# Age-Standardized Mortality of Persons on Probation, in Jail, or in State Prison and the General Population, 2001-2012

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## Abstract

**Objectives:** The number of adults in the United States being held on probation—persons convicted of crimes and serving their sentence in the community rather than in a correctional facility—approached 4 million at the end of 2016 and continues to grow, yet little is known about the health and well-being of this population. We compared the standardized mortality ratios of persons on probation in the United States with persons in jail, persons in state prison, and the general US population.

**Methods:** We used administrative data from 2001-2012 from the Bureau of Justice Statistics and the Centers for Disease Control and Prevention WONDER database and indirect standardization techniques to compare the mortality rates of persons on probation in 15 states with the mortality rates of persons in jail, persons in state prison, and the general US population. We applied the age-specific mortality rates of 3 populations (general US population, persons in jail, and persons in state prison) to the age distribution of persons on probation to estimate standardized mortality ratios.

**Results:** Persons on probation died at a rate 3.42 times higher than persons in jail, 2.81 times higher than persons in state prison, and 2.10 times higher than the general US population, after standardizing the age distribution of persons on probation relative to the other 3 groups.

**Conclusions:** Public health interventions should target persons on probation, who have received less attention from the public health community than persons serving sentences in jails and prisons.

An estimated 3 673 100 (56%) of the 6.6 million adults in the United States who comprised the correctional population in 2016 were on probation, meaning they had been convicted of a crime and were serving a sentence in the community rather than in a correctional facility. More Americans are on probation than all other forms of correctional supervision combined; in 2016, about 1 in 70 adults in the United States were on probation on any given day.[1] This population is expected to grow with current criminal justice reform efforts to expand diversion programs that allow persons to serve sentences in their communities and avoid incarceration.[2-5]

Despite the vast size and projected growth of this population, little is known about the health risks and mortality of persons on probation. To date, research on the morbidity and mortality of persons under correctional supervision has focused largely on persons who are incarcerated and persons who were recently released from correctional facilities.[6-9] Addressing the health and health care needs of the incarcerated population is a key step toward reducing population-level health inequalities.[10] Incarcerated persons have an especially high risk of death immediately after their release; common causes of death include drug overdose, cardiovascular disease, homicide, and suicide.[6] Similar patterns were observed in cross-national comparisons.[11] Another study found that the health of young persons may be particularly vulnerable after contact with the criminal justice system.[12] Several studies emphasize the high rates of intravenous drug use, infectious disease, addiction, posttraumatic stress

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disorder, self-harm, and suicide among the incarcerated population.[13-17] Other work highlights a potentially protective effect of incarceration, finding lower rates of mortality among persons incarcerated in state prisons than among the adult US population, with important differences by race/ethnicity and age.[18]

This research has prompted greater consideration of the public health and transitional planning needs of incarcerated populations, including housing and employment support, mental health and addiction services, and infectious disease treatment.[19-21] Yet the probation population has garnered less attention. The magnitude and projected growth of the probation population suggests that more research should compare the health needs of persons on probation with the health needs of populations that are more often the subject of health research (eg, incarcerated persons).

We begin to address this research gap by using a standard demographic comparison of the mortality rates of persons on probation and other, more well-researched populations. We used available administrative data from the US Department of Justice Bureau of Justice Statistics (BJS) and the Centers for Disease Control and Prevention (CDC) to estimate the standardized mortality ratios (SMRs) of persons on probation compared with persons incarcerated in jail, persons incarcerated in prison, and the general US population. Although crude mortality rates can be calculated for each population, they do not account for the different age compositions of each population, which could lead to misinformed comparisons. Age standardization provides a useful method for comparing the mortality of populations with different age structures, allowing for a more informed evaluation of the health needs of the probation population relative to the other 3 populations. The objective of our study was to better understand the health risks and health care needs of the largest, yet arguably most overlooked, criminal justice–involved population.

## Methods

Our analyses relied on 4 data sets. First, we used data from the Annual Probation Survey and Annual Parole Survey, conducted by the BJS, on all persons on probation in 15 US states (Arkansas, Florida, Kentucky, Louisiana, Maryland, Montana, New York, North Carolina, Ohio, Oregon, South Carolina, Tennessee, Texas, Utah, and Wisconsin) from 2001-2012.[22] We focused on these states because they reliably reported on the population of persons on probation and the number of persons who die while on probation for the period covered. Many other states included in the data set either did not report any deaths among persons on probation (despite having a sufficiently large size that no deaths would be implausible) or reported deaths inconsistently during this period. The data for these 15 states included aggregate counts of persons on probation and aggregate counts of persons who died while on probation as reported annually by state

representatives. Individual-level data (eg, age, race/ethnicity, sex) on those who died were not available.

The average incarceration and community supervision rates in these 15 states are comparable to rates in the national correctional population. The correctional supervision rate per 100 000 population is 2630 nationally and 2364, on average, in these 15 states. The national incarceration rate per 100 000 population is 660, compared with an average of 630 in the 15 states. The national community supervision rate per 100 000 population is 1400, compared with an average of 1241 in these 15 states. Despite this comparability, we estimated the age distribution of the probation population from the 15-state subsample rather than deriving it from a census of the entire population on probation in the United States.

We used published national estimates of the crude mortality rates, age distributions, and age-specific mortality rates of persons incarcerated in local jails and state prisons for the years 2001-2012 collected by the BJS.[23] These data are collected by the BJS from sources that report aggregate counts, rather than individual data, and reflect national estimates. Third, we used data from the National Survey on Drug Use and Health (NSDUH), an annual, individual-level, national probability-based interview survey that provides data on the age distribution of the population of persons on probation during the previous year.[24] These data allowed us to age standardize the mortality rates of persons on probation, persons incarcerated in jail, and persons incarcerated in prison. The data on age distribution in NSDUH reflects national estimates and do not allow for state-level analyses.

Finally, we used data from the CDC WONDER (Wide-ranging ONline Data for Epidemiologic Research) database to derive the average crude mortality rates for the US population for the years 2001-2012. CDC WONDER is a publicly available online resource that includes data on US births, deaths, and certain disease incidence (eg, HIV/AIDS, cancer).[25] We reported the average crude mortality rates calculated from CDC WONDER as aggregate annual counts for the US population overall (aged $\geq$15) and by age category.

Our analysis required us to make decisions about aligning the age groups used by the CDC WONDER, NSDUH, and BJS data sets, which did not perfectly match one another. We made adjustments to align the age distributions used by NSDUH and CDC WONDER with age distributions used by the BJS. In NSDUH, we aligned respondent ages with the age groups used by the BJS by categorizing ages 12-17 as $\leq$17; 18-25 as 18-24; 26-34 as 25-34; 35-49 as 35-44; 50-64 as 45-54; and $\geq$65 as $\geq$55. For data from CDC WONDER, we categorized ages 15-19 as $\leq$17 and 20-24 as 18-24. All other age groups used by CDC WONDER aligned with categories used by the BJS.

We used indirect standardization[26] to estimate comparisons between the mortality rates of persons on probation and the mortality rates of persons incarcerated in jail, persons incarcerated in prison, and the general US population. Indirect standardization is appropriate for age standardizing and comparing the mortality rates of 2 populations when there

are data on the crude mortality rates and age distributions of both populations but the age-specific mortality rates of only 1 population. The crude mortality rates and age distributions were available for all 4 populations, but the age-specific mortality rates were not known for the probation population. By applying the age-specific mortality rates of 1 population—in our case, persons incarcerated in jail, persons incarcerated in prison, and the general US population, separately—to the estimated age distribution of persons on probation, we generated an estimated SMR for the 2 groups.

We begin by calculating crude morality rates for each of the 4 populations, using the average population count, number of deaths, and crude mortality rates for the probation, local jail, state prison, and US populations. These counts reflect the average population and number of deaths, respectively, calculated using the annual counts for the years 2001-2012. Crude mortality rates are based on these averages.

We derived the estimated SMRs by first calculating the number of age-specific expected deaths per 100 000 population for persons incarcerated in jail, persons incarcerated in prison, and the general US population, separately, by using the product of the probation population age distribution and the age-specific mortality rates for each comparison population. We then divided the crude mortality rate of the probation population by the sum of expected deaths from each comparison population to yield each SMR, which is essentially the ratio of observed-to-expected deaths for each population. An SMR >1 signified that the mortality of the probation population was higher than expected given the age-specific mortality rates of the reference population. An SMR <1 signified that the mortality of the probation population was lower than expected given the age-specific mortality rates of the reference population.

We described the age-standardized mortality rates for persons on probation compared with the 3 reference populations and compared the estimated SMRs. We calculated 95% confidence intervals (CIs) for the crude mortality rates and total expected mortality rates as the given rate $\pm$ the product of 1.96 and the standard error (SE) of the rate. We calculated SEs as the product of the rate and the relative SE of the rate divided by 100 (mathematically equivalent to the rate divided by the square root of the number of deaths upon which the rate was based).[20,22,25,27] For the SMRs, we derived 95% CIs by using the method outlined by Breslow and Day.[28]

## Results

The crude mortality rate of persons on probation (390 per 100 000 population) was 2.87 times higher than among persons incarcerated in jail (136 per 100 000 population), 1.54 times higher than among persons incarcerated in prison (254 per 100 000 population), and 2.59 times lower than among the general US population (1011 per 100 000 population; Table 1).

**Table 1.** Number of persons, number of deaths, and crude mortality rate among persons on probation, persons in jail and state prisons, and the general US population, 2001-2012[a]

| Population | Mean Population Count per Year, No.[b] | Mean Deaths per Year, No.[b] | Crude Mortality Rate per 100 000 Population (95% CI) |
|---|---|---|---|
| Persons in jail | 728 417 | 988 | 136 (128-144) |
| Persons in state prisons | 1 270 350 | 3223 | 254 (245-263) |
| Persons on probation[c] | 1 580 939 | 6173 | 390 (353-429) |
| General US population[d] | 238 847 800 | 2 415 238 | 1011 (1010-1012) |

[a]Data sources: Bureau of Justice Statistics,[23] National Survey on Drug Use and Health,[24] and Centers for Disease Control and Prevention WONDER (Wide-ranging ONline Data for Epidemiologic Research).[25]
[b]Means represent the means across study years (2001-2012).
[c]Estimates for persons on probation were calculated by using data from the following 15 states: Arkansas, Florida, Kentucky, Louisiana, Maryland, Montana, New York, North Carolina, Ohio, Oregon, South Carolina, Tennessee, Texas, Utah, and Wisconsin.
[d]Calculated from the population aged $\geq$15.

Overall, the estimated age distribution of persons on probation was younger than the age distribution of persons in jail, in prison, and in the general US population (Table 2). The population aged <25 comprised 45.4% of persons on probation, 28.1% of persons in jail, and 16.6% of persons in prison. The population aged $\geq$45 comprised 10% of persons on probation, 47.5% of the general US population, 15.8% of persons in jail, and 21.7% of persons in state prison.

Results from the indirect standardizations suggest sizable differences between the mortality rates of persons on probation and the mortality rates of the other 3 populations (Table 3). If persons in jail had the age distribution of persons on probation, their expected mortality rate would be 114 per 100 000 population, a decrease relative to their observed mortality rate of 139 per 100 000 population. In the comparison of the mortality rate of persons in jail with the mortality rate of persons on probation, the SMR was 3.42, indicating that persons on probation would die at a higher rate than persons in jail if they had the same age distribution.

After conducting age standardization, however, the observed mortality rate for persons in prison was lower than the crude mortality rate (139 per 100 000 population vs 254 per 100 000 population) because of the lower age of persons on probation. This difference in the age-standardized mortality rate of persons in prison leads to an SMR of 2.81 for persons on probation compared with persons in prison. Likewise, the observed mortality rate of the US population was lower than the crude mortality rate after age standardization (186 per 100 000 population vs 1011 per 100 000 population), again given the lower age of persons on probation. This age-standardized mortality rate yielded an SMR of 2.10 for persons on probation compared with the general US population.

**Table 2.** Age distribution and mortality rates of persons on probation, persons in jail and state prisons, and the general US population, by age, 15 US states, 2001-2012[a]

| Age Group, y[b] | Persons in Jail (n = 728 417) | | Persons in State Prison (n = 1 270 350) | | General US Population (n = 238 847 800) | | Persons on Probation (n = 2034.753)[c] | |
|---|---|---|---|---|---|---|---|---|
| | No. (%) | Mortality Rate per 100 000 Population | No. (%) | Mortality Rate per 100 000 Population | No. (%) | Mortality Rate per 100 000 Population | No. (%) | Mortality Rate per 100 000 Population[d] |
| ≤17 | 6759 (0.9) | 70 | 2575 (0.2) | 60 | 21 481 407 (9.0) | 59 | 302.602 (14.9) | — |
| 18-24 | 197 917 (27.2) | 48 | 207 883 (16.4) | 33 | 21 116 680 (8.8) | 93 | 620.036 (30.5) | — |
| 25-34 | 236 333 (32.4) | 82 | 420 467 (33.1) | 55 | 40 149 449 (16.8) | 105 | 436.296 (21.4) | — |
| 35-44 | 172 583 (23.7) | 152 | 364 517 (28.7) | 145 | 42 757 311 (17.9) | 188 | 473.832 (23.3) | — |
| 45-54 | 91 833 (12.6) | 296 | 202 633 (16.0) | 494 | 42 905 961 (18.0) | 421 | 170.079 (8.4) | — |
| ≥55 | 23 000 (3.2) | 708 | 72 275 (5.7) | 2006 | 70 436 991 (29.5) | 2974 | 31.908 (1.6) | — |

[a]Data sources: Bureau of Justice Statistics,[23] National Survey on Drug Use and Health,[24] and Centers for Disease Control and Prevention WONDER (Wide-ranging ONline Data for Epidemiologic Research).[25] The 15 states were Arkansas, Florida, Kentucky, Louisiana, Maryland, Montana, New York, North Carolina, Ohio, Oregon, South Carolina, Tennessee, Texas, Utah, and Wisconsin.
[b]Age groups for the general US population and persons on probation reflect reassignment of certain ages to align with the age groups used by the Bureau of Justice Statistics to report data for the jail and state prison populations. All estimates for the general US population exclude children aged <15, so that the age distribution for the general US population reflects the proportion of the population aged ≥15.[20-22]
[c]Probation age distribution comes from the National Survey on Drug Use and Health.[24] Because this number is estimated from a probability-based sample and not national counts of the entire probation population, the population counts used to calculate the age distribution are smaller in scale than those used to generate the age distributions for the other populations (which are based on total counts of inmates and the US population).
[d]Age-specific mortality rates for persons on probation were not available. As such, indirect standardization was used to compare the mortality rates of persons on probation with the mortality rates of the general US population, persons in jail, and persons in state prison.

## Discussion

Roughly 1 in 70 US adults is on probation on any given day, yet this population has received less attention from researchers, health practitioners, and policy makers than have persons in jail, in prison, and on parole.[1-5] This inattention may be due to the size of the probation population (relative to the incarcerated population), whose health needs (particularly addiction and mental health challenges) may be difficult for probation administrators to address through existing correctional programs.[29]

The differences in the age distributions among the 4 populations reflect the fact that criminal justice contact is considerably more common in early adulthood than it is at older ages, where more of the general US population is represented.[30,31] Probation may also be more common than incarceration at earlier points in criminal careers, which may also explain why the probation population is younger than the incarcerated population. It is worth drawing attention to the absence of information on the age-specific mortality rates for the probation population, which ultimately necessitated our use of indirect standardization to estimate comparisons of the mortality rates among the probation population and the other 3 populations.

It is also important to emphasize that the insight gleaned from the SMRs is not by comparing crude mortality rates alone. A comparison of crude mortality rates alone does not account for the fact that the general US population is older than the populations serving sentences in the criminal justice system and, thus, is more vulnerable to age-related causes of death. The SMRs help to compare mortality risks across populations by revealing how much higher the mortality risk of the probation population is relative to what might be expected based on the mortality experiences of other populations. The results should prompt further attention from correctional and public health departments on the exposures and health conditions of persons on probation.

What factors might account for these differences? Compared with the general US population, persons on probation are more likely to have addiction and mental health conditions that contribute to mortality.[29] By serving their sentences in their communities, persons on probation may be exposed to risk factors and social environments (eg, peer networks that engage in deviant behavior and risky decision making) that are associated with both contact with the criminal justice system and heightened mortality risk in what is sometimes described as the "pursuit of fast living,"[32] or lifestyles that promote living in the present and engaging in criminal activity as a means of coping with other strains (eg, financial, employment, social capital).

Especially for the most socioeconomically disadvantaged persons, jail and prison may provide a higher level of health care than what is available in their communities, including better nutrition and access to treatment,[33] which may explain the lower mortality rate of the incarcerated population compared with the probation population. For persons on probation, serving sentences in their community means that they are at higher risk of exposure to certain contributors to mortality than persons who serve their sentences in correctional facilities, including illicit drug use, firearms, and motor vehicles, in addition to a higher risk of untreated health

**Table 3.** Indirect standardization of mortality rates of persons on probation to persons in jail (top panel), persons in state prisons (middle panel), and the general US population (bottom panel), 15 US states, 2001-2012[a]

| Age Group, y | No. of Expected Deaths per 100 000 Population[b] | Standardized Mortality Ratio (95% CI)[c] |
|---|---|---|
| | Persons in jail | |
| <17 | 10 | 3.42 (3.10-3.79) |
| 18-24 | 15 | |
| 25-34 | 18 | |
| 35-44 | 35 | |
| 45-54 | 25 | |
| ≥55 | 11 | |
| Total (95% CI) | 114 (107-121) | |
| | Persons in prison | |
| <17 | 9 | 2.81 (2.54-3.11) |
| 18-24 | 10 | |
| 25-34 | 12 | |
| 35-44 | 34 | |
| 45-54 | 42 | |
| ≥55 | 32 | |
| Total (95% CI) | 139 (134-144) | |
| | General US population | |
| <17 | 9 | 2.10 (1.90-2.32) |
| 18-24 | 28 | |
| 25-34 | 22 | |
| 35-44 | 44 | |
| 45-54 | 35 | |
| ≥55 | 48 | |
| Total (95% CI) | 186 (186-186) | |

[a]Data sources: Bureau of Justice Statistics,[23] National Survey on Drug Use and Health,[24] and Centers for Disease Control and Prevention WONDER (Wide-ranging ONline Data for Epidemiologic Research).[25] The 15 states were Arkansas, Florida, Kentucky, Louisiana, Maryland, Montana, New York, North Carolina, Ohio, Oregon, South Carolina, Tennessee, Texas, Utah, and Wisconsin.
[b]Expected deaths are estimated as the product of each population's age-specific mortality rates and the corresponding age distribution of the probation population.
[c]Calculated by dividing the observed number of deaths for persons on probation (n = 390) by the total number of expected deaths.

conditions.[33] These reasons may also explain why the crude mortality rates were higher among the probation population than among the incarcerated populations, in addition to the incarcerated population being somewhat older than the probation population. The higher crude mortality rate of the general population may be explained by the higher proportion of the age distribution represented by midlife and later life, when health conditions and other factors associated with aging heighten overall mortality risk.

### Limitations

This study had several limitations. First, the age groups used by the BJS did not align with the age groups used by the NSDUH or CDC WONDER, which may have led to differences in the proportions of the populations distributed across each age group, particularly the older age group. Although

this inconsistency likely led to some degree of error in our estimates, this error was not likely to be problematic given the relatively small percentage of persons on probation in these older age groups. Given the substantial differences in the total mortality rates across groups, this small amount of measurement error was unlikely to have a substantial effect on the results. Second, reliable data on probation deaths were available from only 15 states, and we could not obtain state-level age distributions of the probation population. As such, national and state-specific mortality rates may have differed from each other. However, we expect that these limitations had a negligible effect on our results.

Third, the data we used spanned 2001-2012. Because the probation population grew in recent years and continues to increase, a higher proportion of persons on probation today may be of older ages relative to the age distribution observed during the study period. More persons serving their sentences in their communities may be subject to risks in the community environment, potentially leading to a higher mortality risk among the probation population than among the other populations. To the extent that the age distribution of the growing probation population aligns increasingly with the age distributions of other populations serving sentences in the criminal justice system or even the general US population, the SMR analysis may be less necessary to compare the mortality experiences (ie, crude mortality rates could be compared). Finally, because of data limitations, we could not conduct sex- and race/ethnicity–specific indirect standardizations. Because contact with the criminal justice system is concentrated among African American men, sex and race/ethnicity–specific comparisons would help us consider the association between various forms of criminal justice contact and higher (or lower) mortality rates for certain populations.

## Conclusions

Public health initiatives aimed at improving the health of the probation population might benefit from an analysis of cause-specific mortality. Persons on probation may be at higher risk than other justice-involved populations for certain causes of death. For example, suicide is the leading cause of death in prison, whereas risky health behaviors, such as drug use and overdose, are especially prevalent among the population on parole.[13] Persons on probation may engage in similar risk behaviors. Simple interventions such as providing persons with naloxone could be an important step in reducing mortality among the probation population. This action may require reexamining probation policies, because some probation departments do not permit the treatment of opioid use disorder. Research is needed to determine why the mortality rate might be higher among this group.

Previous studies have tested the effectiveness of certain public health interventions among persons under community supervision, including promising practices for HIV prevention and treatment.[34,35] Before scaling more intense interventions, it is important to implement patient-centered

interventions that reflect the unique circumstances of the lives of persons on probation and experimental studies that test the efficacy of engaging and retaining persons in such services. Our experience in expanding the Transitions Clinic Network (providing health care services to persons just released from correctional facilities) demonstrated the importance of including persons with a history of incarceration in program design and evaluation and working with correctional facilities, health care system policy makers, and insurers. The same type of inclusion is warranted among the probation population to effectively reach this large group. Furthermore, public health departments, insurers, and correctional policy makers need to work collectively to finance and sustain such interventions and, ultimately, to reduce the high mortality rates of persons on probation.

## Declaration of Conflicting Interests

## Funding

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## References

1. Kaeble D, Cowhig M. *Correctional Populations in the United States, 2016*. Washington, DC: US Department of Justice, Bureau of Justice Statistics; 2018.

2. Phelps MS. The paradox of probation: community supervision in the age of mass incarceration. *Law Policy*. 2013;35(1-2):51-80. doi:10.1111/lapo.12002

3. Phelps MS. Mass probation: toward a more robust theory of state variation in punishment. *Punishm Soc*. 2017;19(1):53-73. doi:10.1177/1462474516649174

4. Kaeble D. *Probation and Parole in the United States, 2016*. Washington, DC: US Department of Justice, Bureau of Justice Statistics; 2018.

5. Doherty F. Obey all laws and be good: probation and the meaning of recidivism. *Georgetown Law J*. 2016;104(2):291-354.

6. Binswanger IA, Stern MF, Deyo RA, et al. Release from prison—a high risk of death for former inmates. *N Engl J Med*. 2007;356(2):157-165. doi:10.1056/NEJMsa064115

7. Rosen DL, Schoenbach VJ, Wohl DA. All-cause and cause-specific mortality among men released from state prison, 1980-2005. *Am J Public Health*. 2008;98(12):2278-2284. doi:10.2105/AJPH.2007.121855

8. 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*. 2011;173(5):479-487. doi:10.1093/aje/kwq422

9. Wildeman C, Wang EA. Mass incarceration, public health, and widening inequality in the USA. *Lancet*. 2017;389(10077):1464-1474. doi:10.1016/S0140-6736(17)30259-3

10. Kinner SA, Young JT. Understanding and improving the health of people who experience incarceration: an overview and synthesis. *Epidemiol Rev*. 2018;40(1):4-11. doi:10.1093/epirev/mxx018

11. Borschmann R, Kinner S, Spittal M. The Mortality After Release From Incarceration Consortium (MARIC) study: strengths of international data linkage. *Int J Popul Data Sci*. 2018;3(4). doi:10.23889/ijpds.v3i4.908

12. Kinner S, Tibble H, Hail-Jares K, et al. Deaths in young people after contact with the youth justice system: a retrospective data linkage study. *Int J Popul Data Sci*. 2018;3(4). doi:10.23889/ijpds.v3i4.899

13. Fazel S, Baillargeon J. The health of prisoners. *Lancet*. 2011;377(9769):956-965. doi:10.1016/S0140-6736(10)61053-7

14. Wirtz AL, Yeh PT, Flath NL, Beyrer C, Dolan K. HIV and viral hepatitis among imprisoned key populations. *Epidemiol Rev*. 2018;40(1):12-26. doi:10.1093/epirev/mxy003

15. Ndeffo-Mbah ML, Vigliotti VS, Skrip LA, Dolan K, Galvani AP. Dynamic models of infectious disease transmission in prisons and the general population. *Epidemiol Rev*. 2018;40(1):40-57. doi:10.1093/epirev/mxx014

16. Baranyi G, Cassidy M, Fazel S, Priebe S, Mundt AP. Prevalence of posttraumatic stress disorder in prisoners [published erratum appears in *Epidemiol Rev*. 2018;40(1):166]. *Epidemiol Rev*. 2018;40(1):134-145. doi:10.1093/epirev/mxx015

17. Borschmann R, Young J, Kinner SA, Spittal M. Self-harm following release from incarceration: patterns and measurement issues. *Int J Popul Data Sci*. 2018;3(4). doi:10.23889/ijpds.v3i4.907

18. Mumola CJ. *Medical Causes of Death in State Prisons, 2001-2004*. Washington, DC: US Department of Justice, Bureau of Justice Statistics; 2007.

19. Freudenberg N, Heller D. A review of opportunities to improve the health of people involved in the criminal justice system in the United States. *Annu Rev Public Health*. 2016;37(1):313-333. doi:10.1146/annurev-publhealth-032315-021420

20. Wang EA, Hong CS, Samuels L, Shavit S, Sanders R, Kushel M. Transitions clinic: creating a community-based model of health care for recently released California prisoners. *Public Health Rep*. 2010;125(2):171-177. doi:10.1177/003335491012500205

21. Dumont DM, Brockmann B, Dickman S, Alexander N, Rich JD. Public health and the epidemic of incarceration. *Annu Rev Public Health*. 2012;33(1):325-339. doi:10.1146/annurev-publhealth-031811-124614

22. US Department of Justice, Bureau of Justice Statistics. Data collection: annual probation survey and annual parole survey. https://www.bjs.gov/index.cfm?ty=dcdetail&iid=27. Accessed July 12, 2019.

23. Noonan ME, Grinder S. *Mortality in Local Jails and State Prisons, 2000-2012—Statistical Tables*. Washington, DC: US Department of Justice, Bureau of Justice Statistics; 2014.

24. US Department of Health and Human Services, Substance Abuse and Mental Health Services Administration. National Survey on Drug Use and Health, 2001-2012. https://nsduh web.rti.org/respweb/homepage.cfm. Accessed July 12, 2019.

25. Centers for Disease Control and Prevention. CDC WONDER. https://wonder.cdc.gov. Accessed July 12, 2019.

26. Preston SH, Heuveline P, Guillot M. *Demography: Measuring and Modeling Population Processes*. Oxford, UK: Blackwell; 2000.

27. Centers for Disease Control and Prevention, National Center for Health Statistics. Vital statistics of United States: 1999, mortality. 1999. https://www.cdc.gov/nchs/data/statab/techap99.pdf. Accessed July 12, 2019.

28. Breslow NE, Day NE. Statistical methods in cancer research: volume II—the design and analysis of cohort studies. *IARC Sci Publ*. 1987;(82):1-406.

29. Lurigio AJ, Swartz JA. Changing the contours of the criminal justice system to meet the needs of persons with serious mental illness. *Crim Just*. 2000;3:45-108.

30. Pettit B, Western B. Mass imprisonment and the life course: race and class inequality in U.S. incarceration. *Am Sociol Rev*. 2004;69(2):151-169. doi:10.1177/000312240406900201

31. Sampson RJ, Laub JH. Desistance from crime over the life course. In: Mortimer JT, Shanahan MJ, eds. *Handbook of the Life Course*. Boston, MA: Springer US; 2003:295-309.

32. Jacobs BA, Wright R. Stick-up, street culture, and offender motivation. *Criminology*. 1999;37(1):149-174. doi:10.1111/j.1745-9125.1999.tb00482.x

33. Patterson EJ. Incarcerating death: mortality in US state correctional facilities, 1985-1998. *Demography*. 2010;47(3):587-607. doi:10.1353/dem.0.0123

34. Gordon MS, Crable EL, Carswell SB, et al. A randomized controlled trial of intensive case management (Project Bridge) for HIV-infected probationers and parolees. *AIDS Behav*. 2018;22(3):1030-1038. doi:10.1007/s10461-017-2016-y

35. El-Bassel N, Gilbert L, Goddard-Eckrich D, et al. Efficacy of a group-based multimedia HIV prevention intervention for drug-involved women under community supervision: Project WORTH. *PLoS One*. 2014;9(11):e111528. doi:10.1371/journal.pone.0111528