Title:

Rates and causes of death after release from incarceration: an individual participant data meta-analysis from 1,471,526 people in eight high- and middle-income countries.

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RESEARCH IN CONTEXT PANEL:

Evidence before this study:

We sought to identify relevant cohort studies that examined the epidemiology of mortality due to any cause(s) following release from prison or jail internationally. We searched MEDLINE, PsycINFO, and Embase for studies published in English from database inception (1966, 1978, and 1975 respectively) until 1 February 2023 using a combination of terms including "prison", "jail", "release", "mortality", "death", "suicide", "overdose", "HIV", "longitudinal", and "cohort". Whilst many studies identified an increased rate of death relative to the surrounding population in the period immediately following release from incarceration, most studies were limited by: 1) small sample sizes; 2) focusing solely on the first two weeks or first month after release; 3) studying cohorts created on the basis of a specific health condition (e.g., HIV) or cohort members having been convicted of a particular offence (e.g., violent offences); or 4) focusing on only one cause of death (e.g., opioid overdose).

Added value of the study:

Our combined sample size (N=1,471,526) is orders of magnitude larger than most previous studies, and our use of two-step individual participant data meta-analyses and a standardised data analysis plan used by 18 cohorts ensured, for the first time, consistency of analysis and aggregate outputs across cohorts. We included all causes of death during discrete time periods for up to 24 years following release from incarceration and included data from cohort studies conducted in eight countries. Our findings demonstrate that the leading causes of death after release from incarceration vary across demographic subgroups, geographical regions, and the length of time between release from incarceration and subsequent death. Additionally, our analyses provided new and compelling evidence that the previously documented 'spike' in deaths on Day 1 following release is likely a partial artefact of the mis-coding of administrative data.

Implications of all the available evidence:

There is a high rate of death from numerous preventable causes after release from incarceration internationally, with rates and causes of death varying across demographic subgroups, geographical regions, and time since release from incarceration. These variations highlight the need for prevention that is socio-demographically, geographically, and temporally tailored, and for effective, sustained health promotion for people who experience incarceration. In addition, routine monitoring of post-release mortality is essential to inform ongoing, country-specific prevention efforts. There is a critical need for greater investment in evidence-based transitional and post-release support to prevent further unnecessary deaths in vulnerable individuals who experience incarceration.

ABSTRACT

Background: Formerly incarcerated people have exceptionally poor health profiles and are at increased risk of preventable mortality when compared to their general population peers. However, not enough is known about the epidemiology of mortality in this population – specifically the rates, causes, and timing of death in specific subgroups and regions – to inform the development of targeted, evidence-based responses.

Methods: We analysed linked administrative data from the multi-national Mortality After Release from Incarceration Consortium (MARIC) study. We examined mortality outcomes for 1,471,526 people released from incarceration in eight countries (Australia, Brazil, Canada, New Zealand, Norway, Scotland, Sweden, USA) from 1980-2018, across 10,534,441 person-years of follow-up (range: 0-24 years per person). We combined data from 18 cohort studies using two-step individual participant data meta-analyses to estimate pooled all-cause and cause-specific crude mortality rates (CMRs) per 100,000 person-years, for specific time periods after release, overall and stratified by age, sex, and region.

Findings: 75,427 deaths were recorded. The all-cause CMR during the first week following release (CMR: 1403; 95%CI:754-2238) was higher than during all other time periods (incidence rate ratio [IRR] compared with Week 2: 1·5 [95%CI:1·2–1·8; I^2=26·0%], Weeks 3-4: IRR=2·0 [95%CI:1·5–2·6; I^2=53·0%], and Weeks 9-12: IRR=2·2 [95%CI:1·6–3·0; I^2=70·5%]). The highest cause-specific mortality rates during the first week were due to alcohol and other drug poisoning (CMR: 657; 95%CI:332-1076), suicide (CMR: 135; 95%CI:36-277), and cardiovascular disease (CMR: 71; 95%CI:16-153). We observed considerable variation in cause-specific CMRs over time since release and across regions. Pooled all-cause CMRs were similar between males (731; 95%CI:630-839) and females (660; 95%CI:560-767) and were higher in older age groups.

Interpretation: The markedly elevated rate of death in the first week post-release underscores an urgent need for investment in evidence-based, coordinated transitional healthcare, including treatment for mental illness and substance use disorders to prevent post-release deaths due to suicide and overdose. Temporal variations in rates and causes of death highlight the need for routine monitoring of post-release mortality.

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INTRODUCTION

More than 30 million people are released from prisons and jails globally every year, and this figure is increasing at a rate in excess of population growth.[1] Incarcerated people experience elevated rates of infectious[2] and non-communicable diseases (NCDs),[3] cognitive disabilities,[4] mental illness,[5] substance use disorders (SUDs),[6] self-harm,[7] and suicide attempts.[7] These complex, co-occurring health conditions often interact in a syndemic fashion[8] and occur against a backdrop of trauma, abuse, and entrenched disadvantage.[9]

For many people, release from incarceration compounds this pre-existing disadvantage as they seek to secure accommodation and employment, gain access to health services, and reintegrate into families and communities.[10] Previous international studies[10-12] have demonstrated that the rate of death after release from incarceration is markedly elevated compared to that observed in the corresponding general population. Despite this, the current knowledge base is not sufficiently granular to inform targeted prevention. Preventing mortality in people who experience incarceration has been identified as a priority by the World Health Organization (WHO)[13] and there are compelling, evidence-based arguments for improving health outcomes and reducing mortality in this population based on human rights, public health, criminal justice, and economic grounds.[14] Detailed information regarding the incidence, timing, and risk factors for all-cause and, critically, cause-specific death after release from incarceration is required to inform meaningful prevention efforts.[10] However, even the largest individual studies in this area lack the sample size and associated statistical power required for such granular analyses.

In this study, using data from a globally unique sample of 1,471,526 adults released from incarceration in eight countries, we aimed to document the incidence, timing, causes, and risk factors for mortality after release from incarceration.

METHODS

Study design and data sources

Data were obtained from the Mortality After Release from Incarceration Consortium (MARIC),[15] a multi-disciplinary collaboration of 30 cohort studies examining mortality in 1,502,007 adults released from incarceration from 1980-2018 in 12 mostly high-income, Western countries. An overview of the consortium, including its available data, objectives, and research methodology, has been published elsewhere.[15] MARIC aims to use novel analytic methods to document precisely who is at what degree of risk of death, and when, after release from incarceration internationally.

Cohorts were identified via a comprehensive search of the literature in March 2016 and via colleagues identifying additional cohorts.[15] Almost all cohorts (29/30; 97%) have linked incarceration data with national or state-based death registers. The combined sample is 88% male (N=1,321,812), reflecting global incarceration trends,[16] and the follow-up time per person ranges from one month to 24 years.

To increase the generalisability of our findings, in this manuscript we analysed data from the 18 cohorts in the consortium including unselected samples of people released from incarceration (i.e., cohorts that were not created on the basis of a specific health condition or prior criminal justice system involvement, but rather everyone released from incarceration during the study period). These 18 cohorts – accounting for 98% (N=1,471,526) of the combined consortium – came from Australia, Brazil, Canada, New Zealand, Norway, Scotland, Sweden, and the USA (Table S1).

Data analysis

We conducted a series of two-step individual participant data (IPD) meta-analyses. The central MARIC research team (hereafter MARIC team) created a standardised statistical analysis plan which was then applied to each of the 18 included cohorts by the individual cohort research teams (hereafter cohort teams). This approach ensured consistency of (a) analysis; and (b) aggregate outputs across cohorts. Aggregate results from these analyses were shared with the MARIC team, who pooled the results using IPD meta-analysis. Cohort data analyses were conducted using Stata, SAS, or SPSS, and analyses using combined aggregate data were conducted using Stata (version 17).

Individual-level data analysis

Each cohort team provided the central MARIC team with aggregated outputs regarding the number of participants, person-days of follow-up, and number of deaths (total and cause-specific) during follow-up, overall and stratified by age category and by sex (ascertained from correctional records and coded as “male” or “female”). They provided crude mortality rates (CMRs), in addition to providing log hazard ratios (HRs) and associated standard errors (SEs) from univariable and multivariable Cox regressions, using age and sex as covariates and time to death as the outcome. Individuals were excluded from the analyses if they were not released from incarceration during the study period, or their recorded release date was after their recorded date of death. Follow-up periods were calculated from the day of release from the first episode of incarceration during the study period (hereafter ‘index incarceration’). Analyses were conducted for the following time periods after release: (1) daily from days 1-14; (2) weekly from weeks 3-12; (3) weeks 13-52 combined; (4) weeks 53+ combined; and (5) total follow-up. For individuals who had multiple incarcerations during the study period, all post-release periods of time at risk (minus any time spent reincarcerated) were included in the analyses. In the Results, we describe (1) deaths after release from the index incarceration, and (2) deaths after release from *any* incarceration (i.e., any episode of incarceration during the study period, including the index incarceration).

Causes of death were categorised into a two-level, mutually exclusive, collectively exhaustive categorisation system using International Classification of Disease (ICD) 9th or 10th edition codes for underlying cause of death (Table S2).

Data synthesis methods

Using aggregate data from the 18 cohorts, we used random effects meta-analyses to estimate pooled all-cause and cause-specific CMRs with 95%CI for the entire follow-up period, and for each of the specified time periods after release from the index incarceration, overall and stratified by age category, by sex, and by region. We used the Freeman-Tukey double arcsine transformation of proportions[17] to calculate confidence intervals and univariable meta-regression to separately examine the effect of sex, age, and region on CMR estimates. We used random effects meta-analysis of the HRs and SEs from the Cox regressions from each cohort to estimate the association between individual factors (age category and sex) and all-cause death. Heterogeneity was quantified using I^2.

Sensitivity analyses

Some people may have been reincarcerated after their index incarceration and died whilst reincarcerated. As such, and given previous research reporting lower death rates during periods of incarceration,[18] we conducted sensitivity analyses on 16/18 cohorts in which we were able to exclude all person-time and deaths during any period of reincarceration, and examined mortality rates in the community during the aforementioned time periods following each release from incarceration (with 'time at risk' commencing again on the day of each subsequent release).

Inspection of data from the day of release (Day 1) suggested that participants in some cohorts may have been incorrectly categorised as being 'released' from incarceration due to deaths that occurred while still incarcerated (i.e., they died in custody and their death was coded as occurring on their day of release; for further information see Supplementary Appendix [p.3], Table S13, and Figure S3). Ten cohorts could definitively differentiate between deaths occurring during incarceration and those occurring after release. For this reason, in our primary analyses our observation period commenced on the first full 24-hour day after release from incarceration (labelled Day 2) for all cohorts.

We conducted sensitivity analyses limited to the ten cohorts mentioned above, examining the overall crude all-cause CMR and the mortality rate in each specified time period after release.

We produced pooled incidence rate ratios (IRRs) to compare all-cause CMRs across different post-release time periods by calculating incidence rate ratios for each cohort and using a random effects meta-analysis to pool results. Finally, to examine the impact of each individual cohort on the overall pooled CMR, we conducted a series of leave-one-out meta-analyses by excluding a single cohort during each analysis.

Ethics approval

Ethics approval was granted from relevant local authorities and ethics committees for all 30 cohorts in the consortium, and no further approval was required for the broader collaborative study.

Role of the funding source

The funder had no role in data collection, analysis, interpretation, writing of the manuscript, or the decision to publish.

RESULTS

A summary of the 18 included cohorts is provided in Table 1 (Table S1 contains reasons for cohort inclusion and exclusion). All included cohorts were from high-income countries in North America, Europe, or Australasia, except for one Brazilian cohort.

(Table 1 here)

There were 1,471,526 people (including 1,299,322 [88·3%] males), 10,534,441 person-years of follow-up time, and 75,427 deaths included in the analyses (Table 1). The all-cause pooled CMR following release from index incarceration was 725 deaths per 100,000 person-years (95%CI:625-831). Heterogeneity was considerable (I^2=100%; Figure 1). Pooled CMRs were similar for males (731, 95%CI:630-839, I^2=100%) and females (660, 95%CI:560-767, I^2=97·7%) (Figure S1; Table S3) and meta-regression revealed no difference in all-cause CMR between males and females (p=0·33, Tables S4-S5). Meta-regression revealed that all-cause pooled CMRs were similar for people aged <25 years and those aged 25-34 years, then increased significantly with age (Figure S2, Tables S5-S7).

(Figure 1 here)

Causes of death

The three leading causes of death over the entire follow-up period were: (1) alcohol and other drug (AOD) poisoning (CMR:146, 95%CI:103-197; I^2=99·7%); (2) cardiovascular disease (CVD) (CMR:102, 95%CI:85-119; I^2=98·6%); and (3) cancer and other neoplasms (CMR:74, 95%CI:61-88; I^2=98·4%; Table 2, Tables S8-S11). Half of all deaths (37,425; 50%) were from injuries (CMR:371, 95%CI:310-438; I^2=98·9%), including AOD poisoning (21·4%), interpersonal violence (8·4%), and suicide (8·2%). 39.4% of all deaths (29,731/75,427) were from NCDs (including CVD, cancer, and liver disease), and 5% of all deaths (3,597/75,427) were from infectious diseases (including HIV, respiratory infections, and tuberculosis). Males had higher mortality rates than females due to CVD and transport-related accidents. There was no statistically significant difference in mortality rate by sex for any other cause of death (Table S4). Mortality rates for infectious diseases and NCDs increased with age. There was no statistically significant difference by age group for rates of mortality due to suicide, AOD poisoning, or transport-related accidents (Tables S6, S7).

(Table 2 here)

Rates of death due to specific causes differed by region (Tables S8-S12). The highest point estimates of death rates due to HIV were recorded in the sole Brazilian cohort (CMR:32, 95%CI:26-38) and the five US studies (CMR:27, 95%CI:10-52; I^2=99·4%). The Brazilian cohort also recorded the highest rates of death from interpersonal violence (CMR:299, 95%CI:281-319) and tuberculosis (CMR:11, 95%CI:8-16), and the lowest rate of death from AOD poisoning (CMR:16, 95%CI:12-22). Europe recorded the highest point estimates of death rates from NCDs (CMR:375, 95%CI: 298-461) and AOD poisoning (CMR:292, 95%CI:258-329). The highest point estimate of death rate from suicide was observed in Australia and New Zealand (CMR:103, 95%CI:74-121; I^2=96·1%).

Deaths during specific time periods after release from incarceration

The all-cause CMR was highest during the first week following release from index incarceration (Days 2-7: 1,612, 95%CI:1,048-2,287; I^2=91•1%), and decreased consistently in subsequent time periods to 737 (95%CI:636-844; I^2=99·6%) more than one year post-release (Figure 2; Table S14). The all-cause CMR during the first week was significantly higher than during all other time periods (for example, the IRR compared with Week 2=1·5 [95%CI:1·2–1·8; I^2=26·0%], Weeks 3-4 IRR=2·0 [95%CI:1·5–2·6; I^2=53·0%], and Weeks 9-12 IRR=2·2 [95%CI:1·6–3·0; I^2=70·5%]). The three highest cause-specific CMRs during Days 2-7 were for deaths from AOD poisoning (CMR:657, 95%CI:332-1,076; I^2=89·0%), suicide (CMR:135; 95%CI:36-277, I^2=71·0%), and CVD (CMR:71; 95%CI:16-153, I^2=45·7%). The CMR for AOD poisoning was higher than that for any other cause of death across the first two weeks, and the point estimate of the rate of deaths from AOD poisoning was higher than that for any other cause of death in all examined time periods (Table S15). AOD poisoning was also the only cause of death for which the CMR was highest during the first week following release (Table S15). Rates of death from suicide, CVD, and transport-related accidents fluctuated across time since release, whereas the rate of cancer-related deaths was highest more than one year post-release (CMR:77, 95%CI:63-93; I^2=98·2%; Figure 2b; Table S15).

Deaths after release from incarceration in specific regions

The rate of all-cause mortality varied considerably across geographical regions. The pooled CMR during Days 2-7 post-release was highest in Europe (2,762 [1,832-3,872]) and lowest in the US (934 [389-1,703]) (Table S16). These differences attenuated over time and, after more than one year post-release, there was no evidence of any difference in all-cause CMR between regions (Table S16).

(Figure 2 here)

Sensitivity analyses

Most cohorts (16/18) captured reincarceration data during follow-up. These cohorts contributed 1,309,958 people (89·0% of the larger cohort), 8,324,428 person-years of follow-up time, and 56,731 deaths to our sensitivity analyses. After excluding time and deaths while incarcerated, the all-cause CMR was 720 (95%CI:605-845), which was almost identical to that calculated in our primary analysis (CMR:725; 95%CI:625-831) (Figure S4). The associations between sex, age, and time to death also remained similar to those from our primary analyses (Table S17).

The mortality rate in the first week following release from *any* incarceration was numerically higher than the mortality rate in the first week following release from index incarceration, although a meta-regression found that this difference was not statistically significant (CMR for Days 2-7 following any release: 2,460 (95%CI:1,516-3,618), I^2=97·8%; CMR days 2-7 following index release: 1,612 (95%CI:1048-2287), I^2=91·1%, Table S18, Figure S5).

When limited to the ten cohorts that provided definitive data on whether deaths occurred during incarceration or post-release, the CMR on the day of release decreased markedly from 4,036 (95%CI:887-8940, I^2=96·9%) to 826 (95%CI:0-3,455, I^2=95·2%) (Table S13). Mortality rates from these ten cohorts during all other time periods were similar to those from the main analysis (Figure S3, Table S13). When the overall CMR analysis was limited to these ten cohorts, the overall all-cause CMR decreased slightly from 725 (95%CI:625-831) to 693 (95%CI:557-845).

Differences between each leave-one-out analysis and the primary analysis were small (Table S19). When compared with the primary analysis (all-cause pooled CMR:725, 95%CI:625-831), the largest differences were when the Fazel and Chang cohort from Sweden was removed (CMR:701, 95%CI:604-805) and when the Lim cohort from the USA was removed (CMR:762, 95%CI:690-838).

DISCUSSION

Our harmonised analysis of data from 1,471,526 people released from incarceration in eight countries from 1980-2018 demonstrates a high rate of death due to a range of mostly preventable causes. This rate was highest during the first week post-release, with the three most common causes of death during this period being AOD poisoning, suicide, and CVD.. Infectious diseases accounted for one in every 20 deaths. With increasing age and time since release, the burden of mortality shifted towards NCDs – particularly CVD, cancer, diabetes, and liver disease – which collectively accounted for 39% of all deaths. We found no association between sex and all-cause mortality rate after release from incarceration. Findings from sensitivity analyses (Table S13, Figure S3) provided new and compelling evidence that the apparent ‘spike’ in deaths on Day 1 observed in previous studies is likely partially an artefact of administrative data.

People with a history of incarceration and a dual diagnosis of mental illness and SUD are at increased risk of numerous adverse outcomes including overdose[19] and suicide. In our study, AOD poisoning and suicide were the two leading causes of death in the first two weeks post-release, and the rate of death from AOD poisoning was higher than the rate for any other cause of death during all observed time periods. Our findings strongly support calls for increased investment in coordinated mental health and substance use treatment for people transitioning from prison to the community.[20] They also support the WHO's call[13] to address the disproportionate burden of acute drug-related deaths experienced by people in contact with the criminal justice system internationally. Importantly, an overwhelming majority of overdose deaths in our sample (97%; 14,671/15,106) occurred more than four weeks after release and, as such, acute prevention efforts would only prevent a small minority of these deaths. Sustained investment in evidence-based treatment and harm reduction will be required to measurably reduce the burden of drug-related deaths among people released from incarceration. Additionally, the rate of death from AOD poisoning was markedly lower in the sole Brazilian cohort, where interpersonal violence was instead the leading cause of death in the early period following release from custody. This finding, which is consistent with population-level epidemiological data from Brazil,[21] demonstrates that efforts to prevent deaths after release from incarceration should be informed by country-specific context and data. Efforts to reduce drug-related deaths after incarceration will have a very modest impact on the burden of preventable mortality in countries with different cause-specific risk profiles.

While the extant policy and research focus on preventing overdose deaths is important, our findings indicate that previous studies may have under-estimated the role of other causes of death, notably NCDs, due to comparatively short follow-up periods. That is, most published studies have had relatively brief follow-up periods, during which overdose deaths often account for the largest proportion of the mortality burden. However, our findings demonstrate that the distribution of causes of death after release from incarceration varies with follow-up time. Many countries have aging prison populations[4] and, as a result, the burden of morbidity and mortality in this population will continue to shift further towards NCDs including CVD, cancer, and diabetes, as people continue to age while incarcerated. Our findings reinforce the importance of effective, sustained health promotion and prevention initiatives among people who experience incarceration. These initiatives should ideally focus on two complementary objectives; (1) acute prevention of deaths due to injury in the first few weeks post-release (particularly AOD poisoning, suicide, and interpersonal violence); and (2) sustained efforts to improve health and reduce the onset, progression, and severity of chronic and infectious diseases (e.g., improving diet, reducing substance use, and increasing physical activity) during and after incarceration.

The rate of death varied considerably across geographical regions. The pooled CMR during Days 2-7 was highest in Europe and lowest in the US. As the US has the highest incarceration rate globally,[1] this finding might reflect an instance of inverse selection,[22] whereby incarcerated people in the US may have relatively fewer health and social vulnerabilities than their incarcerated peers in other countries, due to the threshold for incarceration being lower in the US and those experiencing incarceration subsequently constituting a less select subset of the population. The distribution of causes of death also varied by region, most notably between Brazil and all other countries. Additionally, whilst the proportion of deaths from tuberculosis in our study was just 0.1% (84/75,427 deaths), it would likely have been considerably higher if more data were available from low- and middle-income countries (LMICs), reflecting the morbidity and mortality burden in the settings.[2] Further research in LMICs, where most of the global prison population is detained,[1] is urgently needed.

Our findings highlight the critical importance of coordinated, whole-of-government efforts to prevent deaths following release from incarceration. This problem cannot be solved by correctional healthcare providers alone. Nevertheless, in accordance with established international standards,[23,24] correctional healthcare providers should, at a minimum, ensure that three core components of healthcare are provided for all incarcerated people. First, they should routinely assess health status and identify healthcare needs at every prison reception. Comprehensive screening should include mental illness, SUDs, cognitive disabilities, neurodevelopmental disorders, NCDs, and infectious diseases. Second, they should provide a standard of healthcare identical to that available in the surrounding community, and ensure that incarcerated people have access to all necessary healthcare services free of charge, without discrimination on the grounds of legal status.[23] Given the high observed rates of AOD poisoning and suicide, this must include medications for opioid use disorder,[25] and evidence-based mental health treatment beyond merely prescribing psychotropic medications. Additionally, with >70% of incarcerated people smoking tobacco daily in many countries,[26] enhanced efforts to reduce levels of nicotine dependency should be prioritised. Third, correctional authorities must assist in preparing all people leaving custody for the transition to the community. This should involve a comprehensive pre-release needs assessment and the provision of coordinated transitional healthcare, including provision of the opioid antagonist medication naloxone for people with a history of opioid use disorder.

Alongside these three provisions, governments must develop and implement coordinated, evidence-based responses at scale to ensure that people released from incarceration have an equal opportunity not only to survive, but to thrive. In 2019 the WHO recommended that custodial settings should be included in all public health strategies, policies, and planning by adopting an approach of "prison health in all policies".[27] Our findings provide new and compelling evidence in support of this approach.

Strengths and limitations

This is the largest study of mortality in people released from incarceration ever conducted. Our data span eight countries and four decades, supporting the temporal and geographical breadth of our findings. MARIC is a globally unique resource that provides exceptional granularity of data and ample power for targeted analyses to examine subgroup differences in specific causes of death at specific time points after incarceration.

Our study had six main limitations. First, we did not have access to incarceration records prior to the index incarceration and it is likely that this was not the first incarceration for many cohort members. As the risk of death increases with each subsequent release,[28] this may have impacted our findings as we were unable to examine whether the risk (or causes) of death differed for people released from their very first episode of incarceration. Second, almost all of our cohorts were from high-income countries, while the majority of all incarcerated people globally are detained in LMICs.[1] Further research in LMICs is urgently needed and this will likely require considerable investment in data infrastructure and research capacity building. Third, the individual risk factors we examined were limited to age and sex, but other factors such as race and ethnicity have been demonstrated to be associated with both incarceration rates[29] and mortality outcomes.[30] Furthermore, the simple binary classification of sex utilised (i.e., “male/female”), whilst reflective of the correctional systems in the eight countries, fails to capture individuals identifying as transgender. Fourth, despite the granularity of our data, we had no information regarding what happened between release from incarceration and death. As more countries develop the capacity for cross-sectoral data linkage, opportunities will continue to emerge for linking administrative health, welfare, and justice records to better characterise trajectories after release from incarceration and identify critical points for intervention. Fifth, we did not examine the association between sentence length and mortality risk. Mortality likely varies by length of incarceration (which itself, is likely confounded by age and a range of other covariates), and this will be examined in future MARIC outputs. Finally, eight of the 18 cohorts could not definitively differentiate between deaths that occurred during incarceration and those occurring on the day of release, in the community. These deaths may have been subsequently mis-coded as occurring on the day of release, dramatically and artefactually inflating estimates of mortality on Day 1. However, we were able to disaggregate our findings by cause of death and undertake sensitivity analyses, excluding these cohorts, to inform interpretation. This previously undocumented coding issue highlights the urgent need to improve the quality of correctional records for cross-sectoral data linkage, and the need to proceed with caution when analysing similar data.

Conclusions

The rate of death after release from incarceration is high, particularly during the first week post-release, and it varies across causes of death, regions, and time since release. This highlights the need for effective, sustained health promotion for people who experience incarceration and for routine monitoring of post-release mortality to inform ongoing prevention efforts. While custodial healthcare providers are well-placed to identify and treat myriad health-related conditions and provide a comprehensive transitional plan prior to release, our data suggest that, in many settings, this is either not happening or (most likely) is insufficient to prevent untimely deaths. Our study highlights a critical need for greater investment in evidence-based transitional and post-release support to prevent further unnecessary deaths, and thereby reduce health inequalities at the population level.

How can I find out more or get involved?

For further information about the Mortality After Release from Incarceration Consortium, or to propose a collaboration using MARIC data, please contact the study's Chief Investigator, Prof. Rohan Borschmann (rohan.borschmann@unimelb.edu.au).

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Author contributions:

RB, SAK, MS, JP, SL, DP, DR, EO, and LM obtained funding for the study. CK designed the statistical analysis plan, with input from RB, SAK, and JY. CK accessed and verified the data. IAB, DP, DLR, AB, ZC, RC, CF, SF, LG, AK, PK, FGK, SL, YEL, LNP, SKP, SIR, JMS, MRS, KT, KV, NZ, and SAK provided and analysed single-study cohort data and provided aggregate data for meta-analyses. CK performed all meta-analyses and produced all tables and figures. RB produced the first draft of the manuscript and was responsible for the decision to submit the manuscript. All authors contributed to subsequent iterations of the manuscript and approved the final manuscript prior to submission.

Declarations of interest:

The authors report no conflicts of interest.

Data sharing statement:

Data sharing query	MARIC arrangements
Will individual participant data be available (including data dictionaries)?	No
Which data in particular will be shared?	Not applicable
What other documents will be available?	Study protocol, statistical analysis plan
When will data be available (start and end dates)?	Not applicable
With whom?	Not applicable
For what types of analyses?	Not applicable
By what mechanism will data be made available?	Not applicable

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Table 1: Summary of the 18 included cohorts from the Mortality After Release from Incarceration Consortium (MARIC).

Chief investigator(s)	Country (state/province)	Study dates	Sample size	Females (%)	Age at release, Median (IQR)	Length of follow-up (years), Median, IQR, Range	Length of follow-up (person-years), Total	Deaths (%)
Binswanger	USA (Washington)	1999-2009	76,208	12,229 (16·0%)	32 (25-40)	4·7, 2·4-7·2, 0·0-10·5	370,100	2,507 (3·3%)
Bukten & Clausen	Norway	2000-2016	96,170	9,902 (10·3%)	31 (23-42)	10·1, 5·9-13·8, 0·0-17·0	929,809	7,975 (8·3%)
Cunningham & King	New Zealand	1998-2016	91,632	11,610 (12·7%)	27 (21-37)	10·7, 5·9-15·3, 0·0-19·0	951,846	4,803 (5·2%)
Fazel & Chang	Sweden	2000-2009	47,326	3,846 (8·1%)	36 (26-45)	5·3, 2·7-7·6, 0·0-10·0	242,967	2,874 (6·1%)
Giles	Australia (Western Australia)	2005-2014	13,282	1,661 (12·5%)	31 (25-38)	6·9, 5·2-8·3, 0·0-9·5	89,103	541 (4·1%)
Graham	Scotland	1996-2007	75,033	8,181 (10·9%)	26 (21-35)	6·5, 3·3-9·6, 0·0-12·0	478,891	4,404 (5·9%)
Kariminia	Australia (New South Wales)	1988-2002	82,669	8,667 (10·5%)	28 (22-35)	7·4, 3·6-11·1,0·0-15·0	614,569	5,000 (6·0%)
Kinner ‘A’	Australia (Queensland)	1994-2007	42,015	4,976 (11·8%)	28 (22-37)	7·6, 3·5-10·3, 0·0-14·0	297,223	2,203 (5·2%)
Kouyoumdjian ‘A’	Canada (Ontario)	2000-2009	31,183	2,780 (8·9%)	32 (25-40)	8·2, 5·8-9·0, 0·0-12·5	220,157	1,723 (5·5%)
Kouyoumdjian ‘B’	Canada (Ontario)	2010-2015	52,307	6,357 (12·2%)	32 (24-43)	5·5, 5·2-5·7, 0·0-7·2	270,569	2,034 (3·9%)
Lim	USA (New York)	2001-2005	244,274	29,650 (12·1%)	31 (23-40)	3·1, 1·7-4·2, 0·0-5·0	702,455	1,657 (0·7%)
Liu	Brazil (Mato Grosso do Sul)	2009-2018	62,425	7,215 (1·6%)	31 (26-39)*	5·0, 2·3-7·7, 0·0-10·0	311,069	2,402 (3·8%)
Pizzicato & Viner	USA (Pennsylvania)	2010-2016	82,780	16,371 (19·8%)	31 (24-43)	4·4, 2·5-5·9, 0·0-7·0	342,616	2,516 (3·0%)
Preen ‘A’	Australia (Western Australia)	1994-2003	16,160	1,930 (11·9%)	28 (22-36)	6·1, 3·6-8·9, 0·0-10·0	97,767	673 (4·2%)
Preen ‘B’	Australia (Western Australia)	1985-2008	6,375	666 (10·4%)	27 (22-37)	18·1, 14·8-21·2, 0·0-24·0	111,638	674 (10·6%)
Ranapurwala	USA (North Carolina)	2000-2018	258,617	36,278 (14·0%)	30 (24-39)	10·8, 6·3-15·2, 0·0-19·0	2,708,859	17,422 (6·7%)
Rosen	USA (North Carolina)	1980-1999	113,079	0 (0·0%)	31 (25-39)	8·2, 4·8-13·0, 0·0-20·0	1,010,760	9,001 (8·0%)
Somers	Canada (British Columbia)	2001-2018	79,991	10,245 (12·8%)	33 (25-42)	10·2, 5·3-14·7, 0·0-17·2	784,268	7,018 (8·8%)
Total	**-**	**1980-2018**	**1,471,526**	**172,204 (11·7%)**	**-**	**-**	**10,534,441**	**75,427 (5·1%)**

Study dates are from the beginning of recruitment until the end of follow-up.
IQR: Interquartile range
*Information on age at release was only available for a subset of participants (n=2,393) in the Liu cohort.

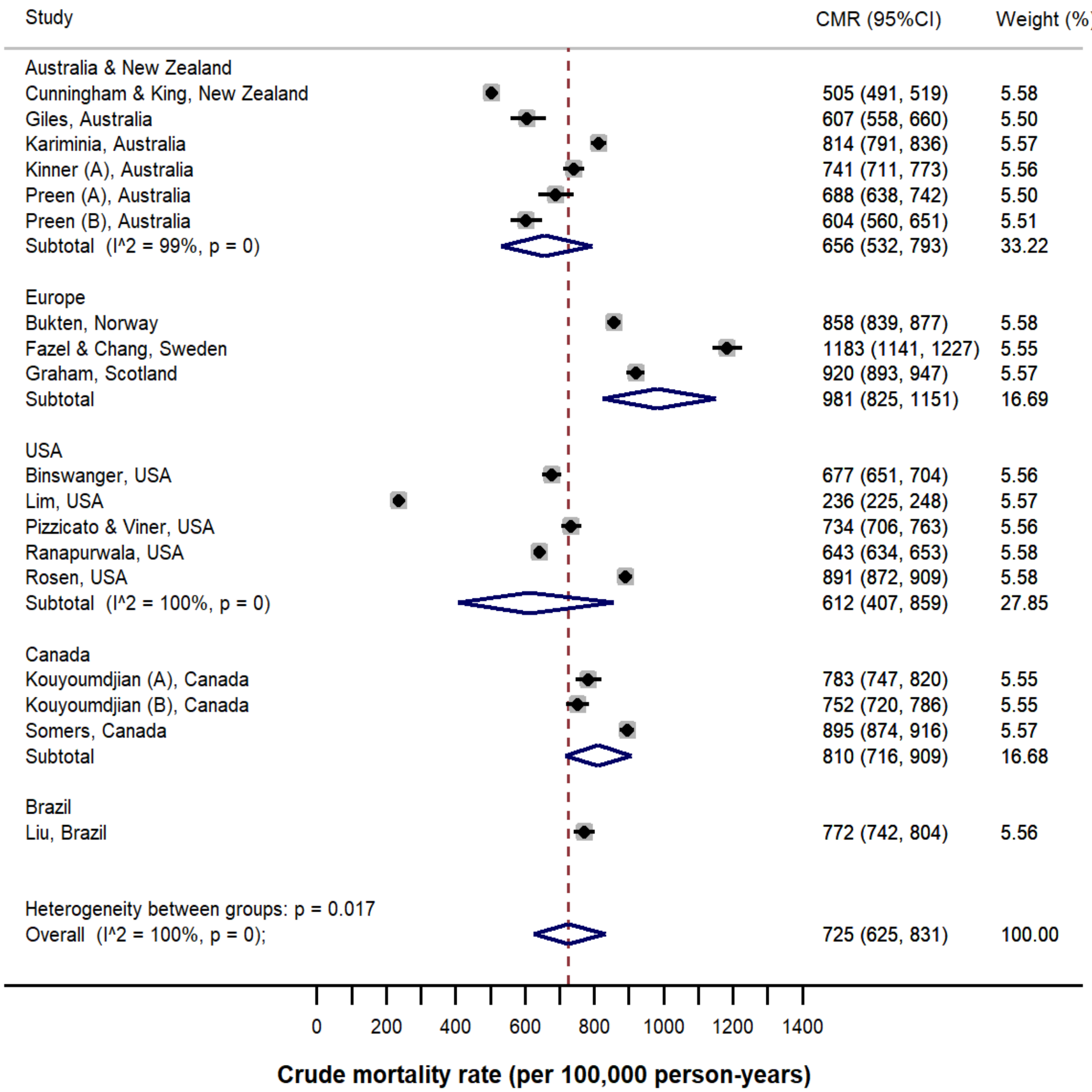

Figure 1: Forest plot of overall crude mortality rates for people released from incarceration, by region.

I^2 and p-value calculated for regions with $\geq$4 cohorts
CMR: Crude mortality rate
95%CI: 95% Confidence Interval

Table 2: Pooled all-cause and cause-specific crude mortality rates, per 100,000 person-years

Cause of death category	N deaths	CMR (95%CI)	Heterogeneity (I-squared)
All cause	75,427	725 (625, 831)	98·8%
A. Maternal, nutritional and infectious diseases	3,679	30 (21-41)	99·5%
HIV	2,041	11 (5-19)	99·1%
Respiratory infections[b]	916	9 (7-12)	93·9%
Tuberculosis[a,b]	84	0·6 (0·2-1·3)	86·9%
Maternal[a,b,c]	15	0·0 (0·0-0·2)	23·7%
Other and ill-defined infectious and nutritional diseases[a,b]	556	7 (5-9)	90·0%
B. Non-communicable diseases	29,731	261 (220-306)	99·6%
Cardiovascular diseases	11,312	102 (85-119)	98·6%
Cancer and other neoplasms	8,926	74 (61-88)	98·4%
Liver disease	3,796	34 (25-43)	98·4%
Chronic respiratory diseases	1,923	15 (12-19)	94·6%
Diabetes	1,011	9 (7-11)	88·8%
Other and ill-defined non-communicable diseases	2,763	26 (21-30)	95·2%
C. Injuries	37,425	371 (310-438)	98·9%
Alcohol and other drug poisoning (unintentional and undetermined intent)	16,126	146 (103-197)	99·7%
Suicide	6,199	67 (49-87)	99·3%
Interpersonal violence	6,361	50 (32-72)	99·5%
Transport-related accidents	5,166	43 (33-56)	98·7%
Other and ill-defined injuries	3,573	37 (29-46)	98·1%
D. Other and ill-defined	3,942	36 (25-48)	100%
Intermediate and immediate causes of death	1,121	8 (6-11)	95·2%
Ill-defined or unknown causes of death	2,818	27 (17-37)	98·9%
Missing cause of death[a]	640	7 (2-14)	99·1%

Rates per 100,000 person-years
CMR: crude mortality rate
95%CI: 95% confidence interval
[a]Cunningham and King could not provide cause specific death data for these causes and was excluded from these analyses.
[b]Binswanger could not provide cause specific death data for these causes and was excluded from these analyses.
[c]Rosen was excluded from maternal deaths analysis as the cohort only contained males.
Due to these exclusions, the number of deaths in the cause-specific categories does not equal the total number of deaths.

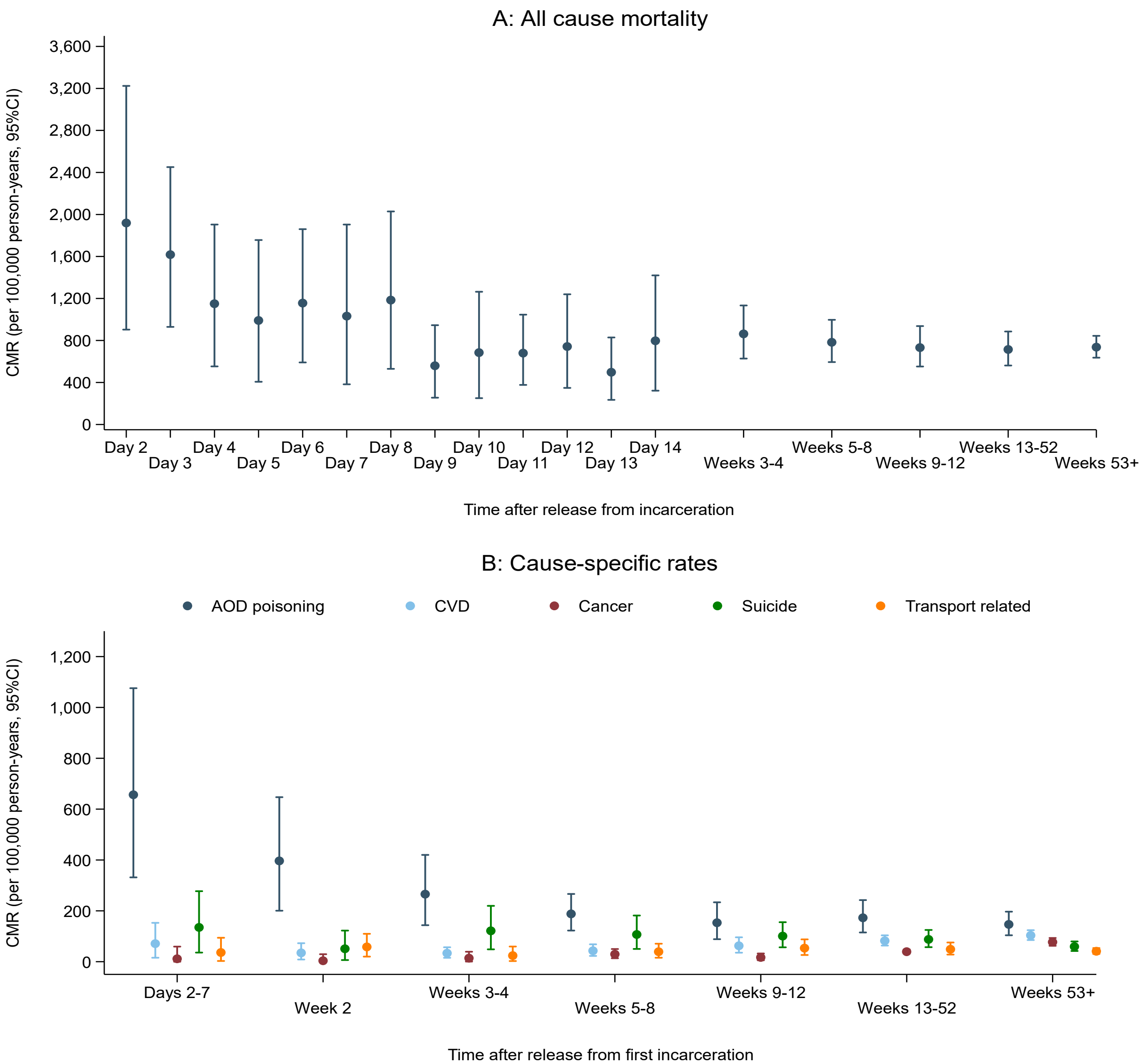

Figure 2: Piecewise pooled mortality rates after release from incarceration.

Rates per 100,000 person-years
AOD: Alcohol and other drugs
CMR: Crude mortality rate
CVD: Cardiovascular disease
95%CI: 95% confidence interval
Cunningham and King and Binswanger could not provide deaths by day data and were excluded from these analyses.

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