths in the country. [19] The model also includes 27 risk factors that influence the onset of each cause of death including: unhealthy alcohol use, tobacco use, substance use (opiate and stimulant use), common mental disorders (anxiety, depression), and chronic pain – collectively referred to as CASM disorders. The structure, parameters, data sources, and prior validation of this LE model can be found in Stevens et al. [20,21]

Information related to dynamics of HIV progression was included as a sub-unit of the model. This sub-unit was previously validated and includes information on ART effects on

CD4 counts, HIV viral load, risk of HIV related death based on initiation and adherence to ART, and drug resistance. [22,23]

The model was augmented to include additional data on CASM screening and treatment from two different sources of individuals living with HIV: a cohort of BSMM/BTW with a history of incarceration that was used to configure the simulated cohort for this study, [24,25] and a cohort of US veterans that allowed for longitudinal observation of the inter-relationships among CASM conditions and their effect on HIV treatment.

The first source of data was the HIV Prevention Trials Network (HPTN) 061 cohort study. [26,27] The study sought to test the feasibility and acceptability of interventions to prevent the acquisition and transmission of HIV among BSMM/BTW. Enrollment took place from 2009 to 2010 in Atlanta, New York City, Washington D.C, Los Angeles, San Francisco, and Boston. We restricted the sample (N=1553) to any participant that had reported any history of incarceration at the baseline study visit (N=914). The sample included 861 (94.3%) BSMM and 52 (5.7%) BTW. Information obtained from the cohort included risks associated with the CASM conditions described above and with HIV-related sexual transmission risk. [25]

Data on CASM conditions were obtained from the Veterans Aging Cohort Study (VACS), which is comprised of US veterans receiving care at VA centers, approximately half of whom are living with HIV. A total of 1231 members from VACS living with HIV were included in analyses that informed the simulation model of which a substantial proportion were Black (70%). [28] The sample reported moderate levels of substance use and mental health disorders including 18.6% for opioid use disorder, 15.4% for stimulant use disorder, 19.1% for major depressive disorder and 45.6% reporting generalized anxiety disorder. Approximately 34% reported chronic pain. These percentages were used in the simulation model.

CASM screening instrument sensitivity and specificity were obtained from the literature. Those with a positive CASM screen were assumed to receive a gold standard diagnostic assessment for the positive condition and other recommended conditions, depending on the screening and treatment strategy being evaluated. Sensitivity and specificity of diagnostic assessment was assumed to be 100%. Treatment effectiveness was also obtained from literature and was generally low: 14% for alcohol use, [29] 13% for depression, [30] 38% for anxiety, [31] 15% for pain, [32] 6% for tobacco use, [33] 24% for opioid misuse, [34] and 11% for stimulant misuse. [35] If successful, treatment of a CASM condition could lead to remission of other CASM conditions and improved adherence to chronic and preventative care, including HIV treatment. These "spillover" benefits of successful CASM treatment were obtained from a prior causal inference analysis based on the VACS cohort. [36] Data sources for each component of the analysis are summarized in Table 1.

Estimation of effects of decarceration on LE among BSMM/BTW were informed by associations that estimated the impact of incarceration on health risks. These were obtained from analyses using the HPTN 061 cohort data and included risk ratios for several CASM including binge drinking (RR: 1.14), stimulant use (RR:1.53), tobacco use (RR: 1.77),

depression (RR: 1.09) and anxiety (1.09). [25,37] These associations informed how simulated decarceration scenarios would reduce health risk and improve LE. We simulated how varying the rate of decarceration, from no decarceration to a scenario in which decarceration was 100%, influence LE. We consider a 33% reduction (i.e., a reduction of 33% of the total number of persons incarcerated) a policy change that is estimated to have little impact on public safety, given current legal analysis. Approximately 25% of the current prison population are low level or non-violent offenders, and research on incarceration of low-level offenders has limited rehabilitative impact and is linked to recidivism, suggesting alternatives to incarceration are more appropriate. The midpoint between 25% and 40%, 33% was considered a feasible intervention target given the anticipated impact according to experts on public safety would be limited.

We also simulated how implementation of different CASM screening scenarios, in tandem with varying the rate of decarceration, affected LE. We focused on screening for alcohol use, depressive symptoms, tobacco, and illicit drug use given the US Preventive Service Task Force recommends routine screening for these factors. [38] The simulations for CASM conditions included screening and treatment for each condition separately and screening and treatment for a combination of CASM conditions. Specifically, for unhealthy alcohol, depressive symptoms, and tobacco use, we simulated the influence on LE of screening for each condition, conducting a diagnostic assessment if indicated, and treating positive cases based on the diagnostic assessment. We also simulated the influence on LE of screening for alcohol, depression, and tobacco and, on positive screen for any of the three, conducting a diagnostic assessment each of the three conditions, and treatment of any condition if indicated by diagnostic assessment. Finally, we simulated the influence of screening for alcohol, depression, and tobacco, and conducting a comprehensive diagnostic assessment and treatment of all psychiatric and substance use conditions (depression, anxiety, pain, and alcohol, marijuana, illicit opioid, and stimulant use) given the strong clustering of these conditions. [18]

To assess LE gains, we compared each screening/decarceration scenario to a counterfactual assuming 100% of cohort members would be exposed to incarceration and no additional CASM screening would occur. LE differences between each intervention scenario and the counterfactual arose from the following modeled effects: health benefits from improvements in CASM conditions due to decarceration and health benefits from improvements in CASM conditions that were treated.

Each of the simulations included a cohort of 100,000 participants resampled from the 914 members of the HPTN061 cohort. A total of 10 simulations for each screening strategy were repeated to obtain 95% confidence intervals for the specified outcomes. Simulations were implemented in C/C++, run on a CRAY CS500 high-performance computing cluster; data were analyzed using R version 4.0.3.

IRB approval was received from the institutional review boards of the coordinating center at Yale University, New Haven, CT, the Veterans Affairs (VA) Connecticut Healthcare System, West Haven, CT, and from the participating clinical sites.

Results

At baseline the modeled BSMM/BTW with HIV were 39.9 years old (median: 42 years, IQR: 31–48). LE was 21.4 additional years meaning this group would live to 61.3 years without reductions in incarceration or improvement in screening and treatment efforts. This is much lower than current life expectancies in the overall US population of people living with HIV, estimated to be 76 years (2014–2016 estimate). [39]

Decarceration alone, even without concurrent increases in CASM screening, could increase LE among BSMM/BTW. Decarceration by 33% resulted in LE increased by an additional 0.3 years of life resulting in a LE of 21.7 years (95% CI: 21.6 – 21.8) and a total LE of 61.6 years. When decarceration was increased to 50%, LE increased by an additional 0.5 years of life resulting in a LE of 21.9 years (95% CI: 21.8 – 22.0) and a total LE of 61.8 years. In a hypothetical maximal scenario of 100% decarceration, relative to 100% of the cohort being exposed to incarceration, LE increased 1.1 years to 22.5 years (95% CI: 22.4 – 22.5) for a total LE of 62.4 years.

Screening and treating CASM conditions individually or jointly led to substantial increases in LE even in the absence of decarceration. Screening and treatment for depression increased LE by 0.1 years to 21.5 years (95% CI: 21.4–21.5) for a total LE of 61.4 years; and tobacco use by 0.1 years to 21.5 years (95% CI: 21.4–21.6) for a total LE of 61.4 years.

Screening and treatment for substance use (including tobacco, alcohol, stimulants, and opioids) increased LE by 0.3 years to 21.7 years (95%CI: 21.6–21.7) for a total LE of 61.6 years while screening alcohol, depression, and tobacco with comprehensive diagnostic assessments for all CASM conditions yielded the largest LE increase of 1.2 years to 22.6 years (95% CI: 22.5–22.7) for a total LE of 62.5 years.

Further increases in LE were seen when CASM screening and treatment scenarios were coupled with scenarios of decarceration. When decarceration rates were set to 33% coupled with comprehensive diagnostic assessments for all CASM conditions, LE increased 1.5 years to 22.9 years (95% CI: 22.8–23.0) for a total LE of 62.8 years. In the same scenario where decarceration was set to 100%, LE increased by 2.1 years to 23.5 years (95% CI: 23.4–23.6) for a total LE of 63.4 years. Figure 1 provides changes in LE based on different CASM screening scenarios coupled with changes in decarceration.

Figure 2 provides changes in select causes of death based on CASM screening and treatment along with a 33% decarceration rate. There were significant decreases in deaths due to HIV and slight decreases for lung disease and overdose, while increases were noted for several conditions with the sharpest increase seen for kidney disease, diabetes, liver disease, and dementia.

Discussion

This is one of the first studies to utilize simulation modeling to estimate how reducing incarceration may improve LE among a sample of BSMM/BTW in the US. Further, we observed bolstered effects when decarceration was coupled with improving screening and

treatment for CASM conditions which are common among incarcerated populations[40,41] and for which access to screening and treatment is currently inadequate. [42–44] The increase in LE, while meaningful for both decarceration and CASM, was more significant for those who were exposed to improved screening and treatment for CASM. When reducing incarceration by one-third while screening and treating all CASM conditions when screening positive for any CASM condition, the model estimated an increase of 1.5 years of life with much of the LE gain attributed to the treatment of the CASM conditions; for comparison, implementing screening for colon cancer among individuals 50–54 years of age has been estimated to increase LE by approximately 0.5 years. [45] This gain in LE is substantial considering interventions such as colon cancer screening that are estimated to increase LE by 0.5 years are considered to be meaningfully impactful (along with the benefits of reducing healthcare costs compared to cancer left untreated).

The results of this study underscore the importance of reducing mass incarceration and improving access to care for common conditions affecting this population and reducing the disproportionate impact of incarceration on communities of color and other minoritized populations. These policy and programmatic changes are warranted to address human rights and social justice, and the results of this study also suggest they are critical to improving health when coupled with access to care for different health conditions including those highlighted in the CASM conditions included here.

Incarceration is associated with several negative outcomes beyond the CASM conditions examined in our models, including higher rates of HIV infection (which have been estimated to be up to five times higher than non-incarcerated individuals), [46] overdose, [47] and suicide. [48] By reducing rates of incarceration, particularly among minority populations, mortality due to these conditions can be reduced, thus increasing overall LE beyond what we found in the CASM conditions examined here.

There were clearly increases in LE among those screened and treated for the different CASM conditions including alcohol use, depression, and tobacco use. However, the maximum benefit was seen in scenarios where screening was bypassed in favor of diagnostic assessment and treatment for all CASM conditions. These results remained consistent regardless of different decarceration rate scenarios. As CASM conditions may influence HIV treatment success including ART initiation and adherence, it is important to understand how treating these conditions may lead to increased LE through improved health and adherence to treatment regimens.

The results from this study complement several studies examining relationships between incarceration and LE. A cross sectional study conducted in New York State found that census-level incarceration was associated with lower LE, with LE decreasing as incarceration rates increased in particular census tracts. [49] A study conducted in 2016 examining LE from 1981 to 2007 found that if mass incarceration had not been in place during this period, LE would increase from 74.1 years to 79.4 years, compared to the 3.5 year increase that was seen during that time period. [50] A modeling study examining LE in the US among those who had been imprisoned found that those imprisoned at 45 years of age would lose approximately 4–5 years of LE, translating to approximately 13% of US LE

at age 45, and noted a modest relative risk between 1.7 to 2.7 for the association between incarceration and overall mortality. [51]

The results from this study indicate that a multi-pronged approach to increasing overall LE and health among incarcerated individuals is needed. Changes in how individuals are jailed along with supportive services for substance use, mental health, and chronic illness should be examined. It is also crucial to ensure support services are provided to individuals post-release, particularly for those who may not have the financial or support systems in place to continue services after release.

Given that many of CASM conditions are related (smoking and alcohol use, substance use and mental health), it is important to consider treatment of multiple conditions to ensure maximum benefit. For instance, treating individuals for substance use may benefit health through "spillover" effects whereby substance use treatment has positive benefits on other conditions such as anxiety, depression, and tobacco use. It may also benefit secondary outcomes including increased adherence to ART, which would increase raters of viral suppression and increase overall LE as a result. It is well known that behaviors including substance use and mental health conditions are related to ART adherence; [52–54] improving screening and treatment for these conditions will not only benefit HIV outcomes, but other disease outcomes.

Limitations

As this is a simulation model, the quality of the results is dependent on the assumptions made and the quality of the data collected and inputted into the model. The HPTN 061 cohort data is a predominantly male sample, over age 30, and inclusive of sexual minority individuals. We therefore would urge caution in generalizing these results to other populations. Second, we note that decarceration leads to several important outcomes beyond increases in LE that were not examined in our models. Future studies should therefore aim to simulate decarceration with respect to non-clinical outcomes such as rates of violence, employment, and overall quality of life. Third, we assumed that treatment success probabilities were independent, i.e., that a patient who failed treatment for one condition was no more or less likely to fail treatment for another condition. There may be correlations in treatment effectiveness, especially in populations bearing multiple simultaneous burdens such as HIV, incarceration, and marginalized status as a racial and sexual minority. Fourth, we assumed diagnostic assessment to have perfect sensitivity and specificity for diagnosing mental and substance disorders because these procedures are often the gold standard against which other methods (e.g., screeners) are evaluated. In reality, however, even clinical diagnostic assessment may not be perfectly accurate, especially in minority and marginalized populations. Fifth, uncertainty in this study is represented only as stochastic uncertainty regarding whether or not cohort members experience mortality at specific times in the life course; we did not perform a full Bayesian uncertainty analysis combining parameter uncertainty with stochastic uncertainty due to the large number of model parameters and technical and computation complexity of the analysis. In prior work focused on alcohol, substance, and mood-related disorders in US PLHIV (but not at incarceration) we found that LE gains were robust to uncertainty in model parameter

values, such as odds ratios that improvement in one condition alleviates other conditions or improves adherence to ART, sensitivities and specificities of screeners, and efficacy of treatments. However, because a Bayesian uncertainty analysis was not conducted here, our reported confidence intervals may underestimate uncertainty. Finally, our study did not consider costs and did not compare the cost-effectiveness of screening strategies, which is likely to be important for policy and budget considerations. We therefore recommend that future studies integrate costs into analysis to assess to what extent the costs of these policies may be offset by reductions in criminal justice costs and future health complications.

Our modeling of decarceration focused only on its impact on preventative healthcare and treatment of chronic conditions including HIV, unhealthy alcohol use, substance use, tobacco use, mental illness, and chronic pain. And although we did have information on mental illness, we did not have information on PTSD among our participants. Decarceration could have major implications outside of these domains, including exposure to and perpetration of violence, economic productivity, life fulfillment, and social and familial ties that have profound impacts in communities targeted by current US incarceration systems. For this reason, we did not attempt to capture the impacts of the modeled decarceration and CASM strategies on quality of life, focusing instead only on quantity of life (i.e., LE) based on observational cohort data. Further research on the comprehensive effects of decarceration coupled to enhanced CASM screening is needed to incorporate its full effects on health and well-being across all those impacted by policies.

Conclusions

We used simulation modeling to demonstrate increased LE arising from decarceration and CASM screening and treatment among US racial and sexual minorities triply impacted by HIV, incarceration, and CASM conditions. We would recommend that future efforts be aimed at implementing CASM into existing treatment programs along with exploration of ways of decreasing incarceration to decrease overall morbidity and mortality for this population. Future studies should also be performed in order to validate our simulation findings in real world settings.

Acknowledgments

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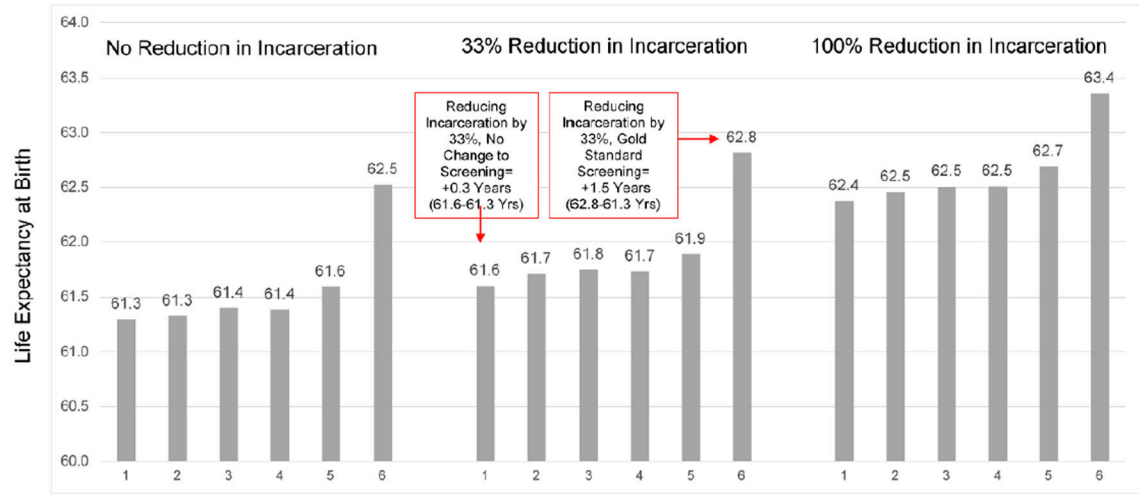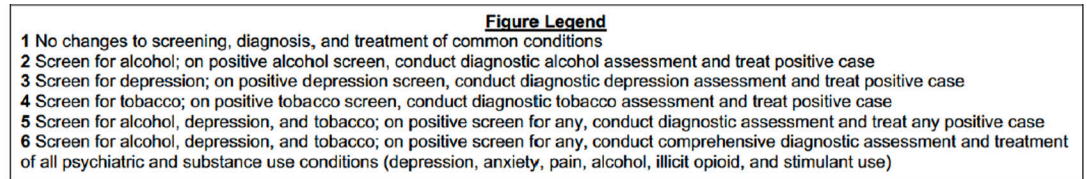
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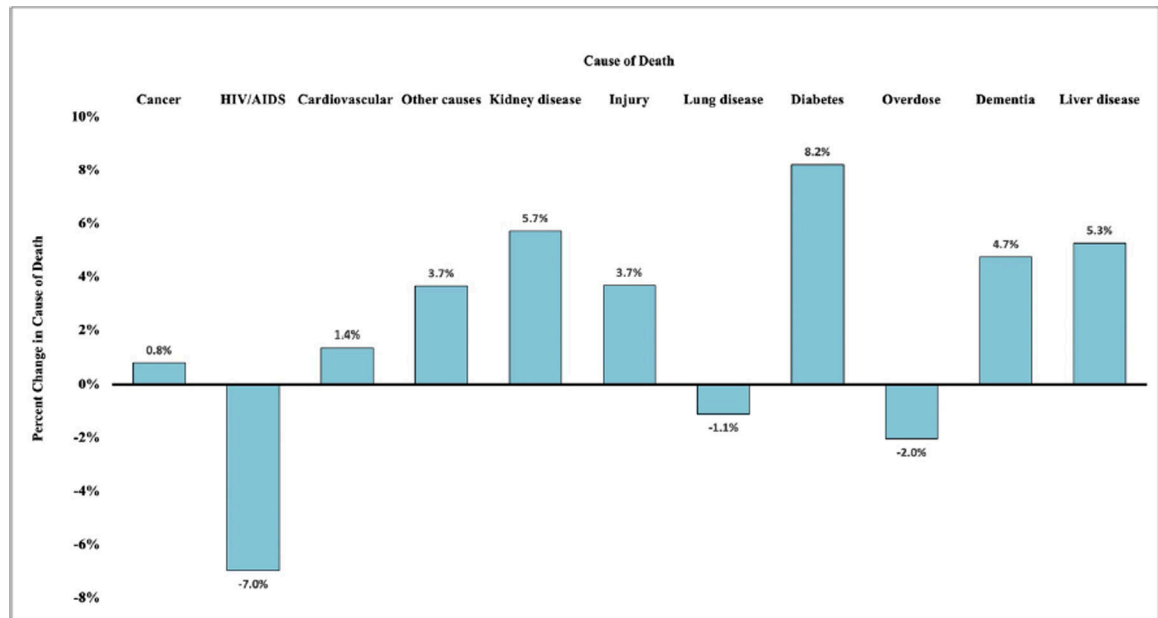Changes in Life Expectancy, CASM and Decarceration Scenarios

Figure 2:
Percent Changes in Cause of Death by Select Causes with 30% Decarceration and CASM Screening/Treatment

Table 1:

Data sources used for modeling study with relevant factors pulled from each of the data sources

Data Source Used	Function of Data Source	Strengths of Data Source Used
HPTN 061 Black Sexual Minority Men Cohort	To estimate effect of incarceration on psychiatric and substance use conditions that in turn drive mortality	Longitudinal data collection; large sample size (N=900+)
Systematic Reviews of Existing Literature	To estimate associations between psychiatric and substance use conditions and increased risk of non-adherence to treatments for HIV and other conditions that drive mortality (e.g., CVD)	Data obtained from peer-reviewed studies that have high validity
Veteran Aging Cohort Study	To emulate randomized trials to estimate how improved screening for and treatment of psychiatric and substance use conditions can reduce these conditions and other related conditions	Large number of participants in sample, detailed records on a multitude of different conditions; allows for causal relationships to be examined