All-cause and cause-specific mortality among Black and White North Carolina state prisoners, 1995-2005

David L. Rosen, MD, PhD,
The University of North Carolina at Chapel Hill Cecil G. Sheps Center for Health Services Research

David A. Wohl, MD, and
The University of North Carolina at Chapel Hill Department of Medicine, Division of Infectious Diseases

Victor J. Schoenbach, PhD
The University of North Carolina at Chapel Hill Gillings School of Global Public Health

Abstract

Purpose—We compared mortality rates among state prisoners and other state residents to identify prisoners' healthcare needs

Methods—We linked North Carolina prison records with state death records for 1995-2005 to estimate all-cause and cause-specific death rates among Black and White male prisoners aged 20-79 years, and used standardized mortality ratios (SMRs) to compare these observed deaths with the expected number based on death rates among state residents

Results—The all-cause SMR of Black prisoners was 0.52 (95%CI: 0.48 0.57), with fewer deaths than expected from accidents, homicides, cardiovascular disease and cancer. The all-cause SMR of White prisoners was 1.12 (95%CI: 1.01, 1.25) with fewer deaths than expected for accidents, but more deaths than expected from viral hepatitis, liver disease, cancer, chronic lower respiratory disease, and HIV.

Conclusions—Mortality of Black prisoners was lower than that of Black state residents for both traumatic and chronic causes of death. Mortality of White prisoners was lower than that of White state residents for accidents, but higher for several chronic causes of death. Future studies should investigate the effect of prisoners' pre-incarceration and in-prison morbidity, the prison environment, and prison healthcare on prisoners' patterns of mortality.

Keywords

Mortality; Prisoners; Minority Health

Correspondence to: David L. Rosen.

INTRODUCTION

The US has the highest incarceration rate in the world[1] with an estimated 1 in 100 adults in prison or jail on any given day.[2] One consequence of this mass incarceration is that prisons have become an important source of healthcare for a portion of America's poor.

Providing healthcare in prison presents many challenges. Compared to the general population, prison populations have high rates of morbidity, particularly from infectious diseases, mental health conditions, and substance use.[3-5] And with the aging of the prison population, prison systems are increasingly confronted with providing care for other chronic diseases.[6, 7] While in principle, prisoners' right to healthcare has been confirmed in the judicial system,[8] in practice the provision of healthcare may be constrained by overcrowding, competing financial needs, and lack of personnel.[9, 10]

Beyond the provision of healthcare, prisons may influence inmates' health by providing food and shelter as well as opportunities for exercise and health education. For some inmates, prisons also provide a refuge from the substance use and violence endemic in their communities; for others, these threats persist—and in some instances are heightened—in prison.[11-13]

These three factors—baseline morbidity, access to care, and the environment—play important roles in influencing prisoners' health and their mortality. Conversely, mortality rates can inform us of the confluent effect of these factors.

Although several studies have examined prisoner mortality, [14-19] few have been conducted in the US during the past twenty years.[20-22] Arguably, the most comprehensive of these more recent studies was a report by the US Bureau of Justice Statistics (BJS), which assessed all deaths of state prisoners, aged 15-64 years, for the years 2001-2004. Similar to older studies, this report found that prisoners had lower death rates than in the general population. But this study was remarkable in that it documented wide disparities in mortality by race. The crude mortality rate for Black prisoners was 57% less than that of Blacks in the general population (206 vs. 484 per 100,000), while the crude mortality rate of White prisoners was 10% greater than Whites in the general population (343 vs. 312 per 100,000).[20]

Further refining estimates of mortality by race, Patterson recently published race stratified age-specific mortality rates among US male prisoners for the years1985 to 1998. She found that mortality rates for both Black and White males were each similar to that of non-incarcerated White males.[22] While the analysis did not include data describing prisoners' cause of death, by excluding traumatic deaths from the comparator (i.e. general) population, Patterson demonstrated that the decrease in mortality among Black prisoners was not entirely due to the environmental protections of prison. Another recent study, which assessed mortality among Georgia state prisoners, found that imprisoned Black men had lower mortality rates than Black men in the general population, although this effect may have been largely an artifact of the state's compassionate release policy.[21]

In this study we use data from a single state to build on the previous examinations of prisoner mortality by race, comparing all-cause and cause-specific mortality among prisoners with that of the general population. Quantification of mortality rates provides a useful albeit blunt barometer to assess prisoners' health and healthcare needs.

METHODS

Data sources and linkage

For the study years 1995 to 2005, we obtained electronic imprisonment records from the North Carolina Department of Correction (NC DOC) and electronic state death records from the North Carolina State Center for Health Statistics. Both sets of records included first and last name, race, sex, date of birth, and last 4 digits of the social security number. In addition, death records included cause and date of death, and imprisonment records included a field indicating whether the inmate died during incarceration. Imprisonment records did not indicate cause of death except for those prisoners who were executed.

To determine prisoners' cause of death, we matched and linked imprisonment and death records based on the personal identifiers common to both databases; matching was conducted using Link Plus software which allows for probabilistic matching of records.[23]

We excluded the thirty three deaths by execution. We also excluded prisoners aged 80 years or older, women, and male prisoners who were neither White nor Black because these groups were too small to calculate race- and age-stratified mortality estimates with adequate precision. Ninety-five percent of records among White and Black male decedent prisoners (797/841) were matched and linked to a state death record. Sixty percent (26/44) of unlinked records were among Blacks.

Cause of death coding

In state death records, cause of death was coded using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), for years 1995 to 1998 and the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), for years 1999 to 2005. The ICD codes were grouped into causes according to the National Center for Health Statistics (NCHS) List of Selected Causes of Death.[24] Because the NCHS list does not include a mental health category, we constructed this category based on coding for the mental health chapters in the ICD-9-CM and ICD-10. Results are presented for all-causes of death as well as by 11 mutually exclusive categories of death, and 14 substituent causes. We also created a category for alcohol- and drug-induced deaths which aggregates deaths from all ICD codes in which alcohol or drug use is explicitly described as the cause (Appendix Table 1).

Prison and state census data—As with other studies of prisoner mortality,[20, 22] denominator data used to determine death rates among prisoners consisted of age- and race-specific person-years derived with the assumption that the counts of prisoners incarcerated on June 30th of each year during the study period approximated the average number of inmates during the year. We obtained these data by querying the NC DOC website (accessed December 12, 2009).

Denominator data for determining death rates among residents were obtained by querying the CDC's Wide-Ranging OnLine Data for Epidemiological Research Web site, which provides stratum-specific decennial census counts and annual intercensal estimates (accessed December 14, 2009).[25, 26]

Analyses of all-cause and cause-specific mortality

To compare mortality across imprisonment status, we first estimated crude all-cause mortality rates separately for male prisoners and for other male residents, stratifying by race (Black or White). We used direct standardization (with ages divided into 10-year groups from 20-29 to 70-79) to adjust our mortality estimates for differences in age-composition

across each population. Age-standardized estimates were weighted using the 2000 US standard population, and CIs and statistical testing accounted for the stratum-specific weights of the standard population.[27]

We examined cause-specific mortality to determine which causes of death contributed to mortality differences between male prisoners and other male state residents. However, for some causes the low number of prisoner deaths resulted in inadequate precision to make comparisons using standardized mortality rates, Accordingly, we used race-stratified standardized mortality ratios (SMRs), to contrast mortality between prisoners and residents. SMRs were estimated as the ratio of observed prisoner deaths divided by expected prisoner deaths. The expected number of prisoner deaths was estimated by multiplying the race-specific death rate for each age stratum of the state resident population by the race-specific number of person-years within each corresponding age-stratum of the prison population and summing the results across all age-strata. We also calculated the difference between observed and expected deaths for each cause.

Approximate 95% CIs for SMRs were calculated when the observed number of deaths per group was 100 or greater; [28] for fewer observed deaths, we calculated exact confidence intervals.[29] .All analyses were conducted using SAS version 9.2 (SAS Institute, Cary, NC); SMRs and 95% CIs were calculated with our own SAS macro.

This study was approved by the Internal Review Board at the University of North Carolina.

RESULTS

From January 1, 1995 to December 31, 2005, 120,959 unique prisoners aged 20 to 79 years were incarcerated in the NC prison system at least once. Eighty-seven percent (105,237/120,959) of these prisoners were male, and of the male prisoners 94% (98,870/105,237) were classified as either White or Black. Of these 98,870 prisoners, 61% (60,037) were Black, and the median age at admission was 32 years (25th -75th percentile inter-quartile limits [IQL]: 24-40). Forty-eight percent of adult Black and White male prisoners had a history of multiple imprisonments in the NC DOC, and the median number of lifetime months imprisoned was 13.8 (IQR: 5.4- 38.9) with a total of 302,695 contributed person years at risk. Death during incarceration occurred among less than one percent of Black and White male prisoners (841/98,870).

Across age groups and the age-adjusted estimate, death rates among Black and White male prisoners were not statistically different (p>0.05) with estimates among Black prisoners generally lower than those of White prisoners (Figure 1, Appendix Table 2). In contrast, Black male residents had higher death rates than White male residents across all age-groups and the age-adjusted estimate (p<0.05). Comparing mortality rates within race, Black prisoners had lower death rates than Black residents across all age groups while White prisoners had lower death rates than White residents for the youngest age group, but higher death rates for ages 50-79 years.

Among both male prisoners and male residents, the most frequent causes of death were cardiovascular disease and cancer (Table 1). However, infections caused nearly 20% of deaths among prisoners, but only about 5% among residents. SMRs among male prisoners differed substantially by race (Table 2). Black prisoners experienced about half the expected number of all-cause deaths (SMR 0.52, 95%CI: 0.48, 0.57). For several causes, the number of deaths among Blacks was 80% less than the expected number (i.e. SMRs <0.2). These causes included alcohol or drugs, diabetes, chronic lower respiratory disease, mental and behavioral disorders, and accidents. There were at least 60% fewer than expected homicide and suicide deaths, and 36% and 31%, respectively, fewer than expected deaths from

cardiovascular disease and cancer. For lung or bronchial cancer, liver cancer, liver disease, and HIV, SMRs included the null. The only cause for which Black prisoners experience an excess number of deaths was viral hepatitis (SMR 3.21, 95%CI: 1.66, 5.61) (Table 2).

In contrast, among White male prisoners there was an excess number of expected deaths (SMR 1.12, 95%CI: 1.01, 1.25) for all-cause-mortality (Table 2). However, in a sensitivity analysis which excluded the 18 Whites with a prison record indicating death but no matching state death record, the SMR included the null (Appendix Table 3). By cause, White prisoners experienced the greatest relative excess of deaths for viral hepatitis (SMR 7.18, 95%CI: 3.83, 12.28) and liver cancer (SMR 5.13, 95%CI: 2.46, 9.44). Cancer and infections accounted for the greatest absolute excess in deaths, 37 and 21, respectively. There were also excess numbers of deaths from non-alcoholic liver disease and chronic lower respiratory disease while SMR CIs for cardiovascular disease, homicide, suicide, and alcohol/drugs all included the null. Among White prisoners, the greatest absolute difference between observed and expected deaths was for accidental causes, in which the number of deaths observed was 45 fewer than the expected.

DISCUSSION

In this study, we compared the mortality experience of prisoners with that of the general population and examined how mortality differed across these populations by cause of death and race.

We found that the number of deaths among Black male prisoners was 48% less than the expected . In contrast, the number of deaths among White male prisoners was only modestly higher than expected, and in a sensitivity analysis this excess was not statistically significant. Our findings echoed those of the Patterson analysis[22] in that the age-standardized mortality rates for Black and White male prisoners were similar to White residents. These results are in stark contrast to mortality rates in the general population—both in the US and in NC—in which mortality is about 40% higher among Blacks than Whites.[30] These findings suggest that incarceration may play a role in equalizing the mortality experience across race.

There are several possible mechanisms by which incarceration may be protective against or contribute to mortality. Relatively rigid provision of food, shelter, security, and medical and ancillary services may all affect mortality in prison. Similarly, environmental controls in prison may foster a unique set of illicit and unhealthy behaviors. Equivalent exposure to prison resources and environmental elements may contribute to similar mortality rates across race.

Among older prisoners, pre-existing morbidity prior to incarceration undoubtedly plays an important role in determining mortality patterns. While morbidity data were not available to us, a few large studies suggest that the prevalence of some chronic conditions among Black prisoners may be less those of White prisoners[31] and less than those of Blacks in the general population [31, 32] With about 16% of Black males, but only 2% of White males, imprisoned during their lifetime,[33] imprisonment among White men may be a stronger marker for disenfranchisement than for Black men. One consequence may be that White men who are imprisoned may be less healthy than White men who are not; this difference is probably less pronounced for Black men.

Examining cause-specific mortality among Black prisoners, we found that they had fewer than expected deaths from most chronic medical conditions, including the two most common causes of death, cancer and cardiovascular disease. Although SMRs for these causes demonstrate a moderate protective effect (i.e. SMR ~ 0.6) they represent large

absolute differences between the number of expected and actual deaths. Causes with large absolute differences drive the all-cause mortality patterns and suggest conditions in which interventions may have the greatest public health impact.

It is possible that lower than expected levels of mortality from chronic conditions is the result of a "healthy worker effect." That is, some individuals are not healthy enough to engage in crime, and as a result, prisoners (and ex-prisoners) tend to be healthier than the general population. In a study of English and Welsh prisoners, Fazel and Benning imply that a healthy worker effect is inconsistent with Fazel's previous study showing high rates of morbidity and poor prison healthcare.[14] Other investigators of prison mortality studies simply concluded that a healthy worker effect was inconsistent with their results.[15, 21] Nonetheless, without both morbidity and mortality data, we cannot rule out the possibility—in these studies and in our own—that some groups of prisoners are healthier than non-prisoners.

Among Black male prisoners, causes of death with a large relative and absolute difference in the number of expected and actual deaths included accidents, homicides, and alcohol and drugs. Given the underlying mechanisms of these types of deaths, it's likely that their prevention was largely due to the environmental controls in prison. Since these causes are among the leading causes of death among young men in the community, it follows that the relatively low number of prisoner deaths from these causes helped to drive down the all-cause mortality rates among the youngest age group of both Black and White prisoners.

Among Black male prisoners, the only cause of death with a statistically significant excess of deaths was viral hepatitis; indeed, the SMR for viral hepatitis was the highest among all causes for both Black and White male prisoners, although it accounted for only 3% (25/797) of all deaths in our population, a proportion similar to that found among Texas prisoners.[34] Although the high prevalence of hepatitis among prisoners is well known, to our knowledge treatment is not widespread despite favorable cost-effectiveness analyses.[35]

In addition to hepatitis, White prisoners had greater than expected numbers of deaths from non-alcoholic liver disease, cancer (including liver and lung), chronic lower respiratory disease, and HIV; the SMR for cardiovascular disease was modestly elevated but its confidence interval included the null. As we suggested above, high rates of mortality from chronic diseases among Whites may be a reflection of high rates of morbidity among the incoming population; sub-optimal access to or quality of healthcare while in prison is another explanation which merits future study.

Our analyses have some limitations. First, 5% of records among deceased prisoners could not be linked to state death records. Exclusion of these unlinked prison records from our analyses of cause-specific deaths artificially lowered some of our SMRs. While SMRs were also artificially low because of the compassionate release of dying prisoners, we demonstrated in sensitivity analyses that this effect was negligible. Another limitation is that the small number of deaths among women and prisoners who were neither White nor Black precluded their inclusion in our analysis. Use of death records has several well documented limitations including differential reliability and validity by cause.[36] As with other studies examining prisoner mortality, the denominators for our death rates were derived from annual one-day censuses of prisoners. While the one-day census underestimates the unique number of prisoners who flow through the prison system annually, it does provide a reasonable estimate of prisoners' person-time at risk. Our estimates of resident deaths constituted all deaths in the population regardless of imprisonment status. Given the relatively high rates of incarceration among Black men, this assumption biased SMR estimates towards the null for

Blacks more than for Whites. Finally, our findings may not be generalizable to other state prison systems.

Mortality among prisoners may be affected by prisoners' pre-incarceration morbidity, the protective environment of prison, and in addition to other basic resources, the availability of prison healthcare. With Black and White prisoners experiencing far fewer than the number of expected deaths from traumatic causes, this study provides further evidence that prison is protective against these causes. Indeed, of all the factors influencing prisoners' mortality, the protective effect of the prison environment appears to have the greatest absolute impact on our findings. Our findings that Black prisoners experienced fewer chronic disease deaths than expected, but White prisoners experienced more cannot be explained with our data. Nevertheless, these findings provide a blunt assessment of prisoners' general health and they represent a primary step in assessing healthcare need. Future studies should be designed to disentangle the effects of morbidity and prison healthcare on chronic disease mortality to further elucidate the healthcare needs of prisoners during their incarceration and following their release.

Acknowledgments

Abbreviations and Acronyms

|	
BJS	Bureau of Justice Statistics
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
ICD	International Classification of Diseases
IQL	Inter-Quartile Limits
NCHS	National Center for Health Statistics
NC	North Carolina
NC DOC	North Carolina Department of Correction
SMR	Standardized Mortality Ratio
SSN	Social Security Number
US	United States
vs.	Versus

REFERENCES

1. Walmsley, R. [March 21, 2010] World Prison Population List, Eighth Edition. Available at http://www.kcl.ac.uk/depsta/law/research/icps/downloads/wppl-8th_41.pdf.
2. [April 5, 2008] The Pew Center on the States. One in 100: Behind Bards in America 2008. Available at http://www.pewcenteronthestates.org.

3. The Health Status of Soon-to-be-Released Inmates, A Report to Congress, Volume 1. National Commission on Correctional Health Care; Chicago: March. 2002

4. Mumola, CJ. Substance Abuse and Treatment, State and Federal Prisoners, 1997. US Department of Justice, Bureau of Justice Statistics; Washington, DC: January. 1999 NCJ 172871

5. James, DJ.; Glaze, LE. Mental Health Problems of Prison and Jail Inmates. US Department of Justice, Bureau of Justice Statistics; Washington, DC: September. 2006 NCJ 213600

6. Mitka M. Aging prisoners stressing health care system. JAMA. Jul 28; 2004 292(4):423–424. [PubMed: 15280325]

7. Williams BA, McGuire J, Lindsay RG, et al. Coming Home: Health Status and Homelessness Risk of Older Pre-release Prisoners. J Gen Intern Med. Jun 8.2010

8. Estelle vs. Gamble. Vol U.S. 97: U.S. Supreme Court. 1976. p. 429

9. Moore, S. [June 10, 2010] California Prisons Must Cut Inmate Population.; The New York Times. August 4. 2009 p. A1at http://www.nytimes.com/2009/2008/2005/us/2005calif.html

10. MacReady N. Cruel and unusual. Lancet. Feb 28; 2009 373(9665):708–709. [PubMed: 19263584]

11. Sung HE. Prevalence and risk factors of violence-related and accident-related injuries among state prisoners. J Correct Health Care. Jul; 16(3):178–187. [PubMed: 20466703]

12. National Prison Rape Elimination Commission United States. National Prison Rape Elimination Commisssion Report. June. p. 276Available at: http://www.ncjrs.gov/pdffiles1/226680.pdf

13. Gillespie W. A multilevel model of drug abuse inside prison. The Prison Journal. 2005; 85(2):223–246.

14. Fazel S, Benning R. Natural deaths in male prisoners: a 20-year mortality study. Eur J Public Health. Aug; 2006 16(4):441–444. [PubMed: 16431869]

15. Clavel F, Benhamou S, Flamant R. Decreased mortality among male prisoners. Lancet. Oct 31; 1987 2(8566):1012–1014. [PubMed: 2889915]

16. Salive ME, Smith GS, Brewer TF. Death in prison: changing mortality patterns among male prisoners in Maryland, 1979-87. Am J Public Health. Dec; 1990 80(12):1479–1480. [PubMed: 2240334]

17. Wobeser WL, Datema J, Bechard B, Ford P. Causes of death among people in custody in Ontario, 1990-1999. Cmaj. Nov 12; 2002 167(10):1109–1113. [PubMed: 12427701]

18. Novick LF, Remmlinger E. A study of 128 deaths in New York City correctional facilities (1971-1976): implications for prisoner health care. Med Care. Sep; 1978 16(9):749–756. [PubMed: 682709]

19. Dalton V. Death and dying in prison in Australia: national overview, 1980-1998. J Law Med Ethics. 1999; 27(3):269–274, 210. Fall. [PubMed: 11067604]

20. Mumola, CJ. Medical Causes of Death in State Prisons, 2001-2004. Bureau of Justice Statistics; Washington, DC: January. 2007 NCJ 216340

21. Spaulding AC, Seals RM, McCallum VA, Perez SD, Brzozowski AK, Steenland NK. Prisoner Survival Inside and Outside of the Institution: Implications for Health-Care Planning. Am J Epidemiol. Jan 14.2011

22. Patterson EJ. Incarcerating death: mortality in U.S. state correctional facilities, 1985-1998. Demography. Aug; 2010 47(3):587–607. [PubMed: 20879679]

23. Winkler, WE. Using the EM Algorithm for Weight Computation in the Fellegi-Sunter Model of Record Linkage. Paper presented at: American Statistical Association 1998 Proceedings of the Section on Survey Research Methods. 1988.

24. National Center for Health Statistics. [October 10, 2006] Documentation for the Public Use Multiple Cause of Death File on Comparability between ICD-9 and ICD-10: A double-coded file based on the 1996 data year multiple cause of death file. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/Comparability/icd9_icd10/ICD9_ICD10_comparability_file_documentation.pdf.

25. United States Department of Commerce U.S. Census Bureau Population Division. Census Population 1970-2000 for Public Health Research, CDC WONDER On-line Database, March 2003.. Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Bridged-Race Population Estimates, United States, 1990 - 2003, July 1st resident

population by state, county, age, sex, race, and Hispanic origin, on CDC WONDER On-line Database, June 2005.

26. United States Department of Health and Human Services (US DHHS). Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Bridged-Race Population Estimates, United States, July 1st resident population by state, county, age, sex, race, and Hispanic origin, compiled from 2000-2005 (vintage 2005) bridged-race postcensal population estimates, on CDC WONDER On-line Database, April 2007.

27. Lilienfeld, DE.; Stolley, PD. Foundations of Epidemiology. Third ed. Oxford Press; 1994.

28. Rothman, K.; Boice, J, Jr.. Epidemiologic Analysis with a Programmable Calculator. USHEW/ PHS; Washington, D.C.: 1979.

29. Goldblatt, P. Longitudinal Study, Mortality and social organisation. HMSO; London: 1990.

30. Centers for Disease Control and Prevention. [Jul 15, 2010] National Center for Health Statistics. Compressed Mortality File 1999-2006. at http://wonder.cdc.gov/cmficd10.html

31. Binswanger IA, Krueger PM, Steiner JF. Prevalence of chronic medical conditions among jail and prison inmates in the USA compared with the general population. J Epidemiol Community Health. Nov; 2009 63(11):912–919. [PubMed: 19648129]

32. Harzke AJ, Baillargeon JG, Pruitt SL, Pulvino JS, Paar DP, Kelley MF. Prevalence of chronic medical conditions among inmates in the Texas prison system. J Urban Health. May; 2010 87(3): 486–503. [PubMed: 20393884]

33. Bonczar, TP. Prevalence of Imprisonment in the U.S. Population, 1974-2001. US Department of Justice, Bureau of Justice Statistics; Washington, DC: August. 2003 NCJ 197976

34. Harzke AJ, Baillargeon JG, Kelley MF, Diamond PM, Goodman KJ, Paar DP. HCV-related mortality among male prison inmates in Texas, 1994-2003. Ann Epidemiol. Aug; 2009 19(8):582–589. [PubMed: 19443239]

35. Tan JA, Joseph TA, Saab S. Treating hepatitis C in the prison population is cost-saving. Hepatology. Nov; 2008 48(5):1387–1395. [PubMed: 18924228]

36. Rosenberg HM. Improving cause-of-death statistics. Am J Public Health. May; 1989 79(5):563–564. [PubMed: 2705587]
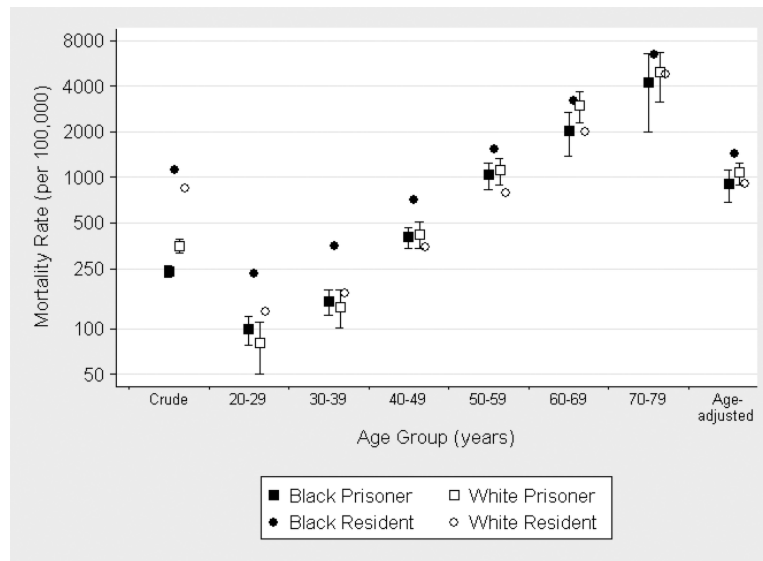
Figure 1.
Race-stratified crude, age stratified, and age adjusted mortality rates among adult male
prisoners and other adult male residents, North Carolina, 1995-2005
Mortality rates were calculated for all Black and White adult (aged 20-79 years) males in
prison and other adult male state residents across 11 years. Age adjusted estimates were
calculated using the US Standard 2000 population. Resident point estimate mortality rates
are labeled with circles; prisoner point estimates are labeled with boxes and accompanied by
95% CIs, presented using lines with caps. Mortality rates are plotted on a log scale. 95% CI
= Ninety-five percent confidence intervals

Table 1

Cause of death among Black and White adult male NC residents and prisoners, 1995-2005[*]

	NC residents (N=264,792), %	NC Prisoners (N=797), %
Cardiovascular disease		
Total	33.6	27.9
Cerebrovascular disease	4.8	2.8
Ischemic heart disease	20.3	16.8
Cancer		
Total	27.9	24.2
Liver cancer	0.7	2.0
Lung or bronchial cancer	10.6	10.5
Liver disease and cirrhosis		
Total	1.9	2.8
Alcoholic liver disease	1.1	0.8
Causes other than alcohol	0.8	2.0
Diabetes	3.0	0.8
Infection		
Total	5.3	19.7
HIV	1.6	13.8
Viral hepatitis	0.3	3.1
Tuberculosis	0.0	0.0
Respiratory disease		
Total	6.6	2.9
Chronic lower respiratory disease	5.0	2.3
Mental and behavioral		
Total	1.6	0.5
Alcohol	0.8	0.3
Drugs	0.1	0.0
Accident		
Total	7.1	5.3
Motor vehicle accident	3.6	2.8
Drug overdose	1.0	1.4
Homicide	1.7	5.3
Suicide	2.7	3.9
Other	8.7	6.9
Alcohol or drugs[†]	3.2	3.3

[*] Sum of percentages for discrete categories of death exceed 100% due to rounding.

[†] Alcohol or drugs is a composite category which aggregates deaths from all ICD codes in which alcohol or drug use is explicitly described as the cause.

NIH-PA Author Manuscript   NIH-PA Author Manuscript   NIH-PA Author Manuscript

Table 2

Cause-specific SMRs and 95% CIs for Black and White adult male state prisoners, North Carolina, 1995–2005

	Black				White			
	Observed(O)	Expected(E)	O-E	SMR	Observed(O)	Expected(E)	O-E	SMR
Death - all cause [*]	481	917.2	-436.2	0.52 (0.48, 0.57)	360	320.4	39.6	1.12 (1.01, 1.25)
Cardiovascular disease								
Total	131	205.7	-74.7	0.64 (0.53, 0.76)	91	79.9	11.1	1.14 (0.92, 1.40)
Cerebrovascular disease	16	34.7	-18.7	0.46 (0.26, 0.75)	6	8.7	-2.7	0.69 (0.25, 1.50)
Ischemic heart disease	67	86.6	-19.6	0.77 (0.60, 0.98)	67	51.9	15.1	1.29 (1.00, 1.64)
Cancer								
Total	88	128.0	-40.0	0.69 (0.55, 0.85)	105	68.3	36.7	1.54 (1.26, 1.86)
Liver cancer	6	4.6	1.4	1.30 (0.48, 2.82)	10	1.9	8.1	5.13 (2.46, 9.44)
Lung or bronchial cancer	36	37.8	-1.8	0.95 (0.67, 1.32)	48	23.0	25.0	2.08 (1.54, 2.76)
Liver disease and cirrhosis								
Total	9	18.6	-9.6	0.49 (0.22, 0.92)	13	8.3	4.7	1.57 (0.84, 2.68)
Alcoholic liver disease	1	13.6	-12.6	0.07 (0.00, 0.41)	5	5.3	-0.3	0.95 (0.31, 2.21)
Causes other than alcohol	8	5.0	3.0	1.61 (0.70, 3.18)	8	3.0	5.0	2.66 (1.15, 5.24)
Diabetes	5	25.0	-20.0	0.20 (0.07, 0.47)	1	7.1	-6.1	0.14 (0.00, 0.78)
Infection								
Total	120	133.2	-13.2	0.90 (0.75, 1.08)	37	15.8	21.2	2.34 (1.65, 3.23)
HIV	96	102.1	-6.1	0.94 (0.76, 1.15)	14	6.5	7.5	2.14 (1.17, 3.59)
Viral hepatitis	12	3.7	8.3	3.21 (1.66, 5.61)	13	1.8	11.2	7.18 (3.83, 12.28)
Tuberculosis	0	0.8	-0.8	0.00 (0.00, 4.70)	0	0.1	-0.1	0.00 (0.00, 42.81)
Respiratory disease								
Total	5	18.2	-13.2	0.27 (0.09, 0.64)	18	11.6	6.4	1.56 (0.92, 2.46)
Chronic lower respiratory dis.	2	10.8	-8.8	0.19 (0.02, 0.67)	16	8.3	7.7	1.93 (1.10, 3.13)
Mental and behavioral								
Total	2	19.5	-17.5	0.10 (0.01, 0.37)	2	5.5	-3.5	0.36 (0.04, 1.31)
Alcohol	1	13.7	-12.7	0.07 (0.00, 0.41)	1	4.0	-3.0	0.25 (0.01, 1.39)
Drugs	0	3.0	-3.0	0.00 (0.00, 1.24)	0	0.3	-0.3	0.00 (0.00, 11.13)
Accident								

	Black				White			
	Observed(O)	Expected(E)	O-E	SMR	Observed(O)	Expected(E)	O-E	SMR
Total	26	136.6	-110.6	0.19 (0.12, 0.28)	16	61.3	-45.3	0.26 (0.15, 0.42)
Motor vehicle accident	15	86.7	-71.7	0.17 (0.10, 0.29)	7	33.0	-26.0	0.21 (0.09, 0.44)
Drug overdose	5	16.6	-11.6	0.30 (0.10, 0.70)	6	12.9	-6.9	0.47 (0.17, 1.02)
Homicide	32	115.3	-83.3	0.28 (0.19, 0.39)	10	10.3	-0.3	0.97 (0.46, 1.78)
Suicide	12	31.0	-19.0	0.39 (0.20, 0.68)	19	26.5	-7.5	0.72 (0.43, 1.12)
Other	33	86.0	-53.0	0.38 (0.26, 0.54)	22	25.7	-3.7	0.86 (0.54, 1.30)
Alcohol or drugs[†]	9	45.5	-36.5	0.20 (0.09, 0.38)	17	23.8	-6.8	0.71 (0.42, 1.14)

*
Includes all deaths recorded in prison records, regardless of whether prison record was matched with state death record to identify cause of death

[†]
Alcohol or drugs is a composite category which aggregates deaths from all ICD codes in which alcohol or drug use is explicitly described as the cause.

Appendix Table 1

Relationship between study causes and NCHS list[*]

	NCHS list number
Cardiovascular disease	053-075
Cerebrovascular disease	070
Ischemic heart disease	058-063
Cancer	020-044
Liver cancer	024
Lung/bronchial cancer	027
Liver disease & cirrhosis	094, 095
Alcoholic liver disease	094
Other causes	095
Diabetes	046
Infection	001-018, 076-081
HIV	016
Viral hepatits	015
Tuberculosis	004, 005
Respiratory disease	082-089
Chronic lower respiratory	083-086
Mental & behavioral[*]	290-319; F00-F99
Alcohol[*]	303, 305.0; F10
Drugs[*]	304, 305.2-305.9; F11-F16, F19, F55
Accident	114-123, 132-133
Motor vehicle accident	114
Drug overdose	122
Homicide	128, 129
Suicide	125, 126
Other	045-052, 090-111, 130, 134-135
Alcohol or drugs[*]	303, 304, 305.0, 305.2-305.9, 571.0–571.3, E850-E858, E950.0-E950.5, E962.0, E980.0-E980.5; F10-F16, F19, F55, K70, K73, K74, X40-X44, X60-X64, X85, Y10-Y14

NCHS list available at
ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/Comparability/icd9_icd10/ICD9_ICD10_comparability_file_documentation.pdf

[*] ICD codes are presented for mental & behavioral conditions and alcohol- and drug-induced deaths

Appendix Table 2

Age-specific and age-standardized mortality rates[*] among adult Black and White male state prisoners, North Carolina, 1995-2005

	NC prisoners	NC residents
Black 20-29 years	99.5 (78.1, 120.9)	230.4 (222.6, 238.2)
30-39	151.2 (122.2, 180.2)	354.5 (344.7, 364.4)
40-49	403.1 (338.3, 467.9)	712.5 (698, 726.9)
50-59	1036.1 (832.0, 1,240.1)	1535.3 (1509, 1561.6)
60-69	2033.7 (1,366.8, 2,700.6)	3171.9 (3122.6, 3221.2)
70-79	4248.4 (1,988.5, 6,508.2)	6461.1 (6371.2, 6551)
Age-adjusted[†]	899.5 (688.1, 1,110.9)	1435.5 (1424.3, 1446.7)
White 20-29 years	80.5 (50.2, 110.9)	130.0 (126.8, 133.2)
30-39	140.1 (100.9, 179.3)	172.2 (168.7, 175.8)
40-49	421.0 (336.9, 505.0)	345.4 (340.3, 350.6)
50-59	1113.4 (884.7, 1,342.2)	786.9 (778.1, 795.6)
60-69	2991.5 (2,301.2, 3,681.7)	2000.4 (1983.5, 2017.2)
70-79	4912.3 (3,138.0, 6,686.6)	4802.8 (4771, 4834.5)
Age-adjusted[†]	1070.4 (894.6, 1,246.2)	900.6 (896.7, 904.5)

[*] per 100,000

[†] adjusted to the US 2000 standard population

Appendix Table 3

Sensitivity analysis of all-cause SMRs among Black and White adult male state prisoners, North Carolina, 1995-2005.

	Black			White		
	Observed	Expected	SMR(95% CI)	Observed	Expected	SMR(95% CI)
All-cause death[*]	481	917.2	0.52 (0.48, 0.57)	360	320.4	1.12 (1.01, 1.25)
Plus 11 compassionate release prisoners	492	917.2	0.54 (0.49, 0.59)	371	320.4	1.16 (1.04, 1.28)
All-cause death (matched)[**]	455	917.2	0.50 (0.45, 0.54)	342	320.4	1.07 (0.96, 1.19)
Plus 11 compassionate release prisoners	466	917.2	0.51 (0.46, 0.56)	353	320.4	1.10 (0.99, 1.22)

[*] Includes all deaths recorded in prison records, regardless of whether prison record was matched with state death record to identify cause of death

[**] Includes only deaths recorded in prison records successfully matched with state death record to identify cause of death.