

Do disparities in suicide-related behaviour across sexual orientations differ by neighbourhood deprivation? A discrete-time survival analysis in Ontario, Canada (2007-2017)

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ABSTRACT

Background

Prior research on the disparities of suicide-related behaviours (SRB) across sexual orientation has been limited by the use of surveys and self-reported data, leading to possible survival bias. Furthermore, there have been no studies examining how neighbourhood deprivation modifies the effects of sexual minority status on SRB. Sexual minority individuals in deprived areas may face unique challenges and stressors that exacerbate their risk of SRB. This study investigates the association between sexual minority status and clinical SRB, and examines whether the effect of neighbourhood deprivation differs across sexual orientation.

Methods

A population-representative survey sample (weighted $n=8,778,120$) was linked to administrative health data in Ontario, Canada to measure SRB-related events (emergency department visits, hospitalizations, and deaths) from 2007 to 2017. Neighbourhood-level deprivation was measured using the Ontario Marginalisation (ON-Marg) index measure of material deprivation at the dissemination area (DA) level. Discrete-time survival analysis models, stratified by sex, tested the effects of neighbourhood deprivation and sexual minority status, while controlling for individual-level covariates.

Results

Sexual minority males had 2.79 times higher odds of SRB compared to their heterosexual counterparts (95% CI 1.66 to 4.71), while sexual minority females had 2.14 times higher odds (95% CI 1.54 to 2.98). Additionally, neighbourhood deprivation was associated with higher odds

of SRB: males in the most deprived neighbourhoods (Q5) had 2.01 times higher odds (95% CI 1.38 to 2.92) of SRB compared to those in the least deprived (Q1), while females had 1.75 times higher odds (95% CI 1.28 to 2.40). No significant interactions were observed between sexual minority status and neighbourhood deprivation levels.

Conclusion

In both males and females, sexual minority status and neighbourhood deprivation on SRB are independent risk factors for SRB. Despite the lack of effect modification, sexual minorities living in the most deprived neighbourhoods have higher chances of SRB. Future investigations should evaluate interventions and policies to improve sexual minority mental health and address neighbourhood deprivation.

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INTRODUCTION

Suicide-related behaviours (SRB) refers to both fatal and non-fatal self-inflicted injuries and poisonings¹; they are both important elements of suicidality as non-fatal SRB has been shown to be a strong predictor of future suicide²⁻⁵. While there is growing evidence that neighbourhood deprivation⁵⁻⁹ and sexual minority status^{10,11} are independent risk factors for SRB, the interaction of these factors on SRB risk is unknown. The neighbourhood opportunity structure perspective offers an explanation for how the social, cultural, psychological, and economic dimensions of deprived neighbourhoods may increase the risk of SRB; however, the risk may be further amplified for sexual minorities¹². Understanding the interactions between sexual minority status and neighbourhood deprivation may help develop new strategies to address SRB risk among the most marginalized individuals in our society.

Sexual minority risk for SRB

A comprehensive systematic literature search for published works from 1995 to 2021 was conducted to understand existing evidence on SRB disparity by sexual orientation and to establish the originality of this study. A broad number of search terms were used to identify studies on SRB disparities by sexual orientation that uses clinical outcomes (e.g. from health administrative records). The search terms used and PRISMA flow diagram are included in Figure 1. Out of four hundred two studies that were screened, only 3 studies used clinical data (i.e. not self-reported data obtained through a survey) and was based on a representative sample to investigate SRB disparities by sexual orientation. All three studies indicated a disparity in SRB by sexual minority status, and all three papers included only fatal SRB. One of those studies took place in the United States (US) and used linked mortality records and nationally representative survey samples. Sexual minority status was determined based on two questions on lifetime and previous year sexual partner patterns and was underpowered with only 85 sexual minority men¹³. Among the two other studies, which both used nationally representative data from Denmark from 1982-2011¹⁴ and 1990-2001¹⁵, sexual minority status was proxied by marital or partnership status, which excludes non-partnered sexual minorities and misclassifies bisexual individuals with an opposite-sex partner.

Based on the results of the systematic search, there is a dearth of studies between 1995 and 2021 that have investigated SRB by sexual orientation using clinical data (i.e. not self-

reported) and representative sample. Moreover, the existing evidence on SRB disparities by sexual orientation is limited by small samples^{2-5,11,16}, convenience samples/selection bias^{4,16-18}, cross-sectional designs^{1,3,5,11,16,18}, and a majority of the studies rely on self-report data^{2-5,11}. These characteristics may lead to biased results. For example, survival bias applies as only individuals who have survived an SRB and are healthy enough to be involved in the research, are accounted for¹⁸. There may also be social desirability bias, wherein individuals are not reporting SRB to avoid certain stigma¹⁸. There is a need for further research, including larger sample sizes that measure clinical outcomes to further grasp sexual minority SRB, and related factors.

Keeping these limitations in mind, prior literature has shown that sexual minorities report worse mental health outcomes¹⁹, including self-reported SRB^{10,11,20} compared to the general population. A meta-analysis of 20 cross-sectional studies found that sexual minorities report an 11-20% lifetime prevalence of suicide attempts compared to 4% in heterosexual individuals¹¹. A widely used theory to explain this disparity is the minority stress model, in which individuals who belong to marginalized groups, including sexual minorities, experience higher stress levels and worse health outcomes due unique social and environmental circumstances of being a non-majority group member²¹. Higher levels of stress lead to allostatic load, or psychological as well as biological 'wear and tear'. This increased stress consequently leads to more extreme levels of individual physical stress response systems, including higher cortisol output, which impacts cognitive and emotional functioning to increase risk of SRB²²⁻²⁷. For sexual minorities, heteronormativity naturalizes heterosexuality as the most valid sexual orientation, with associated implications for gender roles, and ramifications such as discrimination against sexual minorities²⁸. The persistent conflict with the dominant culture of heteronormativity manifests as social and environmental stressors related to discrimination and stigma. More specifically, these stressors can include social isolation, internalisation of negative attitudes, and experiences of homophobia²⁹. A meta-analysis found that minority stressors specific to sexual minorities, including LGBT bias-based victimization, general victimization, bullying, and negative family treatment were significantly associated with both suicidal ideation and suicide attempts among LGBT adolescents and young adults³⁰. Despite general improvements in social, political, and environmental conditions, one study suggested there is still an enduring culture of homophobia, and exposure to minority stressors for sexual minorities (measured based on scales designed to assess distal stressors, such as violence and discrimination, and proximal stressors, such as

internalized homophobia and expectations of rejection), has not decreased; the risk of SRB among sexual minorities had also not decreased, and was worse for younger sexual minority individuals³¹.

Neighbourhood deprivation, stress, and SRB

Area-level material deprivation has been defined as the inability for communities to access and attain basic material needs and resources³². The experiences and challenges of living in a deprived environment result in feelings of hopelessness or despair, and increased emotional distress, which all contribute to stress and suicide among local residents, even those who may not be deprived at an individual level^{33–36}. In a study from Denmark, residents of deprived neighbourhoods had greater perceived stress than the general population, and that perceived stress was significantly associated with higher odds of health-risk behaviours related to diet, physical activity, as well as daily smoking³⁷. Furthermore, there are biological implications of the stress that comes with living in a poor area. One study assessed the allostatic load (measured by ten biomarkers of dysregulated metabolic, cardiovascular, and inflammatory systems including systolic and diastolic blood pressure) of living in deprived neighbourhoods compared to non-deprived areas: findings indicated that participants living in the most deprived quintile had 1.13 times higher allostatic load than those living in the least deprived quintile³⁸. As mentioned in the previous section, higher biological markers of stress impact the body in a way that can elevate risk of SRB.

Multilevel studies of area deprivation emphasise the contextual and place-based dimension of neighbourhood environmental risk factors, which may affect individual health and wellbeing above and beyond the effects of individual-level deprivation^{34,39,40}. A critical review indicates that there have been multilevel studies showing that neighbourhood-level deprivation is associated with various health outcomes, including chronic illness morbidity and all-cause mortality³⁹. Additionally, a study found an association for suicide mortality³³ and a systematic review found associations for suicidal behaviour⁶ by area deprivation after controlling for individual level poverty or deprivation. Results of these multilevel studies suggest that reducing area-level poverty may be an important element to suicide prevention strategies⁴¹. One study examining suicide mortality risk in Ohio found a moderate association between census tract economic deprivation and suicide risk, where the odds for suicide was 1.52 times higher for

residents in medium (vs low) deprivation areas, and 3.4 times higher for those in high (vs low) deprivation areas⁴¹. In addition, a systematic review found lower rates of suicide were associated with higher area-level SES (regardless of the measure being used) in studies from North America and Europe⁴². Neighbourhood deprivation is also linked to mental health outcomes, such as lower self-reported health-related quality of life scores⁴³, as well as higher rates of mental illness^{44,45} and psychotic disorders⁴⁶⁻⁴⁸. Findings from Canadian studies also show a similar pattern⁴⁹⁻⁵¹. For instance, in neighbourhoods where levels of deprivation are higher, suicide rates (as well as undetermined intent violent death rates) were also higher⁵².

Neighbourhood opportunity structure

The theory of neighbourhood opportunity structure may be a useful lens to help unpack potential causal pathways linking area deprivation and health⁵³. More specifically, neighbourhood deprivation may reflect the lack of neighbourhood opportunities that are health-promoting, which includes services, infrastructure, physical/built environment, and employment opportunities³⁹. For instance, a study in Quebec found that patients from materially advantaged areas had shorter wait times to access primary care physicians compared to individuals from deprived areas, with a difference of up to 34 days for residents from the least vs. most deprived areas⁵⁴. A study in Montreal found that as neighbourhood material deprivation declined, access to health care improved, which was reflected in the increased use of preventive health services such as physical and mental health screening⁵⁵. Neighbourhood deprivation may also be linked to physical and built environmental characteristics that may be health damaging^{53,56-61}: for example, an Ontario study found a positive association between alcohol availability (measured by accessibility and density of alcohol stores) and neighbourhood deprivation⁶², which may in turn influence alcohol use, misuse, or may aggravate mental disorders.

The influence of employment opportunities

Residents of neighbourhoods with high deprivation may be disadvantaged in their employment opportunities⁶³. Residents from deprived neighbourhoods may have lower accessibility to appropriate job opportunities due to the lack of local jobs (i.e. spatial proximity) or a robust transportation network (or transit system) that connects residents to jobs that are further away⁶⁴. For example, in the US, residents of high-poverty areas experienced particularly

greater declines in job proximity compared to low-poverty neighbourhoods. Overall, 61 percent of high-poverty tracts experienced declines in job proximity between 2000 and 2012⁶⁵.

Furthermore, it has been proposed that those living in deprived neighbourhoods are more likely to be stigmatised^{66,67}. A longitudinal study from Paris found that an individual's area of residence significantly impacted employment opportunities, to the point that an address in a non-deprived area can triple the chances of being invited to a job interview⁶⁸. Even during local hiring booms there has been evidence of a disparity between residents and workers in the neighbourhood, where the jobs have gone to people who live in other, more prosperous neighbourhoods and who commute from the surrounding areas⁶⁹. Furthermore, the collective economic disadvantage and accompanying social norms due to material deprivation of the areas also decrease opportunities for meaningful social participation in local organisations that offer structure and purpose to improve the communities and its resources⁷⁰.

How neighbourhood deprivation might modify sexual minority risk of SRB

Minority stress theory emphasizes that experiences of discrimination and stress that sexual minorities face due to their minority status could be exacerbated by non-LGB specific stressors^{21,71}. Based on evidence in the literature, there is reason to believe that environmental stressors could have a potential differential effect across sexual orientations, in that same level of neighbourhood deprivation could produce different outcomes for sexual minority vs. heterosexual individuals^{70,72-75}. For example, a prior study showed that the effect of neighbourhood cohesion (sense of belonging and sense of shared connection with neighbours) on mental health was stronger for LGB vs non-LGB participants, suggesting that neighbourhood stressors may have a stronger influence on the health and wellbeing of LGB residents⁷⁶. Additionally, for LGB respondents, perceived neighbourhood quality has been found to be a significant moderator of the association between self-reported experiences of discrimination (not LGB-specific discrimination) and psychological distress; since the same was not found for heterosexual respondents, researchers suggest that the protective role of perceived neighbourhood quality may be greater for LGB minorities⁷⁷. In another study, neighbourhood economic advantage had a stronger protective effect for cannabis use disorders among LGB individuals compared to non-LGB individuals, again indicating stronger neighbourhood effects for sexual minorities on a health outcome⁷⁸. Yet another study found that sexual minority men

living in socioeconomically disadvantaged neighbourhoods report more transactional sex compared to sexual minority men in more advantaged neighbourhoods⁷⁹. Overall, researchers have argued that intersectionality between socioeconomic status and sexual orientation disparities deserves more attention, including contextual or area-level SES by sexual minorities⁷⁸.

There is a disproportionately high number of LGB people that live in deprived areas, who may experience additional stress due to LGB-targeted stigma^{80,81}. Residents from the most deprived neighbourhoods report significantly higher levels of negative attitudes towards sexual minorities: the nationally representative Scottish Social Attitudes survey found that 25% of residents condemned same-sex relationships in deprived neighbourhoods, compared to 17% in non-deprived neighbourhoods⁸². These negative attitudes may in turn heighten sexual minorities' risk of discrimination in deprived areas. A qualitative study found that sexual minority residents of deprived neighbourhoods experience a lack of anonymity, fear of hate crimes and aggression, and believe that their experiences would be different if they were heterosexual¹². For example, lack of anonymity in certain deprived areas may be problematic for sexual minorities who are in the closet, if two people of the same sex were living in a single bedroom property, their sexual orientation may be assumed, and their disclosure of sexual orientation may place them in distress or danger¹². Due to the various ways that the effects of neighbourhood deprivation may be amplified for sexual minorities, further research is needed to examine these potential effects on SRB.

Unique contributions and research question

This study provides unique contributions by addressing distinct gaps in prior literature. First, as the systematic search shows, this study will use clinically relevant SRB outcomes. Second, we will be using a population-based sample, rather than smaller convenience samples or single-centre studies to investigate SRB by sexual orientation. Third, this will be the first study to estimate the interactive effect of sexual minority status and neighbourhood deprivation on SRB. This study hypothesizes that the relationship between sexual minority status and SRB will differ by level of neighbourhood material deprivation. Using a population-based survey and linked longitudinal medical administrative data for people living in Ontario, this study will answer the following research questions: 1) Are sexual minority status and neighbourhood

deprivation independently associated with SRB risk? 2) Does neighbourhood deprivation modify the association between sexual minority status and SRB risk?

METHODS

Our study cohort was created using Ontario participants from multiple cross-sectional cycles of the Canadian Community Health Surveys (CCHS) which is linked to longitudinal health administrative datasets, including the Discharge Abstract Database (DAD), Ontario Mental Health Reporting System (OMHRS), National Ambulatory Care Reporting System (NACRS), and the Canada Vital Statistics Database (CVSD). These datasets were linked using unique encoded identifiers and analysed at the Statistics Canada Research Data Centre. Ethics approval for this study was obtained through Brock University (REB# 20-134).

Study participants

The study cohort is constructed by combining thirteen cycles (2003, 2005, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017) of the Canadian Community Health Surveys (CCHS). The CCHS is a national cross-sectional survey administered by Statistics Canada through a multistage clustered-probability sampling method. The survey collects information related to demographics, health status, health care use, and health determinants. Canadians aged 12 years or older can respond to the CCHS questions in either English or French by telephone through an assisted interview software. About 3% of the Canadian population is not sampled: those living on Aboriginal reserves and settlements, those living in certain remote regions of Quebec and Nunavut, full-time military members, and institutionalised individuals⁸³. For our study, individuals aged 18 years and older were included. Study participant confidentiality is ensured and risk of re-identification is reduced by the Statistics Canada Research Data Centre (RDC) in multiple ways: 1) the Statistics Canada RDCs use unique anonymized ID numbers for linkage to health administrative data, 2) all researchers go through thorough required training in the use of privacy and data handling policies, and 3) there is a detailed process to screen results before any results or data are released from the centre.

Sex and Sexual orientation

Sexual orientation was established by asking participants “Do you consider yourself to be...” and providing the following options: heterosexual, homosexual, bisexual, don’t know, and refuse to say. The single-item measure has been shown to be a valid instrument with high agreement with sexual identity (kappa statistic of 0.89)⁸⁴. In a prior study, the CCHS question captured 99.3% of participants who identified as a sexual minority using a multi-question instrument, and 84.2% of those who reported any lifetime same-sex partners⁸⁴. For this paper, the sexual orientation variable is divided into the following categories: heterosexual, sexual minority (gay/lesbian and bisexual), other (don’t know), and refusal/not stated. A single sexual minority group was created by combining LGB respondents due to small sample size. While recent cycles of the CCHS (2018 and beyond) included questions on sex assigned at birth and gender identity, the earlier cycles, which are used in this study, did not differentiate the concepts of sex and gender. Interviewers were asked to identify the respondent’s sex, and if necessary, to ask the respondent if they were male or female¹¹⁸.

Neighbourhood deprivation

The material deprivation measure was obtained from the Ontario Marginalisation Index (ON-Marg, 2011 and 2016) at the dissemination area (DA) level. The DA has been used as a proxy for residential neighbourhoods^{85–90}, and it is the smallest geographic unit for which Canadian census data are available, with an average population of 400 to 700 residents⁹¹. The material deprivation measure was created using the following variables from the Census: proportion of the population aged 20+ without a high-school diploma, proportion of families who are lone parent families, proportion of total income from government transfer payments for population aged 15+, proportion of the population aged 15+ who are unemployed, proportion of the population considered low-income, and proportion of households living in dwellings that are in need of major repair³². Neighbourhood deprivation is measured as an ordinal variable, ranked from 1 (least deprived) to 5 (most deprived). Each quintile group contains one fifth of the geographic units; if an area has a value of 5 on the material deprivation scale, it means it is in the most deprived 20 percent of areas in Ontario. The quintiles were created province-wide to enable comparability across the province³².

Outcome measure

Using linked health administrative records, the study outcome was any Ontario fatal or non-fatal SRB that resulted in hospitalisation or an emergency department visit from January 2007 to December 2017. To capture all fatal and non-fatal SRB events, SRB-related ICD-10 codes were extracted from the following databases: NACRS, DAD, OMHRS, and CVSD. Identification of relevant diagnostic codes was based on the definition of self-harm and suicide from the Canadian Institute of Health Information (CIHI)⁹² with International Classification of Diseases version 10 (ICD-10) codes: X60-X84 (intentional self-harm), Y10-Y34 (undetermined injuries), and Y87.0 (sequelae of intentional self-harm).

Control variables

The following individual-level variables will be included in the models: 1) sex (male or female), 2) age (continuous), 3) ethnicity (white vs. non-white), 4) marital status (single, married/common-law, divorced/widowed), 5) chronic physical conditions, and 6) educational attainment (no high school, high school, post-secondary, post-graduate). The Chronic Condition Indicator identifies chronic conditions including malignant cancer, diabetes, obesity, and hypertension, and was developed for use by the US Department of Health and Human Services⁹³. Two area-level variables were also included in the models: 1) rurality (rural or urban by postal code), and 2) LGB density. For LGB density, the weighted proportion of sexual minorities by municipality (proxied by Census subdivision⁹⁴) is calculated for each CCHS cycle.

Statistical analysis

For the regression models, discrete-time survival analysis was used to assess the association between sexual minority status and SRB, and whether there is any modification by area-level material deprivation. The analysis models compared the probabilities of experiencing an SRB event vs. not experiencing an SRB event for each person year in the study, to estimate the likelihood of having an SRB event, and examine the risk associated with the included covariates. Among the strengths of the analysis, discrete-time models are useful in studying rare events⁹⁵, including SRB⁹⁶. We used discrete-time survival analysis since our main focus (neighbourhood deprivation) was measured on an annual basis, and to allow for area-level covariates of participants to be able to change based on residential moves and census geography

changes, as the discrete analysis is better suited to include time-varying predictors using a person-year dataset compared to the more commonly used survival analysis, the cox hazards regression model⁹⁷. Discrete-time survival analysis can be modelled through logistic regression model fit to person-year data, where the log-odds of SRB are estimated at each time point for each participant based on the predictors⁹⁸.

In each person-year, participants are coded as either 1 (if they had an SRB event) or 0 (if they did not have an SRB event). If the event is fatal, then they are removed from the dataset in the following years. In the case of non-fatal SRB events, the participant will continue to be observed for further SRB events in subsequent years. Two models are presented, stratified by sex. Accounting for the previously mentioned covariates, the direct effects of material deprivation and sexual minority status on SRB were estimated separately for males and females. In addition, an interaction between material deprivation and sexual minority status was tested. Statistics Canada provides survey weights with the CCHS, which will be applied to for generalizability of the results to the Ontario population. Statistical analyses will be conducted using SAS 9.4 (SAS Institute Incorporated, Cary, NC, USA), and 95% confidence intervals with two-tailed tests will be used.

Treatment of missing data

There are a few reasons loss to follow-up is not a major concern for this study. When CCHS participants agree to linkage of health records, all ED visits and hospitalizations are captured from 2007-2017 using Ontario's complete administrative databases. Additionally, those who die or relocate to another province/country are censored. The level of missingness for the covariates are shown in Table 1 weighted sample characteristics. Individuals who did not state or did not know their sexual orientation were included as a separate category, "don't know/not stated", in our models. In the models, any missingness in covariates is included as a separate level to avoid loss of SRB events. Potential bias in the standard errors was accounted for through applying maximum likelihood bootstrapping with 500 replicates, which has been shown to perform similar to multiple imputations in reducing bias due to data missingness⁹⁹.

RESULTS

Baseline Characteristics

All results are reported with the CCHS survey weights applied. The baseline characteristics of the sample, stratified by sexual minority status are included in Table 1, which shows that the weighted sample consists of 8,778,120 individuals, and a total of 89,646,760 person-years. In total there were 113,865 SRB events: there were 7,235 events among sexual minorities and 101,685 events among heterosexuals. In total, approximately 4% of SRB events were fatal; however, due to privacy concerns with small cell sizes, we are unable to provide further breakdown of these events by sex, sexual minority status, and neighbourhood deprivation levels. Sexual minorities make up about 2.3% of the sample and were younger than heterosexuals (mean age for sexual minority individuals 38.1 vs. mean age heterosexual individuals 42.1). Sexual minorities were less likely to be visible minorities (23.4% vs. 28.6%) and sexual minorities were more likely to be single (55.6% vs. 27.1%). With regards to residential context, there were more sexual minorities living in urban areas (90.8% vs. 86.4%), and more sexual minorities living in deprived neighbourhoods (17.4% vs. 13.9% in the most deprived neighbourhoods).

Table 1: Weighted Sample Characteristics

	Heterosexual n (%)	Sexual minority n (%)	Other n (%)	Refused/not stated n (%)	Overall n (%)
Number of persons	8,298,770	209,880	46,425	223,045	8,778,120
Number of SRB events	101,685	7,235	1,320	3,630	113,865
Total number of person-years	84,863,110	2,047,950	460,860	2,274,850	89,646,760
Mean age as of 2007 (standard deviation)	42.12 (0.02)	38.13 (0.61)	47.79 (2.05)	51.69 (0.51)	42.3 (0.02)
Sex					
Male	4,074,210 (49.1%)	103,480 (49.3%)	1,7630 (38.0%)	114,145 (51.2%)	4,309,465
Female	4,224,560 (50.9%)	106,400 (50.7%)	28,795 (62.0%)	108,900 (48.8%)	4,468,655
Educational attainment					
No highschool	736,745 (8.9%)	15,130 (7.2%)	8,500 (18.3%)	57,180 (25.6%)	817,550 (9.3%)
Highschool	215,8755 (26.0%)	55,530 (26.5%)	14,810 (31.9%)	68,570 (30.7%)	2,297,660 (26.2%)
Post-secondary	4,533,415 (54.6%)	112,615 (53.7%)	17,800 (38.3%)	73,870 (33.1%)	47,37,695 (54.0%)
Post-graduate	80,1165 (9.7%)	25,235 (12.0%)	2,040 (4.4%)	12,110 (5.4%)	840,545 (9.6%)
Missing	68,695 (0.8%)	1,375 (0.7%)	3,280 (7.1%)	11,315 (5.1%)	84,665 (1.0%)

Ethnoracial status					
Non-White	2,369,435 (28.6%)	491,000 (23.4%)	20,765 (44.7%)	79,110 (35.5%)	2,518,410 (28.7%)
White	5,893,380 (71.0%)	159,705 (76.1%)	20,710 (44.6%)	133,485 (59.8%)	6,207,280 (70.7%)
Missing	35,955 (0.4%)	1,075 (0.5%)	4,950 (1.07%)	10,450 (4.7%)	52,430 (0.6%)
Marital status					
Single	2,250,785 (27.1%)	116,800 (55.6%)	13,775 (29.7%)	71,275 (32.0%)	2,452,635 (27.9%)
Married	5,225,820 (63.0%)	76,620 (36.5%)	24,780 (53.4%)	124,330 (55.7%)	5,451,545 (62.1%)
Divorce/widowed	812,450 (9.8%)	16,170 (7.7%)	7,635 (16.4%)	27,165 (12.2%)	863,420 (9.8%)
Missing	9,715 (0.1%)	295 (0.1%)	235 (0.5%)	275 (0.1%)	10,520 (0.1%)
Chronic physical conditions (at least one or more)	751,470 (9.1%)	17,980 (8.6%)	5,005 (10.8%)	32,630 (14.6%)	807,085 (9.2%)
Proportion of LGB in census subdivision (SD)	0.030	0.034	0.032	0.032	0.030
Rurality					
Urban	7,173,255 (86.4%)	190,490 (90.8%)	42,145 (90.8%)	198,165 (88.8%)	7,604,055 (86.6%)
Rural	1,125,515 (13.6%)	19,390 (9.2%)	4,280 (9.2%)	24,875 (11.2%)	1,174,060 (13.4%)
Material deprivation					
1 (Lowest)	2,155,040 (26.0%)	52,050 (24.8%)	9,280 (20.0%)	50,055 (22.4%)	2,266,430 (25.8%)
2	1,808,955 (21.8%)	43,210 (20.6%)	9,675 (20.8%)	48,595 (21.8%)	1,910,435 (21.8%)
3	1,720,615 (20.7%)	36,770 (17.5%)	10,220 (22.0%)	47,260 (21.2%)	1,814,865 (20.7%)
4	1,368,160 (16.5%)	39,635 (18.9%)	7,275 (15.7%)	40,335 (18.1%)	1,455,405 (16.6%)
5 (Highest)	1,153,480 (13.9%)	36,430 (17.4%)	9,455 (20.4%)	35,475 (15.9%)	1,234,835 (14.1%)
Missing	92,525 (1.1%)	1,780 (0.8%)	515 (1.1%)	1,325 (0.6%)	96,145 (1.1%)

Table 2 presents the age-adjusted incidence rates of SRB per 100,000 person-years across the neighbourhood-deprivation quintiles from 2007-2017, stratified by sex. The table indicates that rates of SRB in male and female sexual minorities are consistently higher than heterosexuals, regardless of the level of neighbourhood deprivation. The relationship between neighbourhood deprivation and SRB approaches linearity for heterosexuals, where the lowest SRB rates are seen in the least deprived neighbourhoods, and the highest rates are in the most deprived neighbourhoods. On the other hand, in the case of sexual minorities, the relationship appears to not be linear, where the highest SRB rates are seen in the middle quintiles of

neighbourhood deprivation (i.e. Q2 for sexual minority males and Q3 for sexual minority females).

Table 2: Age-adjusted incidence rates of SRB across levels of neighbourhood deprivation (per 100,000 person-years) from 2007-2017, stratified by sex

	Male		Female	
	Heterosexual SRB per 100,000 person-years (95% CI)	Sexual minority SRB per 100,000 person-years (95% CI)	Heterosexual SRB per 100,000 person-years (95% CI)	Sexual minority SRB per 100,000 person-years (95% CI)
Neighbourhood deprivation				
Q1 (least deprived)	66 (65 to 68)	133 (116 to 149)	103 (101 to 105)	174 (158 to 189)
Q2	60 (58 to 61)	347 (324 to 369)	120 (118 to 123)	156 (143 to 169)
Q3	68 (66 to 69)	186 (168 to 205)	110 (107 to 112)	446 (414 to 479)
Q4	121 (119 to 123)	288 (363 to 413)	124 (121 to 126)	322 (301 to 342)
Q5 (most deprived)	165 (162 to 168)	252 (232 to 272)	177 (174 to 180)	329 (312 to 347)

Table 3 presents the hazard odds ratios (HOR) for the fully adjusted models. The models indicate that sexual minority females had more than double the odds of SRB compared to their heterosexual counterparts (HOR: 2.149, 95% CI 1.545 to 2.989), and the odds of SRB in sexual minority males is almost three times as that of heterosexual males (HOR: 2.796, 95% CI 1.659 to 4.712). ‘Other’ (don’t know response to sexual orientation question) males had over three times higher odds of SRB compared heterosexual males (HOR: 3.704, 95% CI 1.716 to 7.996), while the risk for ‘other’ females was not different from the reference group.

The model results suggest that neighbourhood deprivation was associated with higher odds of SRB, with some evidence for dose-response effects where increased SRB risk were seen in higher levels of deprivation. For males, compared to those in the least deprived neighbourhoods (Q1), those in Q4 had 1.84 times higher odds of SRB (95% CI 1.223 to 2.872), and those in the most deprived neighbourhoods (Q5) had 2.01 times higher odds (95% CI 1.380 to 2.929). Also, females in Q5 had 1.7 times higher odds of SRB (95% CI 1.282 to 2.400). Additional models were conducted that included interaction terms between sexual minority status and neighbourhood deprivation; however, there was no evidence that the effect of

neighbourhood deprivation differed across sexual orientations. Separate models (for males and females) with these interactions were also conducted with neighbourhood deprivation set as continuous variable, but there was also no evidence for effect modification.

Table 3: Hazard odds ratio for the risk of SRB across sexual orientation and neighbourhood deprivation, stratified by sex

	Model 1: Males		Model 2: Females	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Sexual Orientation				
Heterosexual (ref)	reference		reference	
Sexual minority	2.796 (1.659 to 4.712)	0.0001	2.149 (1.545 to 2.989)	<0.0001
Other	3.704 (1.716 to 7.996)	0.0009	0.892 (0.324 to 2.456)	0.8252
Neighbourhood deprivation				
Q1 (least deprived)	reference		reference	
Q2	1.097 (0.734 to 1.641)	0.6507	1.345 (0.903 to 2.002)	0.1448
Q3	1.036 (0.708 to 1.516)	0.8550	1.130 (0.829 to 1.541)	0.4389
Q4	1.874 (1.223 to 2.872)	0.0039	1.299 (0.940 to 1.795)	0.1125
Q5 (most deprived)	2.010 (1.380 to 2.929)	0.0003	1.754 (1.282 to 2.400)	0.0004
Ethnicity				
White	reference		reference	
Non-white	0.887 (0.610 to 1.290)	0.5300	1.014 (0.748 to 1.375)	0.9286
Educational attainment				
Post-graduate	reference		reference	
Post-secondary	1.232 (0.576 to 2.638)	0.5906	1.316 (0.645 to 2.687)	0.4508
Highschool	1.522 (0.737 to 3.144)	0.2567	1.706 (0.840 to 3.465)	0.1396
No highschool	3.158 (1.501 to 6.646)	0.0025	2.466 (1.202 to 5.059)	0.0138
Marital status				
Married	reference		reference	
Single	1.641 (1.222 to 2.203)	0.0010	1.706 (1.317 to 2.209)	<0.0001
Divorced/widowed	2.371 (1.619 to 3.473)	<0.0001	1.727 (1.328 to 2.246)	<0.0001
Chronic physical conditions				
None	reference		reference	
At least 1 chronic condition	2.098 (1.424 to 3.091)	0.0002	2.354 (1.521 to 3.643)	0.0001
LGB Density	0.888 (0.149 to 5.272)	0.8959	0.235 (0.069 to 0.803)	0.0209
Rurality				
Urban	reference		reference	
Rural	0.913 (0.731 to 1.141)	0.4247	1.049 (0.842 to 1.307)	0.6689

DISCUSSION

This study provides evidence that sexual minorities have a greater likelihood of SRB compared to heterosexuals. However, ‘other’ males exhibited elevated risk of SRB (even higher than sexual minority males), while the SRB risk in ‘other’ females was like those in heterosexual females. Further research is needed to unpack and disaggregate the ‘other’ category, which may have different meanings to males and females (or may identify with them for different reasons).

The effect of neighbourhood deprivation on SRB risk was observed in sexual minority and heterosexual males and females; however, the effect of neighbourhood deprivation was not modified by sexual minority status after multivariate adjustment. While the minority stress model points to the potential for effects of socio-environmental exposures to be amplified for sexual minorities^{21,71}, our evidence suggests neighbourhood deprivation effects on SRB risk may be similar between heterosexuals and sexual minorities. Despite research showing that residents of deprived neighbourhoods may be less tolerant of same-sex relationships (compared to non-deprived neighbourhoods) in the Scottish context^{12,82}, this did not translate into heightened SRB risk in LGB residents in deprived neighbourhoods in our study. This may be due to national and cultural differences, or effect modification may only be observed in non-SRB mental health outcomes (e.g., depressive symptoms, stress, etc.), the latter of which should be tested in future research.

This paper uniquely contributes to the literature on sexual minority suicidality by providing high quality evidence through a large population-representative sample, using clinical SRB-outcomes. While prior studies have relied only on self-reported SRB outcomes, our use of clinical SRB-outcomes has the benefits of reducing the risk of selection bias (i.e. avoids loss to follow-up due to death) and response bias. Moreover, this study shows, for the first time, that at each level of neighbourhood level socio-economic status, sexual minorities had consistently higher risk of SRB compared to heterosexuals. In other words, sexual minorities are more at risk of SRB no matter where they are living. Our results also indicate there are more sexual minorities living in the most deprived neighbourhoods (17.4%) compared to heterosexuals (13.9%), which means that even while there is no effect modification (between sexual minority status and neighbourhood deprivation), a higher-than-expected number of sexual minorities experience these dual stressors simultaneously, which would subsequently increase the overall risk of SRB in the sexual minority group.

Our findings contribute to the existing literature by showing that elevated risk associated with sexual minority status is observed in clinical SRB outcomes, at levels in line with self-reported SRB outcomes, which validates the SRB disparity across sexual orientation found in prior studies. Compared to the elevated odds of SRB among sexual minorities in our study (2.8 times in males and 2.1 times in females), a meta-analysis of population-based longitudinal studies using self-reported outcomes found that sexual minority males had 2.21 times the odds of suicide attempts compared to heterosexual males, and sexual minority females had 1.97 times the odds of suicide attempts compared to heterosexual females⁹⁹. The similarity of our results with prior studies of self-reported SRB may be due to the low number of fatal SRB events, which accounted for only 4% of all events in our sample.

Although there have been increasing rights and social acceptance for sexual minorities over the last 2 decades³¹, there is evidence that minority stress continues to negatively impact the health of sexual minorities in Canada. This may not be a surprise, considering that after the study period, the 2018 Survey on Safety in Public and Private Spaces in Canada, that sexual minority Canadians were twice as likely as heterosexual Canadians to have reported facing harassment in public (57% vs. 22%), online (37% vs. 15%) or at work (44% vs. 22%) over the previous 12 months¹⁰⁰. These numbers are an indication that there is still a need for improvement in social conditions that effect the experiences of sexual minorities. Additionally, our findings of a difference in SRB by sexual orientation are logical following population reports that indicate more sexual minorities have poor mental health compared to heterosexuals (32% vs. 11%), are more likely to be diagnosed with a mood or anxiety disorder (41% vs. 16%), and have seriously contemplated suicide in their lifetimes (40% versus 15%)¹⁰⁰. There is an urgent need to improve and promote positive mental health and wellbeing among sexual minorities; for example, supportive family, workplace, and neighbourhood environments have all been suggested to improve wellbeing of sexual minorities in Ontario¹⁰¹.

Policy changes are required to provide for more culturally informed, inclusive training, of healthcare practitioners to be able to assess for suicide risk and suicidal ideation in sexual minority patients. Local health organisations can work with relevant local resources such as Rainbow Health Ontario (RHO), which is a provincial organisation that seeks to promote the health of Ontario's LGBTQ communities¹⁰². For example, RHO provides online education and training courses for healthcare providers to increase their clinical and cultural competency to

care for sexual minority populations and develop and evaluate clinical best practices to screen for SRB in sexual minority population^{103,104}. Furthermore, specific interventions are needed, and one review found 44 interventions in the literature that have been implemented in various contexts to reduce sexual minority stress and its consequences¹⁰⁵; examples of the interventions include anti-bullying school district policies, state-level same-sex marriage laws, training for healthcare providers in working with older LGB adults, and cognitive-behavioural therapy for sexual minorities. These interventions should be considered and evaluated with SRB as an outcome in the North American context. Further research on these interventions may be helpful in finding effective strategies to mitigate the higher risk of SRB that currently exists among sexual minorities.

Neighbourhood deprivation and SRB

Our results show that individuals in the most deprived neighbourhoods had greater likelihood of SRB compared to the least deprived neighbourhoods. These results were like another study that used the same measure of neighbourhood deprivation and was conducted in the same province (i.e., Ontario), which gives us confidence in the validity of our results and reliability of the findings. Using ON-Marg index of deprivation, the study found that males aged 25 to 44 living in the most deprived neighbourhoods had 1.9 times the risk of suicide relative to males in the least deprived neighbourhoods⁵², which is similar to our results (OR: 2.01, or 1.98 when converted to relative risk). For females ages 25 to 44 in the most deprived neighbourhoods, the risk was 1.9 times (compared to OR: 1.75, or 1.74 when converted to relative risk in our study). To compare to international literature, a study based on 15 cities in Europe found inconsistent associations between neighbourhood deprivation and suicide mortality¹⁰⁶. While our results are comparable to cities such as Stockholm, Prague, and Bratislava, where males from the most deprived areas had 1.12 to 1.22 times higher risk (with 1.19 to 1.54 times the risk for females), the association was not observed in other cities such as London and Amsterdam. The authors of the previous study attribute the inconsistent results to cultural/micro-economic differences and methodological differences in the way data was collected across countries. However, it should be noted that this study did not include adjustments for individual level SES, which likely confound (at least partially) the relationship between area-level deprivation and suicidality.

Results appear to be more consistent in multilevel studies, which found moderate associations between neighbourhood deprivation and SRB. For example, a study in Stockholm found a significant effect of neighbourhood deprivation on suicide attempts, with 1.11 times increased odds for each unit increase of deprivation (deprivation was measured as a continuous scale): the authors concluded that neighbourhood-level deprivation seems to have an independent effect on suicidality beyond the impact of individual characteristics⁷. In a New Zealand study, residents from the most deprived neighbourhoods had 1.42 times greater risk of suicide after controlling for individual-level socioeconomic status; however, they did not provide gender stratified results that are conventional in similar studies¹⁰⁷.

Our study shows that neighbourhood deprivation may contribute to SRB risk. However, other issues such as growing housing shortage, inflation, and growing income inequality may exacerbate the impact of neighbourhood deprivation on SRB (i.e. small businesses may close due to increased costs and growing housing cost may further drive residential segregation), since causes of neighbourhood deprivation are rooted in and driven by complex historical and macro-economic forces¹⁰⁸. Upstream, intersectoral, and population-based solutions will be required to improve neighbourhood conditions, and in turn, help reduce SRB risk^{109,110}. Interventions may focus specifically on improving neighbourhood opportunity structure (employment, education, living conditions, etc.)⁵¹; for example one suggestion has been focusing on developing regional labour markets through better connected and more affordable transportation networks so they can be connected to employment opportunities and services¹¹¹. Neighbourhood revitalization has also been suggested to address neighbourhood deprivation. For example, Regent Park public housing redevelopment in Toronto, Ontario is the first large-scale mixed-tenure redevelopment of a public housing community in Canada, that began in 2005 and is ongoing with plans until 2023^{112,113}. Qualitative research suggests that the project has improved the external appearance of the neighbourhood, and perceptions of crime and safety in the neighbourhood; the same research suggests that there is a stark difference in residential satisfaction between condominium and public housing residents in maintenance of their respective buildings¹¹³, and by 2014, the continued stigmatisation of the neighbourhood was also noted¹¹⁴. Furthermore, existing research on such neighbourhood revitalization efforts focuses on perceptions in the community, and so there is a need to investigate its impact on SRB.

More recent studies suggest that place-based interventions may not be sufficient to address the problems associated with neighbourhood deprivation but may be more effectively addressed through broader social policies¹¹⁵. For example, one critique of socially mixed public housing redevelopment is that it does not directly address the causes of advanced marginalisation and enduring inequities that have daily impacts on the lives of individuals in deprived areas¹¹⁴; moreover, not all deprived areas across the country will be suitable to be targeted for redevelopment. Future research can examine effects of macro-economic policies, such as universal income¹¹⁶ to tackle inequalities in SRB risk.

Limitations and strengths

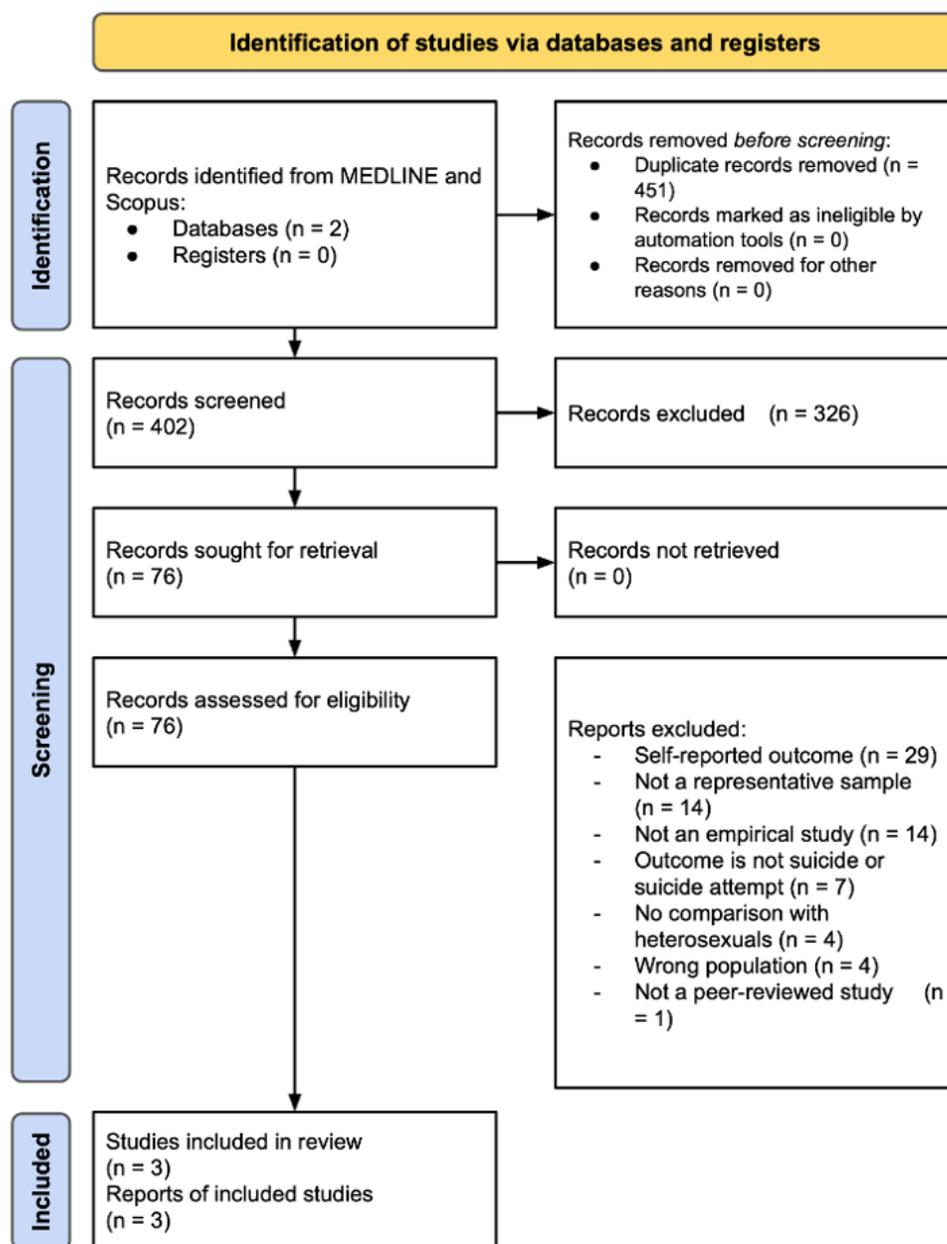
There are some limitations that need to be considered. First, the CCHS provides options for selecting a response to the questions concerning sexual orientation that do not capture sexual minorities other than lesbian, gay, or bisexual individuals (e.g., pansexual, asexual, etc.). In addition, due to the rare outcome and to ensure adequate sample size for each group, sexual minorities (lesbian, gay, and bisexuals individuals) were grouped together, which prevented detecting any nuances or differences between these groups (although previous literature found that the directions of risk of attempted suicide are consistent between homosexual and bisexual groups¹¹⁷). The administrative data used for the SRB outcomes can be considered a limitation in that more minor SRB events that were not presented to hospitals in Ontario were not captured. Minor events especially in areas with poor healthcare services may be under-represented (e.g., rural residents who had an SRB incident may be less likely to visit the emergency department compared to urban residents, especially if they are more physically isolated or their local hospital is understaffed); however, we included a rurality indicator to partially account for this potential confounder. Additionally, any individuals who moved out of the province were not included in the full study period due to differences in administrative record keeping between provinces. Lastly, this study only used the ON-Marg measure of neighbourhood deprivation even though there are other measures of neighbourhood deprivation. However, the ON-Marg index is widely used (which improves its comparability with prior studies), and considers multiple measures of socio-economic indicators of deprivation based on the Canadian census, which offer the most reliable socio-economic data of Canadians³². Strengths of the study include the use of longitudinal, population-representative, clinical data with a large sample. Additionally, including

both fatal and non-fatal SRB events allows for an estimate of the most severe forms of SRB that use healthcare resources in Ontario. Finally, our study contributes to the literature on neighbourhood deprivation effects on SRB by examining potential effect modification via sexual orientation.

CONCLUSION

Both sexual minority status and neighbourhood deprivation independently contribute to an increased risk of SRB. Further investigation may consider neighbourhood effects when examining sexual orientation and SRB to better understand these issues. More research is needed 1) to evaluate interventions aimed at addressing the sexual minority SRB disparity, and 2) to evaluate the efficacy of specific interventions such as neighbourhood revitalization, and other policy changes that would ameliorate the effects of neighbourhood deprivation on SRB for both sexual minorities and the general population.

Figure 1: PRISMA flow diagram and search terms for literature search



Search terms of: ("lesbian" OR "gay" OR "bisexual" OR "sex" OR "minorit*" OR "orientation" OR "homosexual" OR "sex* identity") AND ("suicid*" OR "self?harm") AND ("administrative" OR "medical?records" OR "hospital-based" OR "clinical" OR "emergency" OR "ED" OR "acute care") for the period January 1995 to December 2021.

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