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All-cause and External-cause Mortality Disparities Among Australians in Same-Sex Relationships Before and After Marriage Equality: A Nationwide Cohort Study, 2011 - 2023

Karinna Saxby

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All-cause and External-cause Mortality Disparities Among Australians in Same-Sex Relationships Before and After Marriage Equality: A Nationwide Cohort Study, 2011–2023

Abstract

Objective: To examine secular trends in mortality by sexual orientation in Australia.

Methods: Using Australian Census-linked-mortality records (2011–2023), Cox proportional hazard models were used to estimate all-cause and external-cause mortality risk among adults in same-sex relationships (n=54,529) and different-sex relationships (n=7,923,328), separately by sex. Inverse probability weights balanced comparators on age, educational attainment, and household income. Results were stratified into periods before and after Australia's 2017 legalisation of same-sex marriage.

Results: Compared to those in different-sex relationships, females and males in same-sex relationships experienced elevated all-cause mortality risk [HR1.25 (95% CI 1.15;1.35) and HR1.24 (95%CI 1.16;1.31), respectively] and external-cause mortality risk [HR2.56 (95%CI 2.01;3.26) and HR1.96 (95%CI 1.64;2.71), respectively]. Inequalities in external-cause mortality risk declined following Marriage Equality among females (HR 3.40 → 2.04) and males (HR 2.01 → 1.93) in same-sex relationships, though remained significantly elevated in both periods.

Conclusions: Australians in same-sex relationships experience elevated mortality risk relative to those in different-sex relationships, with inequalities persisting after marriage equality. Routine collection of sexual identity in the Australian Census would support ongoing monitoring of these disparities.

1. Introduction

Sexual minorities represent a substantial and increasingly visible share of the population, with 3–9% of adults identifying as lesbian, gay, pansexual, or asexual.¹⁻³ Alongside growing recognition and improved data collection around sexual identities, persistent health burdens relative to heterosexual populations have been identified. In particular, elevated risks of mental health conditions have consistently been reported across survey, administrative, and clinical studies, with sexual minorities experiencing substantially elevated rates of anxiety and depression, substance use disorders, self-harm behaviour, and mortality from suicide and other external causes (i.e., alcohol, drug- and poisoning-related deaths).⁴⁻⁹ Several studies have also documented elevated risk of chronic disease risk factors and a higher prevalence of long-term health conditions among sexual minorities, including asthma and lung conditions (particularly among sexual minority women), cardiovascular disease, and cancer, though findings are less consistent across conditions and populations, potentially reflecting differences in outcomes measured, confounder adjustment, and study design.^{8,10,11} Mortality data, which are less susceptible to self-report bias and measurement heterogeneity, suggest sexual minorities are at higher risk of all-cause mortality,^{12,13} though estimates vary across populations studied. For example, sexual minority women are at increased risk of mortality from cancer, cardiovascular disease, and respiratory disease¹⁰ and sexual minority men have faced substantially elevated HIV-related mortality, particularly prior to the availability of antiretroviral therapy.¹⁴

These health inequities are widely understood to arise from stigma-related stressors, with domains affected including experiences of interpersonal discrimination and violence, barriers to preventive health services, and increased risky health behaviours (such as alcohol and substance use and reduced physical activity).^{4,9,15,16} In turn, stigma reduction measures, anti-discrimination legislation, and supportive social climates have been linked to improved health outcomes, and particularly better mental health, among sexual minorities.^{15,17,18} Yet it remains unclear whether these social and legal advances have affected trends in all-cause or external-cause mortality among sexual minorities. This gap is particularly notable given the recent changes in the visibility, legal rights and societal attitudes towards sexual minorities, including the legalisation of same-sex marriage in 38 countries (over a dozen within the past decade alone), increased societal-level tolerance toward and acceptance of sexual minorities, and broader demographic shifts in the share of individuals identifying as sexual minorities.¹⁹

The limited longitudinal evidence to date is mixed. Results from Denmark between 1982 and 2011 suggested there were declining trends in mortality risk among males in same-sex

relationships (n~3,500), but rising mortality among females in same-sex relationships (n~1,400), relative to those in different-sex relationships.²⁰ The other longitudinal study, which pooled registry data from Sweden and Denmark between 1989 to 2002, found broadly declining suicide-related mortality among individuals in same-sex relationships (n=28,649) relative to those in different-sex relationships.⁶ These heterogeneous findings, against a backdrop of dynamic and country-specific shifts in legislation and social climate, highlight the need for contemporary assessment of mortality trends by sexual orientation.

This study provides the first nationwide evidence on all- and external-cause mortality by sexual orientation in Australia between 2011 and 2023 and explores trends before and after Australia's legalisation of same-sex marriage in 2017. Given empirical research suggests that same-sex marriage legalisation is linked to more favourable attitudes towards sexual minorities and improved sexual minority mental health,^{21,22} it is hypothesised that mortality risk may reduce among sexual minorities after marriage equality, particularly for external causes.

2. Methods

Data

The data for this analysis comes from the Person-Level Integrated Data Asset (PLIDA), an individual-level linked dataset which combines information from the population Census linked to death records.²³ The Australian Census is conducted every five years and includes demographic and household information such as age, sex, educational attainment, income, and household relationships. Death records contain information on date of death and cause of death. The full data item list for PLIDA is provided by the Australian Bureau of Statistics.²⁴ This study uses information from the 2011 Census and linked to death records spanning from the August 2011 to December 2023 (the most recent and complete data available at the time of writing). The death records include all deaths that occurred and were registered in Australia but, with the exception of Australian diplomats, deaths of Australian residents occurring overseas are not included.²⁵

Study design and participants

In this retrospective cohort study, all cohabiting individuals aged 18 years and above in same-sex and different-sex relationships were identified. Relationship status and partnership type were measured at a single point in time — Census night in August 2011 — and treated as fixed for the duration of follow-up. Following the Census question on household relationships, individuals in “de facto marriage, female same-sex couple” or “de facto marriage, male same-

sex couple” were classified as being in a same-sex relationship while individuals in different-sex relationships were identified from being either “in de facto marriage, opposite-sex couple” or “in a registered marriage.” As same-sex marriage was not legalised in Australia until December 2017, same-sex couples in the 2011 Census were recorded as cohabiting (de facto) partners regardless of any overseas marriage.

Outcomes

The index date was defined as August 2011 (i.e., the Census month). The primary outcomes were all-cause, external-cause, and non-external cause mortality between August 2011 and December 2023, with person-time calculated in months from the index date (August 2011) until month-year of death or end of follow-up (December 2023). Deaths from external causes were classified according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) following Case, Deaton ²⁶; namely, alcoholic liver diseases, and cirrhosis (ICD10 K70, K73-74), suicide (X60-84, Y87.0), and poisonings (X40-45, Y10-15, Y45, Y47, Y49).

Statistical analyses

To construct comparable cohorts, inverse probability weights (IPWs) were applied to the population in different sex relationships, using age, highest educational attainment (less than high school, high school, certificate or diploma, or university level), and household equivalised income (in deciles) as covariates. Weights were estimated separately by sex. The characteristics of the unweighted and weighted cohorts were then described and Kaplan–Meier curves were used to compare all-cause survival between individuals in same-sex and different-sex relationships.

Cox proportional hazards models were then estimated, separately by sex, for all-cause, external cause, and non-external cause mortality for the full study period (2011–2023). For cause-specific analyses, deaths from other causes were treated as censored events (i.e., competing risks were not explicitly modelled). Schoenfeld residuals were additionally used to test for proportional hazards and showed evidence of non-proportionality for all-cause, but not for cause-specific mortality. Subsequently, extended Cox models were estimated, allowing the effect of being in a same-sex relationship on mortality risk to vary over time. Details on these models are provided in Supplementary Material SM1.

Additional analyses were then conducted. First, models were stratified by age group (18–39, 40–59, and 60 years and older) to examine whether mortality disparities varied across the age

distribution. Second, models were stratified by calendar time into periods before (August 2011–December 2017) and after (January 2018–December 2023) Australia’s legalisation of same-sex marriage.²⁷ Differences in all-cause and cause-specific inequalities before and after Marriage Equality were considered to be statistically significant if 95% confidence intervals were not overlapping.²⁸

The robustness to alternative weighting procedures was then investigated. While the fully adjusted specification, which maximises comparability between groups with respect to age, education, and income, is the preferred estimate, it is possible that educational attainment and household income may act partially as mediators in this context. For example, studies have consistently shown that sexual minorities invest more heavily in education and human capital in anticipation of labour market discrimination.^{9,29} To this end, the results across the full sequence of weighting specifications (unadjusted, age-weighted, age and education weighted, age and income weighted, and fully weighted) were applied to allow assessment of the sensitivity of findings to this analytic choice.

Finally, to assess sensitivity to the choice of baseline Census, the baseline analysis was replicated using the 2016 Census sample of adults in same-sex and different-sex relationships as an alternative starting cohort. For each cohort, analyses were restricted to a matched follow-up period; namely, August 2016 to December 2017 and January 2018 to December 2023.

All analyses were conducted using STATA version 17. No primary data collection was undertaken. Data from PLIDA was analysed as per the data-sharing agreement with the Australian Bureau of Statistics. This study is reported according to STROBE guidelines.

Role of the funding source

Funding bodies had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

3. Results

The analytical sample comprised 54,529 individuals in same-sex relationships and 7,923,328 individuals in different-sex relationships. The descriptives for the unweighted sample are provided in Supplementary Material SM.2. On average, compared to individuals in different-sex relationships, individuals in same-sex relationships were younger, had higher household incomes, and higher levels of educational attainment. The weighted descriptive sample statistics for the study sample are presented in Table 1.

During follow-up, 575 deaths occurred among females in same-sex relationships (2.2%) and 1,047 deaths occurred among males in same-sex relationships (3.8%), compared with 254,067 (6.3%) and 443,073 (11.3%) deaths, respectively, in females and males in different-sex relationships. Deaths from external causes were proportionately higher among both females and males in same-sex relationships (11.7 and 13.2%, respectively) relative to females and males in different-sex relationships (2.0 and 2.8% respectively).

Kaplan–Meier survival curves for the preferred weighted sample demonstrate clear differences in overall survival between individuals in same-sex relationships compared with individuals in different-sex relationships of the same sex (Figure 1). Differences in survival between groups widened progressively with time, with the steepest decline observed among males in same-sex relationships. At 12 years of follow-up, estimated survival probabilities were 0.979 for females in same-sex relationships, 0.983 for females in different-sex relationships; corresponding to an additional 4.4 deaths per 1,000 females in same-sex relationships. The corresponding survival probabilities were 0.963 for males in same-sex relationships and 0.971 for males in different-sex relationships; equivalent to an additional 6.6 deaths per 1,000 males in same-sex relationships. Had females in same-sex relationships experienced the mortality of females in different-sex relationships over 12 years of follow-up, an estimated 453 deaths would have been observed; however, 560 deaths were observed. Thus, approximately 19% of deaths among females in same-sex relationships are estimated to be excess deaths. The corresponding figures for males were 809 expected deaths against 1,032 observed, representing approximately 22% excess mortality among males in same-sex relationships.

Unadjusted Kaplan–Meier survival curves and curves with sequential levels of IPW adjustment are provided in Supplementary Material SM.3. Without adjustment, individuals in same-sex relationships appear to have a survival advantage; however, this reflects the younger age profile of this group rather than a genuine protective effect. After age adjustment, impaired survival among same-sex partnered individuals emerges, and is more pronounced after additional adjustment for education and income.

The Cox proportional hazards models for all-cause, external-cause, and non-external mortality are presented in Table 2. Compared to females in different-sex relationships, females in same-sex relationships experienced significantly elevated all-cause mortality [HR=1.25 (95%CI 1.15;1.35)], external cause mortality [HR=2.56 (95%CI 2.01;3.26)], and non-external cause-mortality [HR=1.17 (95%CI 1.07;1.27)]. Elevated mortality risk was more pronounced among females in same-sex relationships aged 18-39 years, followed by those aged 40-59

years, but were not significantly different for those aged 60 years and older. Premature mortality from all-cause, external cause, and non-external causes was elevated in the periods before and after legalisation of same-sex marriage, though attenuated in the post-legalisation period. While differences were statistically insignificant, reductions in mortality risk following Marriage Equality were larger for external causes among females in same-sex relationships (HR=3.40 →2.04).

Similar patterns emerged for males in same-sex relationships. Compared to males in different-sex relationships, males in same-sex relationships had significantly elevated mortality risk for deaths from all-causes [HR 1.24 (95%CI 1.16;1.31)], external causes [HR 1.96 (95%CI 1.65;2.32)], and non-external causes [HR 1.17 (95%CI 1.10;1.25)]. Once more, mortality risk was generally larger for younger age groups, however, elevated external cause mortality risk was highest for males in same-sex relationships aged 60 years and above.

The excess all-cause and non-external cause mortality risk among males in same-sex relationships were broadly similar before and after legalisation of same-sex marriage. While the risk from deaths from external causes marginally reduced from HR 2.01 (95%CI 1.54;2.63) before Marriage Equality to HR 1.93 (95%CI 1.55;2.40) after Marriage Equality, confidence intervals were overlapping.

Extended Cox models allowing the effect of same-sex relationship status on mortality risk to vary over time are provided in Supplementary Material SM4. Across all outcomes and both sexes, the initial hazard ratio exceeded the corresponding average-effect estimate from the baseline Cox models, while the interaction term between same-sex relationship status and follow-up time was consistently below unity, though not statistically significant. This indicates that the mortality risk for individuals in same-sex relationships was at its highest at the start of follow-up and declined progressively over time.

Sensitivity analyses exploring the robustness of the results to alternative weighting procedures are provided in Supplementary Material SM5. Regardless of the weighting procedure applied, elevated external cause mortality risk among individuals in same-sex relationships was statistically significant across all specifications. More broadly, results were consistent once age was accounted for, with sequential addition of income and educational attainment yielding hazard ratios approaching the fully adjusted baseline estimates.

Further sensitivity analyses using an alternative periodisation for cohorts identified in same-sex and different-sex relationships in the 2011 and the 2016 Census (restricting the pre-

marriage equality period to August 2016–December 2017) are provided in Supplementary Material SM6. Results were broadly consistent across the 2011 and 2016 Census cohorts, supporting the robustness of the primary findings. For both Census cohorts, elevated mortality risk persisted across both periods for females in same-sex relationships, albeit somewhat reduced after Marriage Equality. For the 2011 and 2016 Census cohorts, premature mortality risk among males in same-sex relationships was higher relative to males in opposite sex relationships but was not statistically significant in the pre–Marriage Equality period.

4. Discussion

This study finds elevated all-cause, external-cause, and non-external-cause mortality among Australians in same-sex relationships compared with those in different-sex relationships, with disparities most pronounced among younger age groups. External-cause mortality was particularly elevated, at approximately two-fold higher risk for both females and males in same-sex relationships. Following the legalisation of same-sex marriage, external-cause mortality disparities declined, with the largest absolute reduction observed among females in same-sex relationships, though confidence intervals overlapped across periods and external-cause mortality remained significantly elevated for both sexes throughout the study period.

These findings broadly align with previous international studies reporting elevated all-cause and external cause mortality risk among sexual minorities.^{6,13,20,30} Notably, they align with the study in Denmark and Sweden⁶ which reported that suicide risk was most pronounced for young adults and females in same-sex relationships. These findings also align with other studies documenting larger mental health inequalities, including higher suicidal ideation, among sexual minorities during young adulthood, particularly among sexual minority females.

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The reductions in external-cause mortality after marriage equality are consistent with studies that showed there were improvements in mental health, including reduced suicidal ideation, among sexual minorities following the legalisation of same-sex marriage in the United States³² and broader evidence linking reduced institutional discrimination to better mental health outcomes among sexual minorities.^{9,33,34} Although direct evidence from Australia is limited, international studies have identified several pathways through which marriage equality may have improved mental health among sexual minorities. These include increased societal-level tolerance toward and acceptance of sexual minorities, fewer anti-LGBT hate crimes, reduced

employment and housing discrimination, and improved access to preventative healthcare^{22,35-37}.

The more pronounced reductions in external-cause mortality risk after marriage equality in Australia among females in same-sex relationships may reflect their comparatively higher baseline burden of external-cause risk factors, including elevated suicide risk^{6,31} and higher alcohol and substance use^{5,38}, relative to heterosexual women – and thus greater scope for improvement following reform. A study in the United States further found that civil union legislation was linked to lower levels of perceived discrimination, depression, and hazardous drinking in sexual minority women.³⁹ Taken together, it is possible that sexual minority females may have experienced a greater reduction in stigma-related stressors after Marriage Equality, though further research in the Australian context, including investigation into underlying mechanisms is warranted.

These results should be considered with the context of several limitations. First, as the 2011 Census does not include a direct question on sexual orientation, sexual minorities are identified solely through cohabiting same-sex relationships. This approach therefore significantly underestimates sexual minorities in the population and the findings may therefore not be generalisable to sexual minorities who were non-partnered, not living with their partner, or unwilling to disclose their relationship status at the time of the 2011 Census. It is also likely that some individuals may not have felt safe to disclose their relationship status, particularly in 2011 when same-sex marriage was not legal. However, because identity concealment and internalised stigma are associated with poorer mental health and health-risk behaviours⁴⁰, their exclusion in this study may result in downwardly biased estimates.

Additionally, sexual identity and partnership patterns can change across the life course⁴¹ and some individuals classified in same-sex or opposite-sex partnerships at baseline may have subsequently partnered with someone of a different sex. The extent of such transitions in the Australian population is not well quantified and it remains challenging to accurately capture changes in relationship status or partnership type over time, including transitions from opposite-sex to same-sex partnerships or vice versa, dissolution of partnerships, or entry into new partnerships. However, any resulting misclassification would likely attenuate the observed differences between groups.

Moreover, individuals in cohabiting partnerships are likely positively selected on health-related characteristics; partnered individuals tend to report better health, greater social connectedness,

and lower mortality risk than their unpartnered counterparts.^{42,43} Similar patterns have been observed among lesbian and gay populations, where partnered individuals report better health across multiple domains than their unpartnered peers.⁴⁴ Partnered individuals captured in this study may therefore represent a comparatively healthier subset, and mortality disparities relative to the broader sexual minority population may be larger than those reported here.

Efforts to embed questions on sexual orientation in population-level datasets, such as the Census, would substantially improve the evidence base and enable a more comprehensive understanding of mortality disparities by sexual orientation.

It is also important to note that a small number of deaths may be missed if individuals in the study population permanently emigrated from Australia and subsequently died overseas, as these deaths are generally not captured in Australian death records.²⁵ However, permanent emigration from Australia is very low – less than 0.1% of the total population per year.⁴⁵ The probability of both emigrating and then dying during the follow-up period is therefore likely to have a small impact on the presented estimates. Further, to the extent that such deaths are missed, affected individuals would contribute immortal person-time, biasing results toward the null.

Despite these limitations, this study boasts several strengths and unique contributions. It is, to the author's knowledge, the largest population-based study of mortality risk by sexual orientation globally and the first to provide these estimates for Australia. The study is also the first to examine mortality trends before and after a major institutional reform which had profound impacts on sexual minorities in Australia. The extended follow-up period spanning six years pre- and post-reform also provided a rare opportunity to assess long-term changes in mortality risk in the context of this major structural policy shift. In addition, the use of whole-of-population Census and death registration data allowed for comprehensive national coverage, and adjustment of important confounders such as income and education.

5. Public health implications

These results have important implications for both health and social policy. Chiefly, the substantially increased risk of mortality from external causes among sexual minorities highlights the need for targeted prevention strategies and continued efforts to foster inclusive social environments.

While Australia has made progress with respect to Marriage Equality, anti-discrimination legislation, and more broadly more favourable societal attitudes towards sexual minorities,

many discriminatory policies remain commonplace. These include the lack of a comprehensive ban on conversion practices and anti-discrimination exemptions that allow religious schools and organisations to discriminate against LGB staff and students ⁴⁶.

The results also suggest that enhancing equitable access to health care for sexual minorities, especially mental healthcare, is crucial. Indeed, enhancing equity of access to inclusive care has been cited as a key priority within the Australian government's recently implemented a 10-Year National Action Plan for the Health and Wellbeing of LGBTIQ+ People (2025–2035) ⁴⁷. Through this Action Plan, dedicated funding has been earmarked for provider training as well as for resourcing LGBTIQ+ Community Controlled Health Organisations. However, it remains to be seen whether this training is voluntary and whether these supports will be targeted to specific regions. In particular, previous Australian studies have indicated that despite being in poorer health, sexual minorities use less preventive healthcare, particularly in areas where there was less community-level support for marriage equality ^{8,9,16,34}. Taken together, these findings suggest that continued investment in inclusive mental health care should be considered alongside stigma-reduction measures.

Ultimately, the significant and persistent differences in external-cause mortality experienced by sexual minorities, even six years after Australia's marriage equality reform, highlight the need for urgent and coordinated policy response. These responses should consider both the modifiable risks and societal-level conditions that perpetuate sexual minority health inequities. Younger populations in particular should be targeted.

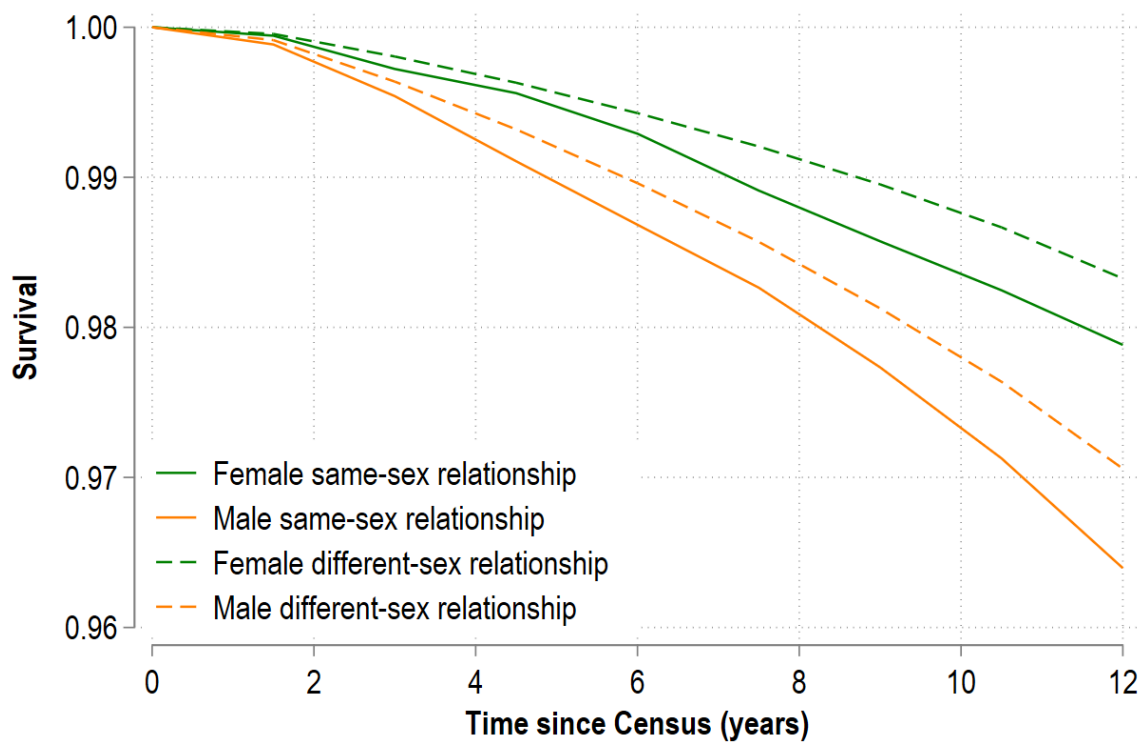
Tables and Figures

Table 1 – Descriptive statistics for weighted sample of individuals in same-sex and different-sex relationships

	Female same-sex relationship (n=26,644)	Female different-sex relationship (n=200,356)	Male same-sex relationship (n=27,885)	Male different-sex relationship (n=194,816)
	Mean/%	Mean/%	Mean/%	Mean/%
Age entry (years)	40.5	40.5	41.4	41.4
Age exit (years)	52.7	52.7	53.6	53.6
<u>Age group entry (years)</u>				
18-34	34.4%	34.5%	32.3%	32.5%
35-44	29.9%	29.8%	30.2%	30.1%
45-54	22.8%	22.7%	22.6%	22.6%
55-64	10.6%	10.6%	10.6%	10.6%
65+	2.3%	2.3%	4.2%	4.2%
Person-years	12.2	12.3	12.2	12.2
<u>Educational attainment entry</u>				
Less than High School	12.0%	11.9%	12.0%	12.0%
High School	14.9%	14.9%	18.2%	18.2%
Diploma/Certificate	25.6%	25.6%	26.1%	26.1%
University	44.4%	44.4%	40.6%	40.6%
<u>Equivalised household income entry*</u>				
1 (lowest decile)	1.1%	1.1%	1.0%	1.0%
2	0.9%	0.9%	0.4%	0.4%
3	2.4%	2.4%	1.7%	1.7%
4	6.4%	6.4%	4.2%	4.2%
5	9.6%	9.6%	6.6%	6.6%
6	9.8%	9.8%	6.8%	6.8%
7	14.6%	14.6%	12.3%	12.3%
8	11.7%	11.7%	10.4%	10.4%
9	17.5%	17.5%	18.6%	18.6%
10 (highest decile)	20.2%	20.2%	32.3%	32.3%
Death – any cause	2.2%	1.7%	3.8%	3.0%
Death – external	0.3%	0.1%	0.5%	0.3%

Notes: *lowest decile includes individuals reporting 'nil' or negative income. 519,332 individuals were missing information on educational attainment, 741,555 individuals were missing information on household income. Entry date is August 2011 (i.e., the Census month). Descriptive statistics shown are weighted and represent a pseudo-population rather than raw sample counts. Unweighted sample is provided in Supplementary Material SM.2.

Figure 1 – Cumulative survival in individuals in same-sex relationships compared with individuals in different-sex relationships



Notes: Kaplan–Meier survival curves for all-cause mortality. Individuals in different-sex relationships adjusted using inverse propensity weights to be similar to those in same-sex relationships with respect to age, highest educational attainment (less than high school, high school, certificate or diploma, or university level), and household equivalised income (in deciles) at the time of the 2011 Census. As curves are IPW-adjusted, readers should refer to the regression estimates for formal tests of uncertainty.

Table 2 – Cause specific Hazard Ratios for individuals in same-sex relationships compared with individuals in different-sex relationships

	Female in same-sex relationship compared to female in different-sex relationship			Male in same-sex relationship compared to male in different-sex relationship		
	All-cause	External cause	Non-external cause	All-cause	External cause	Non-external cause
Full sample	1.25*** [1.15, 1.35]	2.56*** [2.01, 3.26]	1.17*** [1.07, 1.27]	1.24*** [1.16, 1.31]	1.96*** [1.65, 2.32]	1.17*** [1.10, 1.25]
Age: 18-39 years	1.70*** [1.38, 2.08]	3.32*** [2.37, 4.65]	1.32* [1.02, 1.70]	1.69*** [1.43, 2.00]	2.11*** [1.64, 2.71]	1.45** [1.16, 1.81]
Age: 40-59 years	1.30*** [1.15, 1.46]	2.01*** [1.38, 2.95]	1.25*** [1.10, 1.41]	1.36*** [1.23, 1.50]	1.74*** [1.34, 2.27]	1.32*** [1.19, 1.46]
Age: 60+ years	1.05 [0.91, 1.21]	2.24 [0.93, 5.40]	1.04 [0.90, 1.20]	1.07 [0.98, 1.17]	2.31*** [1.43, 3.72]	1.05 [0.96, 1.15]
August 2011 – December 2017 (pre Marriage Equality)	1.31*** [1.14, 1.49]	3.40*** [2.42, 4.79]	1.17* [1.02, 1.36]	1.23*** [1.12, 1.36]	2.01*** [1.54, 2.63]	1.16** [1.04, 1.29]
January 2018 – December 2023 (post Marriage Equality)	1.21*** [1.09, 1.34]	2.04*** [1.45, 2.88]	1.16** [1.04, 1.29]	1.24*** [1.15, 1.34]	1.93*** [1.55, 2.40]	1.18*** [1.08, 1.28]

Notes: For each sex, inverse probability weights were applied to the population in different sex relationships, using age, highest educational attainment (less than high school, high school, certificate or diploma, or university level), and household equivalised income (in deciles) as covariates. Age based on age at entry (2011 Census).

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Supplementary Material

SM.1. Cox model

A Cox proportional-hazards model was used to estimate overall, or cause-specific, survival as follows:

$$h_i(t) = h_0(t) \exp(\beta_1 S_i) \quad (1)$$

Where $h(t)_i$ is the hazard of an individual i dying at survival time t (as measured by time from the August 2011 Census until event or censoring; S_i is an indicator variable equal to 1 if the individual was in a same-sex relationship at the time of the Census; and $h_0(t)$ represents the baseline hazard. Confounding by age (exact age in years), educational attainment (less than high school, high school, certificate or diploma, or university level), and household equivalised income (in deciles) was addressed through inverse probability weighting applied to the different-sex comparison group prior to model estimation, rather than through covariate adjustment in the outcome model. Models were estimated separately by sex. Participants were followed from the August 2011 Census to death or December 2023, whichever occurred first; for cause-specific mortality, deaths from other causes were treated as censoring events (i.e., competing risks were not explicitly modelled).

Schoenfeld residuals indicated evidence of non-proportionality for all-cause, but not cause-specific, mortality. To accommodate this, an extended Cox model was estimated for all-cause mortality, allowing the effect of same-sex relationship status on mortality risk to vary continuously over follow-up time:

$$h_i(t) = h_0(t) \cdot \exp((\beta_0 + \beta_1 t) \cdot S_i) \quad (2)$$

where $\beta(t)$ is a time-varying coefficient estimated as a function of t .

SM.2. Unweighted descriptive characteristics

	<u>Female same-sex relationship</u> <u>(n=26,644)</u>		<u>Female different-sex</u> <u>relationship (4,018,943)</u>		<u>Male same-sex relationship</u> <u>(27,885)</u>		<u>Male different-sex relationship</u> <u>(n=3,904,385)</u>	
	Mean/%.	Freq.	Mean/%.	Freq.	Mean/%.	Freq.	Mean/%.	Freq.
Age entry (years)	40.5	-	47.5	-	41.4	-	50.4	-
Age exit (years)	52.7	-	59.5	-	53.6	-	62.2	-
<i><u>Age group entry (years)</u></i>								
18-34	34.4%	9,175	22.9%	921,095	32.3%	9,019	17.9%	697,926
35-44	29.9%	7,957	23.4%	941,279	30.2%	8,432	21.9%	856,889
45-54	22.8%	6,068	21.2%	852,800	22.6%	6,304	21.1%	823,796
55-64	10.6%	2,825	17.2%	692,658	10.6%	2,947	18.6%	726,215
65+	2.3%	619	15.2%	611,111	4.2%	1,183	20.5%	799,559
Person-years	12.2	-	12.0	-	12.2	-	11.7	-
<i><u>Educational attainment entry</u></i>								
Less than High School	12.0%	3,186	31.2%	1,252,089	12.0%	3,339	23.5%	919,192
High School	14.9%	3,982	16.0%	641,312	18.2%	5,074	12.5%	487,269
Diploma/Certificate	25.6%	6,827	21.0%	843,969	26.1%	7,268	36.0%	1,406,141
University	44.4%	11,835	24.7%	993,372	40.6%	11,329	22.1%	862,341
<i><u>Equivalised household income entry*</u></i>								
1 (lowest decile)	1.1%	285	2.4%	95,565	1.0%	276	2.4%	95,496
2	0.9%	251	2.1%	84,124	0.4%	120	2.1%	83,356
3	2.4%	646	8.5%	342,616	1.7%	472	8.8%	342,466
4	6.4%	1,703	13.0%	524,213	4.2%	1,164	13.3%	519,748
5	9.6%	2,550	14.5%	581,497	6.6%	1,840	14.7%	575,708
6	9.8%	2,612	11.6%	464,571	6.8%	1,892	11.8%	459,412
7	14.6%	3,885	12.3%	494,663	12.3%	3,439	12.6%	490,924
8	11.7%	3,110	8.7%	351,577	10.4%	2,911	8.9%	348,494
9	17.5%	4,669	9.5%	380,424	18.6%	5,178	9.7%	378,620
10 (highest decile)	20.2%	5,391	7.1%	286,839	32.3%	9,002	7.3%	284,593
Death – any cause	2.2%	575	6.3%	254,067	3.8%	1,047	11.3%	443,073
Death – external	0.3%	67	0.1%	5,069	0.5%	138	0.3%	12,596

SM.3. Unadjusted and sequentially adjusted Kaplan-Meir survival curves

Figure SM. 1 – Unadjusted Kaplan-Meir survival curve for all-cause mortality

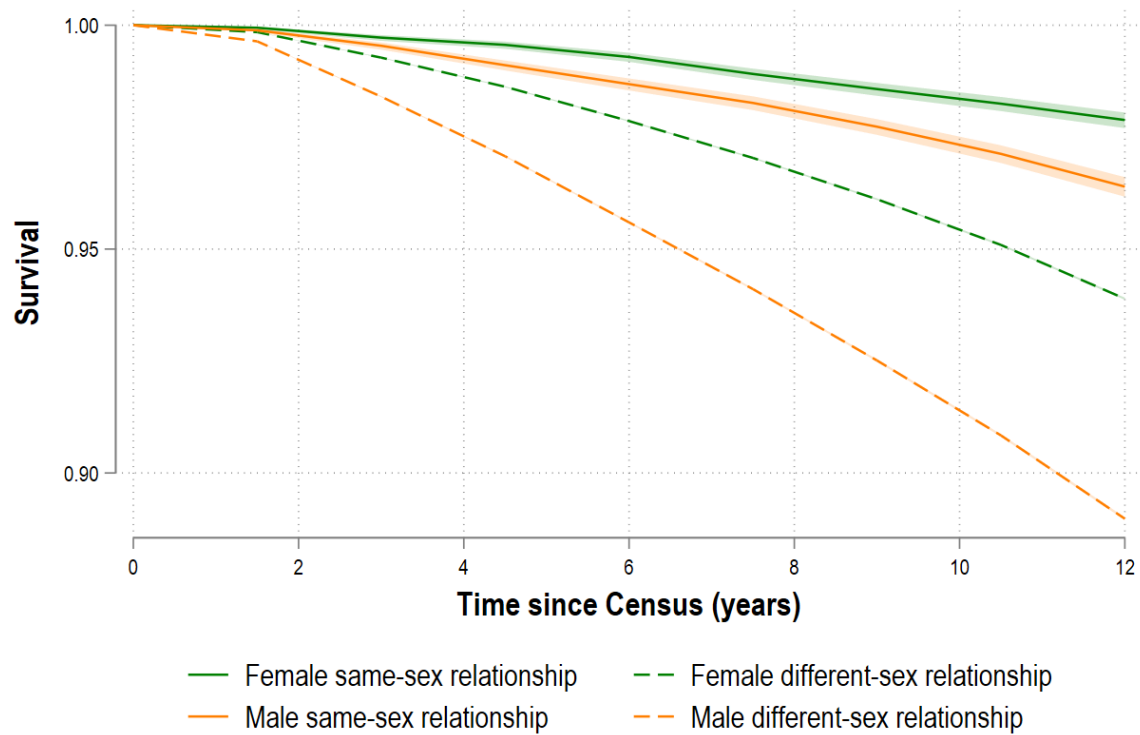


Figure SM. 2 – Sequentially adjusted Kaplan-Meir survival curve for all-cause mortality – females

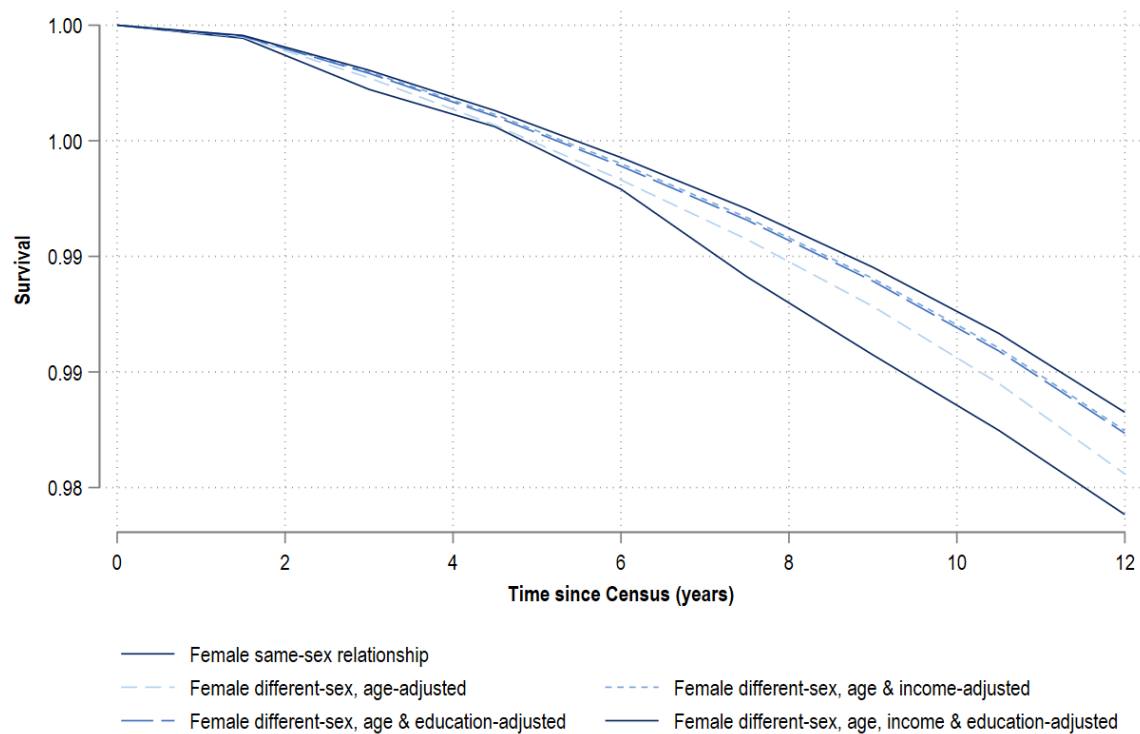
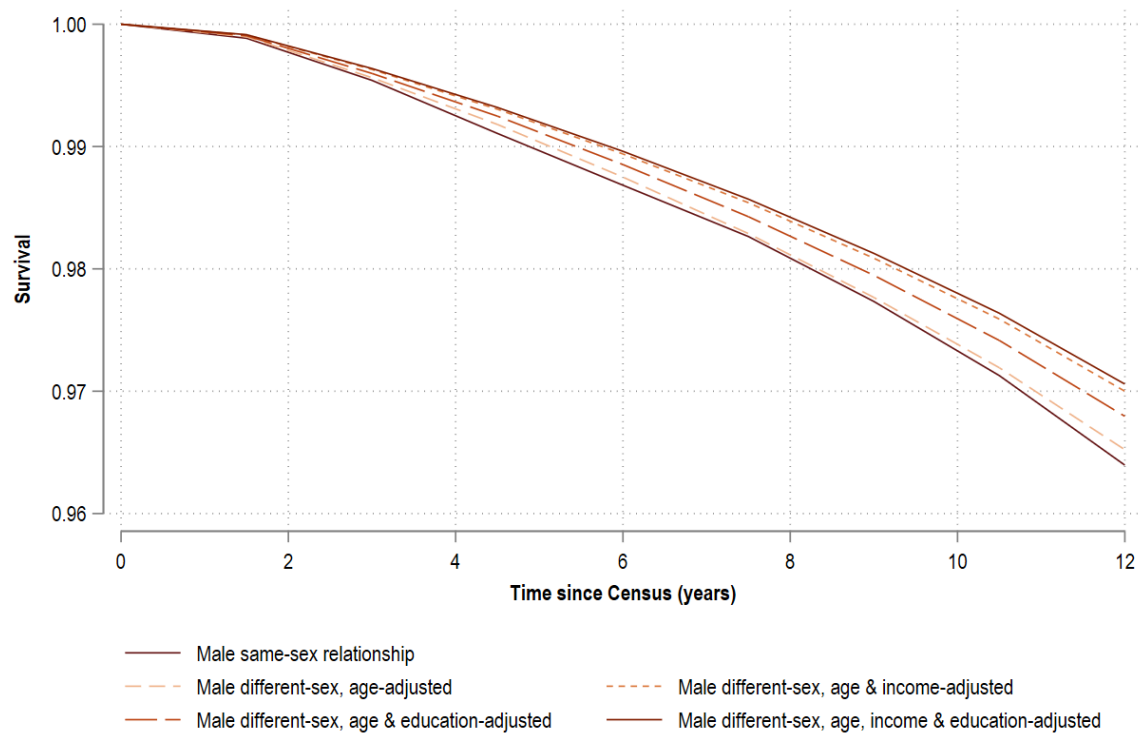


Figure SM. 3 – Sequentially adjusted Kaplan-Meier survival curve for all-cause mortality – females



SM.4. Extended Cox Models: Effect of Same-Sex Partnership on Mortality Risk Over Time

	Female in same-sex relationship compared to female in different-sex relationship			Male in same-sex relationship compared to male in different-sex relationship		
	All-cause	External cause	Non-external cause	All-cause	External cause	Non-external cause
Baseline hazard ratio	1.690* [1.037,2.753]	3.182 [0.546,18.54]	1.608 [0.964,2.682]	1.264 [0.872,1.833]	2.783* [1.015,7.634]	1.147 [0.768,1.714]
Trend in hazard ratio	0.932 [0.834,1.042]	0.951 [0.637,1.421]	0.928 [0.826,1.043]	0.995 [0.914,1.083]	0.922 [0.732,1.162]	1.005 [0.917,1.101]

SM.5. Unadjusted and sequentially adjusted Cox proportional hazard models

	Female in same-sex relationship compared to female in different-sex relationship			Male in same-sex relationship compared to male in different-sex relationship		
Weighting procedure	All-cause	External cause	Non-external cause	All-cause	External cause	Non-external cause
No adjustment	0.334*** [0.308,0.363]	1.952*** [1.534,2.484]	0.302*** [0.277,0.329]	0.317*** [0.299,0.337]	1.470*** [1.243,1.738]	0.284*** [0.267,0.304]
Age adjustment	1.043 [0.981,1.108]	2.174*** [1.708,2.768]	1.005 [0.921,1.096]	1.073 [0.988,1.164]	1.596*** [1.349,1.888]	0.99 [0.928,1.057]
Age, income adjustment	1.188*** [1.094,1.289]	2.394*** [1.879,3.050]	1.113* [1.020,1.214]	1.211*** [1.140,1.287]	1.885*** [1.592,2.233]	1.149*** [1.076,1.226]
Age, educational attainment adjustment	1.181*** [1.088,1.282]	1.826*** [1.543,2.161]	1.104* [1.011,1.204]	1.133*** [1.066,1.204]	2.478*** [1.946,3.156]	1.071* [1.004,1.143]
<i>Age, income, educational attainment adjustment (baseline model)</i>	<i>1.245*** [1.147,1.351]</i>	<i>2.559*** [2.008,3.261]</i>	<i>1.165*** [1.067,1.271]</i>	<i>1.236*** [1.163,1.314]</i>	<i>1.960*** [1.654,2.322]</i>	<i>1.170*** [1.097,1.249]</i>

SM.6. Cox proportional hazard models testing the sensitivity to Census 2011 and Census 2016 cohorts

	Female in same-sex relationship compared to female in different-sex relationship			Male in same-sex relationship compared to male in different-sex relationship		
	All-cause	External cause	Non-external cause	All-cause	External cause	Non-external cause
<i>2011 Census cohort</i>						
August 2016 - December 2017	1.577*** [1.269,1.960]	5.480*** [3.410,8.806]	1.314* [1.027,1.680]	1.122 [0.929,1.355]	1.354 [0.764,2.401]	1.099 [0.900,1.342]
January 2018 – December 2023	1.209*** [1.089,1.343]	2.040*** [1.445,2.879]	1.159** [1.038,1.294]	1.239*** [1.147,1.339]	1.928*** [1.549,2.399]	1.178*** [1.084,1.279]
<i>2016 Census cohort</i>						
August 2016 - December 2017	1.646*** [1.355,2.001]	4.264*** [2.544,7.146]	1.489*** [1.205,1.839]	1.173 [0.992,1.387]	1.651* [1.020,2.671]	1.127 [0.943,1.348]
January 2018 – December 2023	1.147** [1.040,1.266]	2.542*** [1.897,3.407]	1.071 [0.965,1.189]	1.184*** [1.102,1.272]	2.094*** [1.714,2.558]	1.110** [1.028,1.199]

