

**Disparities in Mental Health, Physical Health, and Substance Use Across Sexual
Orientations in Adults**

Zachary Bellows

Applied Health Sciences

Submitted in fulfilment of the requirements for the degree of

Master of Science

Faculty of Health Sciences, Brock University

St. Catharines, Ontario

© Zachary Bellows 2024

Abstract:

Background

Studying disparities across sexual orientations is important for the design and implementation of public health interventions to improve health in lesbian, gay, and bisexual (LGB) individuals. While prior studies have shown LGB individuals have elevated risk of poor mental health, poor physical health, and substance use, existing study designs may be improved by using representative samples, wider ranges of health outcomes, heterosexual comparison groups, and disaggregated data. The goal of this study is to provide estimates of multiple health disparities across sexual orientations in Canada based on these principles.

Methods

Using data from 2009-2014 Canadian Community Health Surveys, a sample of 19,980,000 weighted individuals was created. Outcomes included mental health, physical health, binge drinking, illicit drug use, and cannabis use. The study used cross-tabulations and logistic regression models, stratified by sex, to estimate health disparities across sexual orientations. The design of the study is based on pooled cross-sectional analyses. Ten controls, including year of birth, marital status, and income, were included in the fully-adjusted regression models.

Results

Among LGB individuals, there was evidence for elevated risk of poor mental health (i.e. gay men, bisexual men, bisexual women), poor physical health (i.e. bisexual men, bisexual women), binge drinking (i.e. lesbians, bisexual women), illicit drug use (i.e. lesbians, bisexual women), and cannabis use (i.e. lesbians, bisexual women) relative to their heterosexual counterparts. Those identifying as 'don't know' or 'refuse' showed reduced odds of substance use. Bisexual women exhibited highest disparities in health outcomes, e.g. OR=3.3, 95% 2.58 - 4.22 for poor mental health. Trends over time showed worsening mental health among bisexual women

(relative to changes in heterosexual women), and decreasing substance use in gay and bisexual men, and lesbians.

Conclusion

This study highlights health disparities across sexual orientations in Canada, especially bisexual women, calling for targeted interventions (e.g. increased training of service providers in working with bisexual women and community outreach against biphobia). Future research should aim to explore these disparities longitudinally while also including the use of administrative-linked health data to reduce potential bias in self-reported data.

Table of Contents:

Abstract	
List of Tables	
List of Figures	
Introduction	1
Prior literature and the minority stress model	1
Gaps in literature	3
Testing the minority stress theory using a narrow set of health outcomes	3
Limitations of convenience samples	4
Missing heterosexual comparison group	5
Issues with no disaggregation across sexual minority groups	6
Study objectives	9
Methods	10
Study participants	10
Research ethics	11
Sex and sexual orientation	12
Outcome variables	12
Control variables	14

Statistical analysis	14
Results	15
Discussion	26
Substance use in sexual minority women.....	27
Substance use in 'don't know' and 'refuse' individuals.....	28
Mental and physical health in sexual minority individuals.....	29
Changes in disparities over time (2009-2014)	30
Limitations and strengths.....	31
Implications.....	32
Conclusion	34
Bibliography	35
Appendix A	45
Appendix B	47
Appendix C	48
Appendix D	50

List of Tables:

Table 1: Descriptive Statistics by Sexual Orientation: Mental and Physical Health, Substance Use, Demographics, and Socioeconomic Indicators from the Canadian Community Health Survey across 2009-2014 **15**

Table 2: Male adjusted and unadjusted odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians..... **17**

Table 3: Female adjusted and unadjusted odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians..... **18**

Table 4. Results for Mann-Kendall Trend Test across poor mental health, poor physical health, binge drinks, illicit drug use, and cannabis use across sex and sexual orientation for Canadians from 2009-2014 **26**

Table A1. Prior studies with their similar corresponding control variables for each health outcome **45**

Table B1. Weighted number of item non-response (including don't know and refused) for all variables **47**

Table D1. Male poisson risk ratios and unimputed odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians **50**

Table D2. Female poisson risk ratios and unimputed odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians **51**

List of Figures:

Figure 1. Odds ratio disparity over time for poor mental health outcome for males 2009-2014	21
Figure 2. Odds ratio disparity over time for poor mental health for females 2009-2014..	21
Figure 3. Odds ratio disparity over time for poor physical health for males 2009-2014..	22
Figure 4. Odds ratio disparity over time for poor physical health for females 2009-2014	22
Figure 5. Odds ratio disparity over time for binge drinking for males 2009-2014..	23
Figure 6. Odds ratio disparity over time for binge drinking for females 2009-2014	23
Figure 7. Odds ratio disparity over time for illicit drug use for males 2009-2014	24
Figure 8. Odds ratio disparity over time for illicit drug use for females 2009-2014..	24
Figure 9. Odds ratio disparity over time for cannabis use for males 2009-2014	25
Figure 10. Odds ratio disparity over time for cannabis use for females 2009-2014	25
Figure A1. Directed Acyclic Graph Depicting Potential Relationships Between Exposures and Health Outcomes	46

Introduction:

Promoting health equity in marginalised communities is a fundamental objective of public health; however, to address these disparities effectively, it is crucial to understand their magnitude. The purpose of this study is to provide an estimate of health disparities across sexual orientations with regards to mental health, physical health, alcohol consumption, and substance use (illicit drug use and cannabis use). Many epidemiological studies often focus on a single health or disease outcome, yet stressors associated with being a lesbian, gay, or bisexual (LGB) individual may lead to a generalised health impact that cannot be adequately captured using only a single health outcome (1). While single disease/outcome studies have contributed insights into specific health issues faced by LGB individuals, stressors associated with being LGB can have wide-ranging effects on various aspects of health, e.g. experiences of discrimination or social stigma may not only affect risk of mental health disparities, but also lead to increased substance use and physical health problems (2). By examining these outcomes together, we can identify the broader health impact experienced by LGB individuals, beyond isolated disease-specific studies.

In the following, we will 1) discuss the minority stress model which has been used as the primary explanatory model for disparities in health across sexual orientations (3), 2) highlight some methodological issues in quantitative studies of sexual minority health, and 3) present our aim to more comprehensively assess health differences across sexual orientations.

Prior literature and the minority stress model

The minority stress model posits that belonging to a minority group inherently presents unique social and environmental circumstances, leading to elevated stress responses and adverse health outcomes(4,5). This model was proposed by Meyer(2) to explain health disparities experienced by minorities across varying strata of social advantage and disadvantage, such as race(6), gender(7), and sexual orientation(8). With regards to health

disparities across sexual orientation, the model specifically highlights how clashes with heteronormative culture can engender environments where sexual minorities face distinctive stressors. These include, but are not limited to, the internalisation of negative societal attitudes, anticipation of rejection, and experiences of discrimination(9), which can damage the mental and physical health of sexual minorities in various ways. For example, studies have shown that the chronic stress experienced by sexual minorities can have a negative impact on mental health, with the risk of depression and anxiety ranging from 1.26 to 2.52 times higher compared to their heterosexual counterparts(10). In addition, sexual minority status has been linked to a range of physical health outcomes, including hypertension, cardiovascular disease, and diabetes(11), along with higher allostatic load (i.e accumulation of physiological wear and tear) in bisexual men, but not in gay men(12). Further studies have indicated that some LGB individuals were up to three times as likely to report worse self-rated physical health as well as more physical health symptoms (e.g., pain, insomnia,intestinal problems) and conditions (e.g., diabetes, asthma, high blood pressure) when compared to heterosexuals(13). One systematic review completed in 2019 studying the relationship between minority stress and biological outcomes found that 81% of included studies had at least one analysis that documented an association between minority stress and a physical health disorder(3).

The minority stress model also suggests that substance use may be a coping strategy to deal with minority stressors(2). For example, one study which pooled data from the 2007 to the 2012 CCHS sought after the co-occurrence of heavy drinking and anxiety/mood disorders among LGB individuals compared to their heterosexual counterparts(14). This study found that the rates of anxiety based disorders, mood based disorders, and anxiety-mood based disorders were elevated across all LGB groups while the odds for having a co-occurring anxiety or mood disorder and heavy drinking (described in this study as five or more drinks in one occasion) were 2.0 times higher among gay/lesbian individuals and 3.3 times higher in bisexual individuals, when compared to their heterosexual counterparts. Further evidence of substance

use, such as with illicit drugs, has been found to be up to 6.97 times more likely among some sexual minority communities in the USA relative to heterosexual individuals(15).

Respondent-driven sampling in Canada has also shown that the burden of substance use among gay and bisexuals is high relative to the general population in Vancouver, with 24% of all gay or bisexual men surveyed currently receiving treatment for a mental health or substance-use disorder(16). Substance use for bisexuals in Ontario is also heightened, where a study found that the prevalence rate of problem drinking and polydrug use among the group was 31.2% and 30.5% respectively, versus 19% and 2.4% in the general population(17). A 2021 review on social vulnerabilities for substance use suggested that social stressors such as early/ongoing exposure to discrimination was a major social risk factor (often faced by sexual minorities) for substance use disorder, which may explain the unique vulnerability to substance use in this group(18).

Gaps in literature:

In the following, we will highlight a number of specific gaps/problems in the literature that we aim to address in our study: 1) testing the minority stress theory with a narrow set of health outcomes, 2) limitations of convenience samples , 3) missing heterosexual comparison group, and 4) the lack of appropriate disaggregation across sexual orientation groups.

Testing the minority stress theory using a narrow set of health outcomes

White et al. argue the traditional explanatory models used in epidemiology studies are often “disease specific”, identifying risk factors for specific health conditions (1); however, social exposures (e.g. the impact of poverty or discrimination) may have a more generalised and cumulative health impact rather than being specific to one illness, and the focus on a single disease/condition may not adequately capture the generalised impact of the social exposure on overall health(19). The practice of disease-specific epidemiological investigations is also

common among studies of sexual minority health, with many prior studies examining disparities across sexual orientation in a narrow range of health outcomes such as substance use(20), mental health(21), and physical health(3). Yet, the mechanism through which minority stress is theorised to impact health outcomes, namely prejudice, discrimination, expectations of rejection, sexual minority identity concealment, self-stigmatisation, and institutionalised heterosexism(2), are not specific to any given disorder or condition and are expected to have a generalised, cumulative health impact. Therefore, studies that focus narrowly on a single disease/disorder, rather than focusing on domains of health (such as mental health or physical health), have been argued by Frost (22), to risk “false null” findings that could imply social disadvantage does not affect the health of sexual minorities. While an argument can be made that the accumulation of single-disease studies can be examined together to provide a domain-level perspective in the case of a literature review (e.g. disparity in mental health across sexual orientation)(23) differences across sample characteristics, timeframes, regions/countries, survey instruments, measurement of covariates, and even how sexual orientation is measured (e.g. focusing on sexual identity vs sexual behaviour) across studies hamper comparability. Therefore, if possible, studies of disparities in health status across sexual orientation would benefit from the examination of a wide range of health outcomes to capture the generalised health impact of minority stress.

Limitations of convenience samples

A number of studies that examined sexual minority health have relied on convenience samples or small, non-representative samples(16,21,24–26). Convenience sampling involves selecting participants based on their availability and ease of recruitment(27), which limits the generalizability of the findings since the characteristics of those who volunteer as participants may systematically differ from non-participants. For example, researchers in 2017 used a sample of 719 Vancouver participants to understand the prevalence of mental health disorders

and substance use in gay and bisexual men(16). They had initially recruited 119 participants in the Greater Vancouver area through community agencies or online through mobile apps and websites used by gay and bisexual men, and subsequently asked each of these initial participants to recruit up to 6 other participants(16). A second study, based in Sudbury and Windsor, Ontario, used a self-identified sample of 531 participants to identify work-related stressors associated with poor mental health and substance use in sexual minorities(21). Primary recruitment strategy was in-person recruitment at Pride and other community events, with postcards advertising the study being distributed by community organisations and unions, and LGBTQ+ support groups, and was supplemented by advertisement on radio, social media websites, and mobile meet-up apps including Grindr and Scruff. While both studies highlighted elevated rates of poor mental health and/or substance use among sexual minorities, these recruitment strategies may lead to a sample who are over-represented by those who are well connected to LGBTQ+ community groups, attend LGBTQ+ events and venues, those who frequently use social media, or meet-up apps. Those who are isolated from the LGBTQ+ community or not out of the closet are less likely to be recruited leading to potential sampling bias(27). Therefore, if people who are isolated have a systematically different health status compared to those who are well-connected, as suggested by prior literature(28) , then prior studies using convenience samples will likely be biased. The use of population-based samples is better equipped to recruit a broader range of sexual minority individuals, such as those who are remote or disconnected with LGBTQ+ community groups since they do not rely on area-specific recruitment strategies or based on social/community networks(29).

Missing heterosexual comparison group

Some previous studies have investigated sexual minority health without including a heterosexual comparison group(16,21,23,30), which makes it difficult to quantify disparities and measure the impact of minority stress, since comparing health outcomes between sexual

minority groups who face minority stress and heterosexual individuals are required to highlight disparity. Using a heterosexual comparison group provides a reference point that allows us to determine the extent of health disparities across sexual orientations.

For example, one study sought to understand the potential effects from the influence of family of origin and chosen family on sleep problems in a sample of 1703 LGB individuals in the United Kingdom(31). Using data from a nationally representative survey, the study found that family support was independently associated with various sleep outcomes among LGB individuals. However, without including heterosexual individuals, the study was unable to explore potentially differing effects between sexual minority and heterosexual groups. Another study, which included 267 lesbian, gay, and gender diverse individuals, made comparisons between these groups regarding the rates of eating disorder, depression, other eating disorder-related variables (e.g. weight-base self worth), and social stigma(32). More specially, the study explored potential mediating relationships such as whether depression mediated the association between social stigma and the risk of eating disorder. However, the lack of a general population comparison group made it difficult to know whether these processes were unique to the LGB population. While these studies helped characterise health problems in sexual minority individuals, the use of comparison groups would help contextualise these health problems (i.e. understand the risk irrespective of sexual minority status) and shed light on the specific challenges faced by LGB individuals. Furthermore, it may improve the identification of sexual minority status as a risk factor in various physical and mental health conditions, which may lead to the development of evidence based interventions by highlighting the need for the development of unique LGB tailored policies/interventions.

Issues with no disaggregation across sexual minority groups

Another gap in the prior literature is the aggregation of lesbian, gay, and bisexual, individuals into a single “LGB” or sexual minority category(33–35), which may be problematic

since it hides important disparities between lesbian, gay, and bisexual individuals. An emerging body of studies provide evidence that there may be increased risk in mental health(10,36), substance use(37,38), and sexual health outcomes(39,40) in bisexual individuals compared to monosexual individuals (i.e. heterosexual, and gay/lesbian). This problem can be illustrated by comparing two studies that estimated the disparities in suicide-related behaviours across sexual orientations using emergency department data in Ontario, Canada(34,36). The first study (n=169,091), which aggregated all sexual minorities into a single group, found that sexual minority men and women had 2.18 times and 2.07 higher odds of suicide-related behaviours respectively compared to their heterosexual counterparts (34), $p < 0.01$. However, a subsequent study that disaggregated gay/lesbian and bisexual and used the same sample (n=123,995)(36), found that while gay men, bisexual men, and lesbians had approximately 2 times higher risk of suicide-related behaviours compared to their heterosexual counterparts ($p < 0.05$), bisexual women had over 3 times the risk ($p < 0.001$), which was not shown in the first study since lesbians and bisexual women were aggregated into a single group.

Two studies on substance use disparities across sexual orientations, both using nationally representative samples of the US, also highlight the importance of disaggregating by sexual orientation(38,41). While the first study found that the sexual minority women were significantly more likely to misuse alcohol, cannabis, and other illicit drugs when compared to the heterosexual group(41), the second study provided further insights, indicating that lesbians did not have significantly higher odds of substance misuse when compared to heterosexual women. However, bisexual women were more likely to misuse alcohol with an odds ratio (OR) of 1.6, more likely to use cannabis with an odds ratio of 3.6, and more likely to use other drugs non-medically with an odds ratio of 2.2 (38). The aggregation of bisexual women and lesbians in the first study led to overestimated risk in lesbians, and underestimated risk in bisexual women. These studies show the importance of separating data across gay/lesbian and bisexual individuals, which allows for the recognition of different circumstances and effects of minority

stress on different sexual minority populations, since bisexual individuals have unique minority stressors including 1) marginalisation by both heterosexual and gay/lesbian communities(42), 2) experience of biphobia and invalidation (e.g. being dismissed or excluded based on prejudice and stereotypes about bisexual individuals)(43), and 3) encounter mistrust and stereotypes (e.g. related to their ability to commit) that affect their relationships and overall well being(44).

Another related issue is that even when a study disaggregates gays/lesbians from bisexuals, men and women may be aggregated into a single group, and gender/sex is typically used as an adjustment variable in these studies(45–47), which can lead to misestimations since there may be significant gender/sex differences within a given sexual orientation (e.g. gay men vs. lesbians). For example, in a study using the National Health and Nutrition Examination Survey that pooled data from 2005-2010, participants were categorised as either heterosexual, lesbian/gay or bisexual for the purposes of their analysis(46). After controlling for gender, age, and education, they found that gays/lesbians had 84% higher odds than heterosexuals to report current smoking. While the direct effect of gender (arguably sex, as gender identity was not ascertained specifically) on smoking is accounted for, it is likely that the disparity between men and women in the general population may be different than the disparity between gay men and lesbian, or between bisexual men and women. While the general US population in 2010 saw a smoking prevalence of 21.5% among men and 17.3% among women, with 4.2% higher in men(48), prior research has found that US-based lesbian women have a prevalence of smoking 6.9% higher compared to gay men. Therefore, by solely controlling for sex as an adjustment variable, without exploring the indirect effect of sex through sexual orientation, these studies may have mistakenly obscured important differences between groups (e.g. gay men vs lesbians). Disaggregating the data by both sexual orientation and sex is likely necessary to capture the nuances that exist within and across these groups accurately. The use of disaggregated analysis by sex can reveal a more complete story by revealing indirect effects of sex across all predictor variables(49), which may be an advantage over the use of an interactive

term of sexual orientation by sex. On the other hand, the use of disaggregated analysis by sex may reduce the statistical power to detect differences across subgroups resulting in a higher chance for type-2 error(50). In a study examining differences in acute health problems, general mental health, total acute physical symptoms, general physical health, and body mass index across gender and sexual orientation(51), the authors noted that the small number of sexual minority participants (i.e. 25 bisexual men, 65 bisexual women, 64 gay men, and 79 lesbian women) likely resulted in their inability to detect gender modifications to the effect of sexual orientation. While disaggregated analysis by sex allows second level sex differences to be revealed across all model covariates, it comes at a cost to statistical power that may be too high for many studies except for large scale population-based samples collected by national statistical bureaus.

Study objectives:

Overall aim: This study aims to investigate health disparities among sexual minorities in Canada using nationally representative data while addressing common pitfalls in sexual minority health research to contribute valuable insights into promoting sexual minority health and further informing healthcare research on health disparities. List of our detailed objectives included 1) investigating the disparity in mental health, physical health, binge drinking, illicit drug use, and cannabis use across sexual orientations; and 2) examining whether the trends in disparities have changed over time between 2009-14.

This study provides valuable information regarding a wide range of health disparities experienced by sexual minorities using nationally representative data while addressing common pitfalls in sexual minority health studies, which will contribute valuable information to help promote sexual minority health in Canada and better inform healthcare resource allocation. The present study contributes to the literature on health disparities across sexual orientations in a few ways. First, while prior studies have often focused on a limited range of health outcomes

following disease-specific epidemiological studies, this study investigated a number of health outcomes including mental health, physical health, binge drinking alcohol, illicit drug use, and cannabis use to provide a more comprehensive picture of the health challenges faced by sexual minorities. Second, unlike prior studies that use a convenience sample, we used data from a nationally representative survey that includes sexual minorities who are disconnected from LGBTQ+ communities or who live in remote areas. Third, while some previous studies lacked a heterosexual comparison group, this study includes a comparison group so that we can investigate the impact of minority stress on LGB health status by comparing them to a heterosexual group that is unlikely to be exposed to these stressors. Finally, by disaggregating lesbian/gay, bisexual, and heterosexual groups, and conducting separate models for men and women (as a response to sex), this study may be able to highlight important differences within the sexual minority population. Using nationally representative data from Canada, our research question asked: What are the disparities in mental health, physical health, binge drinking alcohol, illicit drug use, and cannabis use across sexual orientation?

Methods:

Study participants

The Canadian Community Health Survey (CCHS) is a cross-sectional population-based survey, conducted annually. The CCHS employs a multistage clustered-probability sampling technique, using computer-assisted telephone interview software with respondents capable of participating in the survey using either English or French (52). The sampling frame excludes individuals living on First Nations Reserves and Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of extremely remote regions. This study cohort was created from Canadian participants of six cross-sectional cycles (2009-2014) of the CCHS. Our sample consisted of 19,980,000 weighted individuals aged 18 to 59 at the time of survey completion. Survey weights were used to ensure the CCHS sample represents the population of

Canada(53). In the 2009-2010 survey, the overall person-level response rate was 89.3%(52). Response rates each year saw slight decreases, with 2013-2014 having a person-level response rate of 87.3%(54). The data was accessed through the Statistics Canada Research Data Centre.

Research ethics

The data for this project is provided by Statistics Canada through the Research Data Centre program (<https://www.statcan.gc.ca/eng/microdata/data-centres>). Data from Statistics Canada is protected by law, including the Statistics Acts(55), Privacy Act(56), and Access to Information Act(57). Measures used to protect respondent identities involve data collection and the nature of data files available for access, procedures used to access data, physical protection of data, and control of released data. Statistics Canada employees are responsible for ensuring the security of confidential information. Before data is collected from a respondent, they are informed of the voluntary nature of the survey, and are permitted to refuse to answer any questions, or end the interview at any point.

Data is anonymized and access only took place on a secure desktop on-site at the RDC with no access to the internet. Only outputs vetted by Statistics Canada employees were retained. Data that is made available cannot be connected to an individual or household. Data was not stored or preserved by the researcher at any time. Only Statistics Canada vetted outputs were retained, which eliminates the possibility for privacy concerns. Data was used in accordance with Statistics Canada protocols on data disclosure and personal health information: Statistics Canada's Privacy Policy addresses the secure retention, transfer and disposal of personal health information in both paper and electronic format. Personal health information with direct personal identifiers was retained only temporarily. It was isolated in secure network folders then securely destroyed by a Statistics Canada-approved method such as cross-cut shredding for paper or secure wiping or physical destruction for media and devices.

Statistics Canada also protects personal health information in transit. Protections include an encrypted file transfer system that is used for inbound and outbound electronic file transfers, and a requirement to remove direct personal identifiers before transferring paper. The study has received ethical approval from the Brock University Research Ethics Board (certificate number: 23-125 - CHUM).

Sex and sexual orientation

Participants were asked to indicate their sex as either male or female. As of 2014, the CCHS did not include questions on gender identity. In order to determine sexual orientation, participants were asked, "Do you consider yourself to be...", and were given the following response options: heterosexual, homosexual, bisexual, or 'don't know', or 'refuse to say'. When compared to questionnaires that encompass sexual identity, behaviour, and attraction through a multi-question approach, this single-question approach has been shown to be a reliable measure and has displayed a strong correlation with sexual identity (kappa statistic of 0.89)(58). In previous versions of the CCHS, the single-question method successfully identified 99.3% of participants who identified as a sexual minority based on a comprehensive questionnaire, as well as 84.2% of those who reported engaging in same-sex relationships at any point in their lives(58). In this study, sexual orientation is represented by five categories: heterosexual, gay/lesbian (homosexual), bisexual, 'don't know', and 'refuse to say'.

Outcome variables

Outcomes of this study include mental health, physical health, binge drinking alcohol, illicit drug use, and cannabis use. Each outcome was self-rated and extracted based on responses to the CCHS. Mental health and physical health were self-rated on a 5-point scale (i.e. excellent, very good, good, fair, and poor). A scoping review on the validity of single item self-rated mental health found that ratings of fair and poor self-rated mental health had 4.57 to

9.97 times higher risk of being diagnosed with major depressive disorder(59). Similarly, fair and poor physical self-rated health has been associated with a 2-fold higher mortality risk compared with persons reporting a higher health status(60). Mental health and physical health were dichotomized as: excellent, very good, good, vs. fair, poor for physical and mental health, as prior research has noted collapsing the categorical response into a dichotomous variable of good (and higher) versus less than good led to similar results as using the 5-level outcome (61). Prior studies noted high reliability for the mental health measure ($k=0.80$) (59) and the physical health measure ($k=0.73$) (62).

Cannabis use was determined by its use in the past 12 months, based on a self-reported response to essentially: "During the past 12 months have you used marijuana?". Illicit drug use was determined by a derived drug use variable based on questions asking the participant if they used the following drugs in the past 12 months: cocaine or crack, speed/amphetamines, ecstasy/MDMA (3,4-Methylenedioxy-methamphetamine), hallucinogens, PCP (Phencyclidine), LSD/acid (Lysergic acid diethylamide), sniffing glue, gasoline, other solvents, and heroin. Illicit drug use was dichotomized into using any of the above vs. no use. Binge drinking alcohol was determined by any instance of self-reported binge drinking in the past 12 months, where binge drinking is defined by the CCHS as a male having more than four standard alcoholic drinks in one occasion or a female having more than three standard alcoholic drinks in one occasion (63).

Previous studies have provided validation for self-administered single-item screening questions aimed at detecting unhealthy substance use. These studies indicate that individuals with substance use conditions are at least three times more likely to yield a positive screen and are less than one-third as likely to yield a negative screen (64). Furthermore, the reliability of self-rated substance consumption measures has been demonstrated in prior literature. For instance, the reliability coefficient ($kappa$) for binge drinking alcohol stands at 0.76, while it ranges from 0.72 (for hallucinogens) to 0.76 (for cocaine) for illicit drug use. Additionally, the

reliability coefficient for cannabis use is reported at 0.82 (65). These findings underscore the utility and validity of self-administered screening questions and self-rated substance consumption measures in identifying and assessing unhealthy substance use behaviours.

Control variables

The following variables were used in the models as statistical controls: 1) year of birth (continuous), 2) marital status (married or common law vs. single, separated, divorced, or widowed), 3) educational attainment (achieved at least a post-secondary degree/certificate vs. not), 4) student status (current student vs. not), 5) self-reported ethnic minority status (yes vs. no), 6) employment status (Any work in the last year vs. not), 7) rurality status (yes vs. no) based on prescribed rural postal codes(66), 8) province of residence, 9) year of interview as dummies (2009-2014), and 10) federal income. Federal income in the CCHS is derived (by Statistics Canada) from a variable which distributes respondents into deciles providing a relative measure of their household income to the household incomes of all other respondents by adjusting the ratio of their total household income to the low income cut-off corresponding to their household and community size. Previous studies examining mental health and substance use disparities across sexual orientations have used the same control variables(34,36,67,68), a table showing the prior studies with the corresponding control variables for each outcome is in Appendix A, Table A1. A directed acyclic graph showing the relationship between these control variables and the potential health outcome is shown in Appendix A, Figure A1. The selection of these control variables were driven by prior studies, which is also displayed by the DAG.

Statistical analysis

First, cross-tabulations of sexual orientations and outcomes, along with covariates, are calculated. Second, logistic regression models were used to estimate differences across sexual

orientations in: mental health, physical health, binge drinking alcohol, illicit drug use, and cannabis use. All models were stratified by sex. Unadjusted models and adjusted models were estimated for each outcome. The following sensitivity tests were also performed: 1) models using a modified poisson regression; 2) models using complete case analyses (dropping cases with missing data instead of multiple imputations); and 3) models with interactions between sexual orientation and year of interview to check for potential change over the study period. Multiple imputation by chained equations was used to impute missing values in all covariates. The level of missingness for all variables are shown in Appendix B, *Table B1*. Sample size calculations are available in Appendix C.

Results:

The descriptive statistics of the study participants (weighted $n = 19,980,000$) is detailed in *Table 1*, which includes cross-tabulations between sexual orientation with each outcome and sociodemographic covariates (e.g. age, income, ethnicity, etc.).

Table 1: Descriptive Statistics by Sexual Orientation: Mental and Physical Health, Substance Use, Demographics, and Socioeconomic Indicators from the Canadian Community Health Survey

	Heterosexual	Homosexual	Bisexual	Don't Know	Refuse	Total
Number of Persons	19,122,000	284,000	215,000	59,000	120,000	19,980,000
Poor Physical Health, N (column %)	1,623,000 (8.49%)	28,000 (9.86%)	38,000 (17.67%)	8,000 (13.56%)	18,000 (15.00%)	1,767,000 (8.84%)
Poor Mental Health, N (column %)	1,121,000 (5.86%)	26,000 (9.15%)	44,000 (20.47%)	6,000 (10.17%)	13,000 (10.83%)	1,210,000 (6.06%)
Binge Drank Alcohol¹, mean (column %)	9,527,000 (49.82%)	169,000 (59.51%)	132,000 (61.40%)	11,000 (18.64%)	29,000 (24.17%)	9,906,000 (49.58%)
Illicit Drug Use², N (column %)	962,000 (5.03%)	22,000 (7.75%)	28,000 (13.02%)	1,000 (1.69%)	3,000 (2.50%)	1,016,000 (5.09%)
Cannabis Use³, N (column %)	987,000 (5.16%)	22,000 (7.75%)	28,000 (13.02%)	1,000 (1.69%)	3,000 (2.50%)	1,041,000 (5.21%)
Mean Age (standard deviation)	39 (12.11)	39 (12.36)	32 (11.96)	41 (12.41)	40 (12.39)	39 (12.15)
Married, N (column %)	11,948,000 (62.48%)	102,000 (35.92%)	64,000 (29.77%)	31,000 (52.54%)	58,000 (48.33%)	12,280,000 (61.46%)

Has Completed Post-Secondary, N (column %)	12,328,000 (64.47%)	208,000 (73.24%)	104,000 (48.37%)	26,000 (44.07%)	66,000 (55.00%)	12,783,000 (63.98%)
Current Student, N (column %)	2,577,000 (13.48%)	46,000 (16.20%)	55,000 (25.58%)	6,000 (10.17%)	17,000 (14.17%)	2,727,000 (13.65%)
White, N (column %)	14,460,000 (75.62%)	240,000 (84.51%)	164,000 (76.23%)	30,000 (50.85%)	62,000 (51.67%)	15,082,000 (75.49%)
Employed in the last year, N (column %)	16,767,000 (87.68%)	255,000 (89.79%)	173,000 (80.47%)	39,000 (66.10%)	90,000 (75.00%)	17,324,000 (86.71%)
Lives Rural, N (column %)	2,898,000 (15.16%)	26,000 (9.15%)	22,000 (10.23%)	8,000 (13.56%)	11,000 (9.17%)	2,994,000 (14.98%)
Income Quintile						
Q1 (Lowest), N (column %)	3,082,000 (16.11%)	42,000 (14.79%)	65,000 (30.23%)	21,000 (35.59%)	35,000 (29.17%)	3,291,000 (16.47%)
Q2, N (column %)	3,211,000 (16.79%)	45,000 (15.85%)	41,000 (19.07%)	9,000 (15.25%)	20,000 (16.67%)	3,366,000 (16.85%)
Q3, N (column %)	3,627,000 (18.97%)	47,000 (16.55%)	47,000 (21.86%)	10,000 (16.95%)	15,000 (12.50%)	3,778,000 (18.91%)
Q4, N (column %)	4,049,000 (21.17%)	57,000 (20.07%)	29,000 (13.49%)	7,000 (11.86%)	14,000 (11.67%)	4,184,000 (20.94%)
Q5 (Highest), N (column %)	4,310,000 (22.54%)	84,000 (29.58%)	23,000 (10.70%)	5,000 (8.47%)	8,000 (6.67%)	4,452,000 (22.28%)

¹ Defined as 4 or more standard drinks for females during one occasion in the past 12 months, and 5 or more standard drinks for males during one occasion in the past 12 months

² Defined as any use in the past 12 months

³ Defined as any use in the past 12 months

Note Data pooled from 2009 to 2014, total weighted sample size n=19,980,000 individuals

Table 2 shows the adjusted (i.e. model 1a-5a) and unadjusted (i.e. models 1b-5b) models for men. In fully adjusted models, while Gay men had 57% greater odds of reporting poor mental health (OR=1.57, 95% CI 1.15 to 2.16, p=0.005) relative to their heterosexual counterparts, there was no evidence that they had different odds of poor physical health, binge drinking, illicit drug use, or cannabis use. Bisexual men had 176% greater odds of reporting poor mental health (OR=2.76, 95% CI 2.01 to 3.77, p<0.001), and 57% greater odds of poor physical health (OR=1.57, 95% CI 1.10 to 2.25, p=0.013), but no evidence for differences in binge drinking, illicit drug use, or cannabis use. Men in the 'don't know' group showed no elevated odds of poor mental or physical health; however, they had reduced odds of binge drinking by a factor of 0.35 (95% CI 0.19 to 0.62, p<0.001), reduced odds of illicit drug use by a

factor of 0.16 (95% CI 0.08 to 0.32, $p < 0.001$), and reduced odds of cannabis use by a factor of 0.16 (95% CI 0.08 to 0.30, $p < 0.001$). Similarly, men in the 'refuse' group had no differences in mental or physical health, but had reduced odds of binge drinking (OR=0.40, 95% CI 0.24 to 0.66, $p < 0.001$), illicit drug use (OR=0.43, 95% CI 0.22 to 0.86, $p = 0.016$), and cannabis use (OR=0.38, 95% CI 0.19 to 0.80, $p = 0.009$).

Table 2. Male adjusted and unadjusted odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians

Sexual Orientation	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Model	Adjusted models		Unadjusted models	
	Model 1a: Poor Mental Health (Male)		Model 1b: Poor Mental Health (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.57 (1.15-2.16)	0.005	1.80 (1.33-2.44)	0.000
Bisexual	2.76 (2.01-3.77)	0.000	4.17 (2.99-5.80)	0.000
Don't Know	0.97 (0.50-1.88)	0.928	1.82 (1.03-3.23)	0.040
Refuse	1.26 (0.58-2.74)	0.554	2.05 (1.02-4.10)	0.043
	Model 2a: Poor Physical Health (Male)		Model 2b: Poor Physical Health (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.21 (0.89-1.63)	0.224	1.22 (0.91-1.63)	0.185
Bisexual	1.57 (1.10-2.25)	0.013	2.18 (1.53-3.09)	0.000
Don't Know	0.63 (0.35-1.13)	0.123	1.37 (0.82-2.29)	0.225
Refuse	1.22 (0.61-2.44)	0.578	1.95 (1.12-3.40)	0.019
	Model 3a: Binge Drinks Alcohol (Male)		Model 3b: Binge Drinks Alcohol (Male)	
Heterosexual	Reference		Reference	
Homosexual	0.93 (0.76-1.14)	0.482	1.10 (0.90-1.33)	0.352
Bisexual	0.94 (0.67-1.32)	0.718	0.99 (0.75-1.32)	0.967
Don't Know	0.35 (0.19-0.62)	0.000	0.26 (0.15-0.43)	0.000
Refuse	0.40 (0.24-0.66)	0.000	0.32 (0.22-0.48)	0.000
	Model 4a: Uses Illicit Drugs (Male)		Model 4b: Uses Illicit Drugs (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.16 (0.82-1.65)	0.407	1.31 (0.93-1.84)	0.121
Bisexual	1.32 (0.88-1.99)	0.184	1.82 (1.23-2.68)	0.003
Don't Know	0.16 (0.08-0.32)	0.000	0.17 (0.09-0.33)	0.000
Refuse	0.43 (0.22-0.86)	0.016	0.47 (0.24-0.93)	0.031
	Model 5a: Uses Cannabis (Male)		Model 5b: Uses Cannabis (Male)	
Heterosexual	Reference		Reference	

Homosexual	1.13 (0.77-1.64)	0.534	1.27 (0.88-1.82)	0.197
Bisexual	1.20 (0.80-1.80)	0.386	1.69 (1.15-2.47)	0.007
Don't Know	0.16 (0.08-0.30)	0.000	0.17 (0.09-0.32)	0.000
Refuse	0.38 (0.19-0.80)	0.009	0.43 (0.21-0.88)	0.020

Note Data pooled from 2009 to 2014, total weighted sample size n=19,980,000 individuals. Adjusted models are controlled for variables including year of birth, marital status, educational attainment, student status, self-reported ethnic minority status, employment status, rurality status, province of residence, year of interview, and federal income.

Table 3 shows the adjusted (i.e. model 1a-5a) and unadjusted (i.e. models 1b-5b) models for women where lesbians showed no evidence for a difference in poor mental or physical health relative to their heterosexual counterpart, but had 56% greater odds of binge drinking (95% CI 1.19 to 2.05, $p=0.001$), 83% greater odds of illicit drug use (95% CI 1.29 to 2.61, $p=0.001$), and 76% greater odds of cannabis use (95% CI 1.23 to 2.52, $p=0.002$). Relative to their heterosexual counterparts, Bisexual women exhibited the largest disparity for all health outcomes: 230% greater odds of poor mental health (95% CI 2.58 to 4.22, $p<0.001$), 139% greater odds of poor physical health (95% CI 1.84 to 3.10, $p<0.001$), 68% greater odds of binge drinking (95% CI 1.36 to 2.08, $p<0.001$), 134% greater odds of illicit drug use (95% CI 1.73 to 3.17, $p<0.001$), and 133% greater odds of cannabis use (95% CI 1.73 to 3.14, $p<0.001$). While women in the 'don't know' group showed no evidence of differences in poor mental health, poor physical health, or cannabis use, they had lower odds of binge drinking (OR=0.35, 95% CI 0.22 to 0.55, $p<0.001$) and lower odds of illicit drug use (OR=0.28, 95% CI 0.08 to 0.96, $p=0.043$). Women in the 'refuse' group had no evidence of differences in poor mental health, poor physical health, illicit drug use, or cannabis use, but had lower odds of binge drinking by a factor of 0.54 (95% CI 0.30 to 0.98, $p=0.042$). Generally, adjusting for covariates reduced the magnitude of associations between sexual orientation and health outcomes, but the patterns of significance—where the same groups exhibited significant differences in outcomes relative to heterosexuals—remained unchanged.

Table 3. Female adjusted and unadjusted odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians

Sexual Orientation	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Model	Adjusted models		Unadjusted models	
	Model 6a: Poor Mental Health (Female)		Model 6b: Poor Mental Health (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.30 (0.96-1.78)	0.094	1.39 (1.02-1.89)	0.036
Bisexual	3.30 (2.58-4.22)	0.000	4.04 (3.16-5.16)	0.000
Don't Know	1.04 (0.58-1.85)	0.904	1.72 (0.98-3.01)	0.057
Refuse	1.38 (0.75-2.56)	0.304	1.96 (1.11-3.47)	0.021
	Model 7a: Poor Physical Health (Female)		Model 7b: Poor Physical Health (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.16 (0.85-1.60)	0.352	1.22 (0.91-1.63)	0.185
Bisexual	2.39 (1.84-3.10)	0.000	2.18 (1.53-3.09)	0.000
Don't Know	0.85 (0.47-1.52)	0.577	1.37 (0.82-2.29)	0.225
Refuse	1.25 (0.65-2.38)	0.504	1.95 (1.12-3.40)	0.019
	Model 8a: Binge Drinks Alcohol (Female)		Model 8b: Binge Drinks Alcohol (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.56 (1.19-2.05)	0.001	1.92 (1.51-2.44)	0.000
Bisexual	1.68 (1.36-2.08)	0.000	2.52 (2.09-3.04)	0.000
Don't Know	0.35 (0.22-0.55)	0.000	0.24 (0.15-0.39)	0.000
Refuse	0.54 (0.30-0.98)	0.042	0.36 (0.22-0.60)	0.000
	Model 9a: Uses Illicit Drugs (Female)		Model 9b: Uses Illicit Drugs (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.83 (1.29-2.61)	0.001	1.31 (0.93-1.84)	0.121
Bisexual	2.34 (1.73-3.17)	0.000	1.82 (1.23-2.68)	0.003
Don't Know	0.28 (0.08-0.96)	0.043	0.17 (0.09-0.33)	0.000
Refuse	0.68 (0.20-2.33)	0.534	0.47 (0.24-0.93)	0.031
	Model 10a: Uses Cannabis (Female)		Model 10b: Uses Cannabis (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.76 (1.23-2.52)	0.002	1.94 (1.38-2.73)	0.000
Bisexual	2.33 (1.73-3.14)	0.000	4.27 (3.26-5.59)	0.000
Don't Know	0.35 (0.12-1.01)	0.053	0.33 (0.12-0.96)	0.043
Refuse	0.64 (0.19-2.20)	0.483	0.61 (0.19-1.95)	0.401

^{Note} Data pooled from 2009 to 2014, total weighted sample size n=19,980,000 individuals. Adjusted models are controlled for variables including year of birth, marital status, educational attainment, student status, self-reported ethnic minority status, employment status, rurality status, province of residence, year of interview, and federal income.

The sensitivity test results are overall consistent with the findings from main models. To begin with, the modified Poisson regression analyses (see Appendix D, *Table D1* models 1c-5c

for males and Appendix D, *Table D2* models 6c-10c for females) confirmed these patterns of significance, showing consistent differences for the same groups when compared to their heterosexual counterparts. In addition, models using unimputed data (Appendix D, *Table D1* models 1d-5d for male, Appendix D, *Table D2 models 6d-10d for female*) showed similar directionality, strength of association, and patterns of significant results compared to the imputed main analyses. Weighted number of item non-response for all variables can be found in Appendix B *Table B1* (weighted n=19,980,000), where level of missingness varied from 0% for variables such as student status and rurality to the highest at 4.49% for reports of income quintile.

Results for change over time, based on the sexual orientation interaction with 'year of interview' are shown graphically in *figures 1-10* and the linear trends are tested using the Mann-Kendall Trend Test in R shown in *Table 4*. Bisexual women were the only group to show evidence for an increasing disparity in mental health over our study period from 2009-2014 ($\tau=0.867$, $p=0.024$) exhibited in *Figure 2*. Evidence for a decreasing disparity in substance use was found across multiple groups including 1) gay mens' illicit drug use ($\tau=-0.867$, $p=0.024$) and cannabis use ($\tau=-0.867$, $p=0.024$), 2) bisexual mens' illicit drug use ($\tau=-0.867$, $p=0.024$) and cannabis use ($\tau=-0.867$, $p=0.024$), as well as 3) lesbian womens illicit drug use ($\tau=-0.867$, $p=0.024$).

Figure 1. Odds ratio disparity over time for poor mental health outcome for males 2009-2014

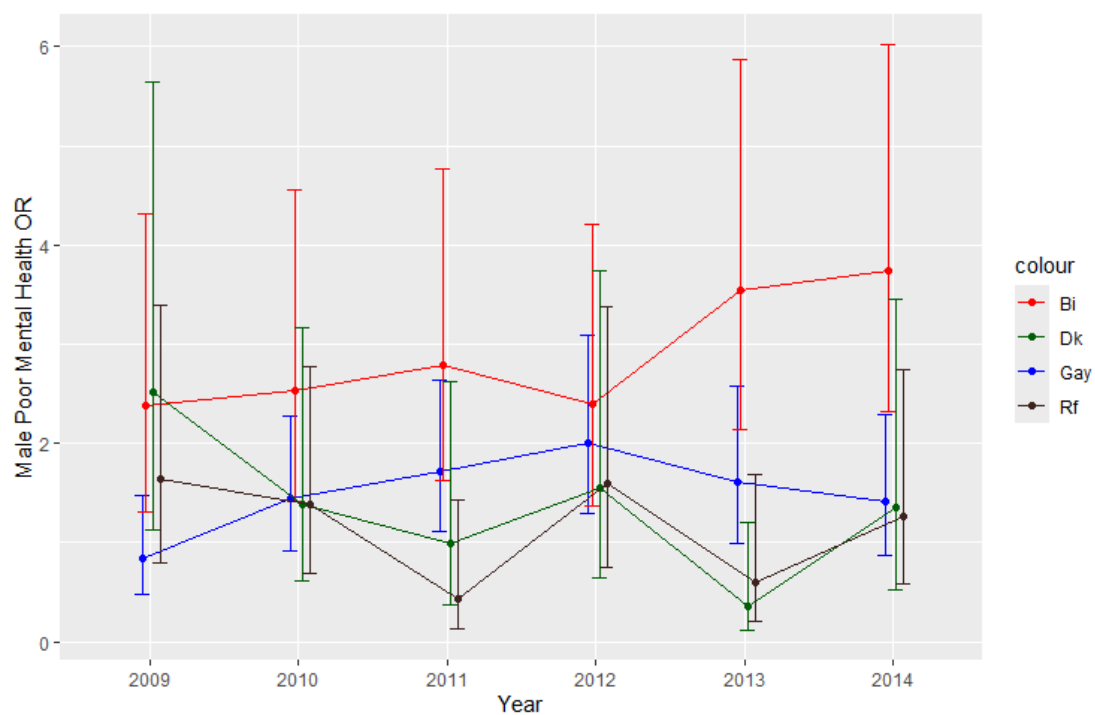


Figure 2. Odds ratio disparity over time for poor mental health for females 2009-2014

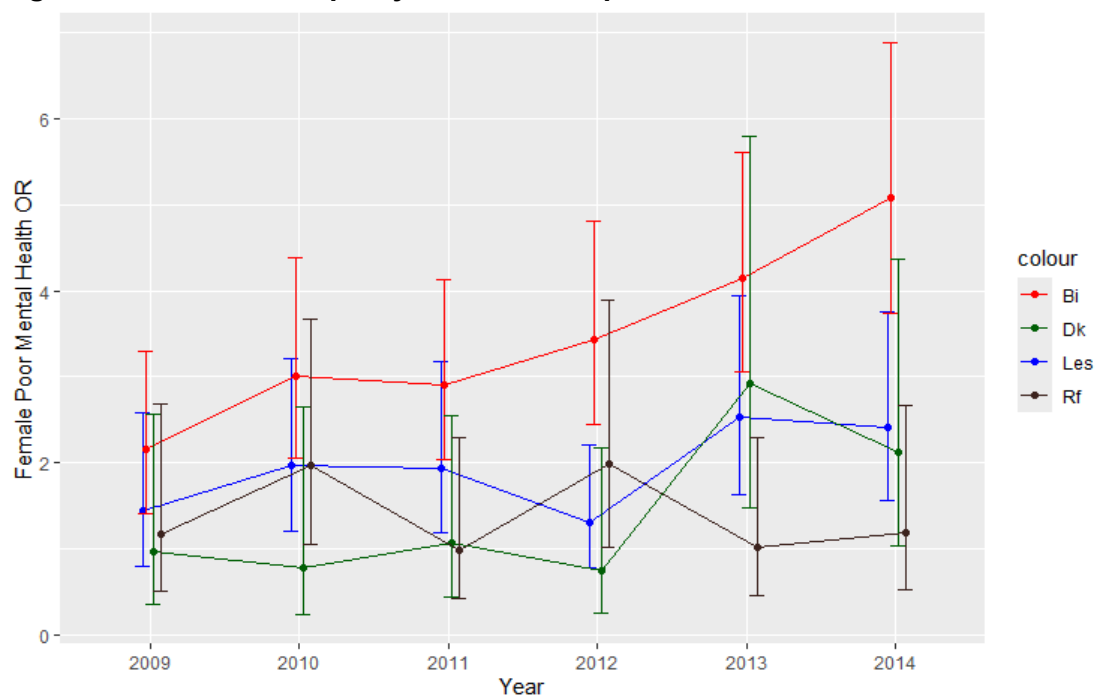


Figure 3. Odds ratio disparity over time for poor physical health for males 2009-2014

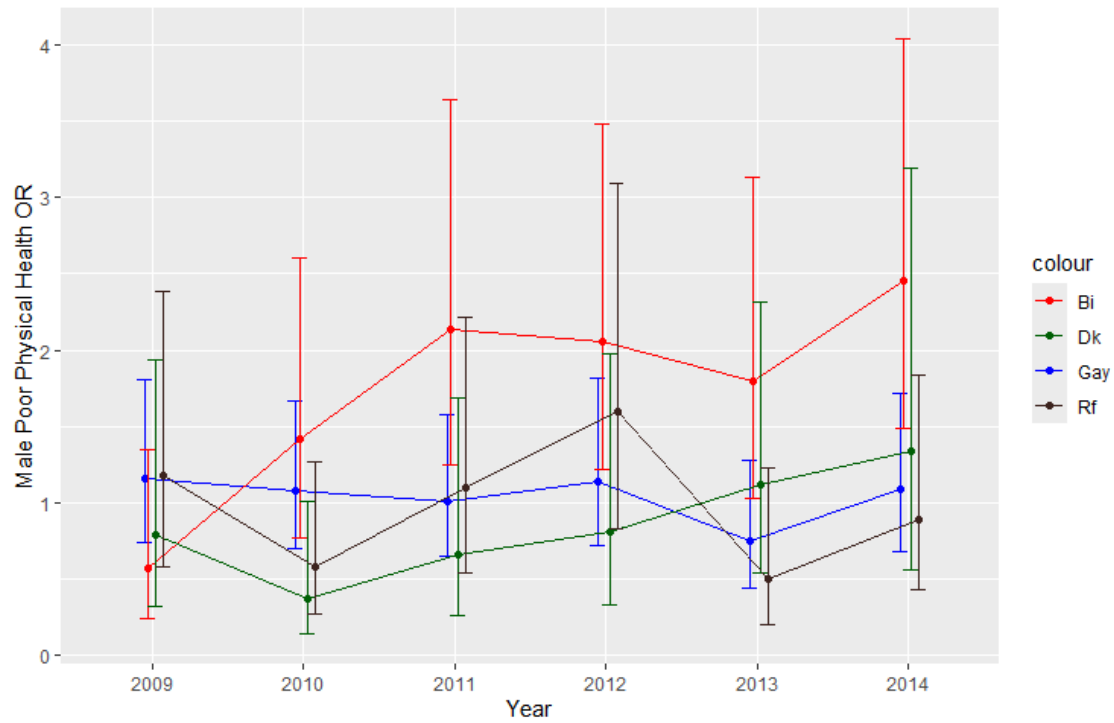


Figure 4. Odds ratio disparity over time for poor physical health for females 2009-2014

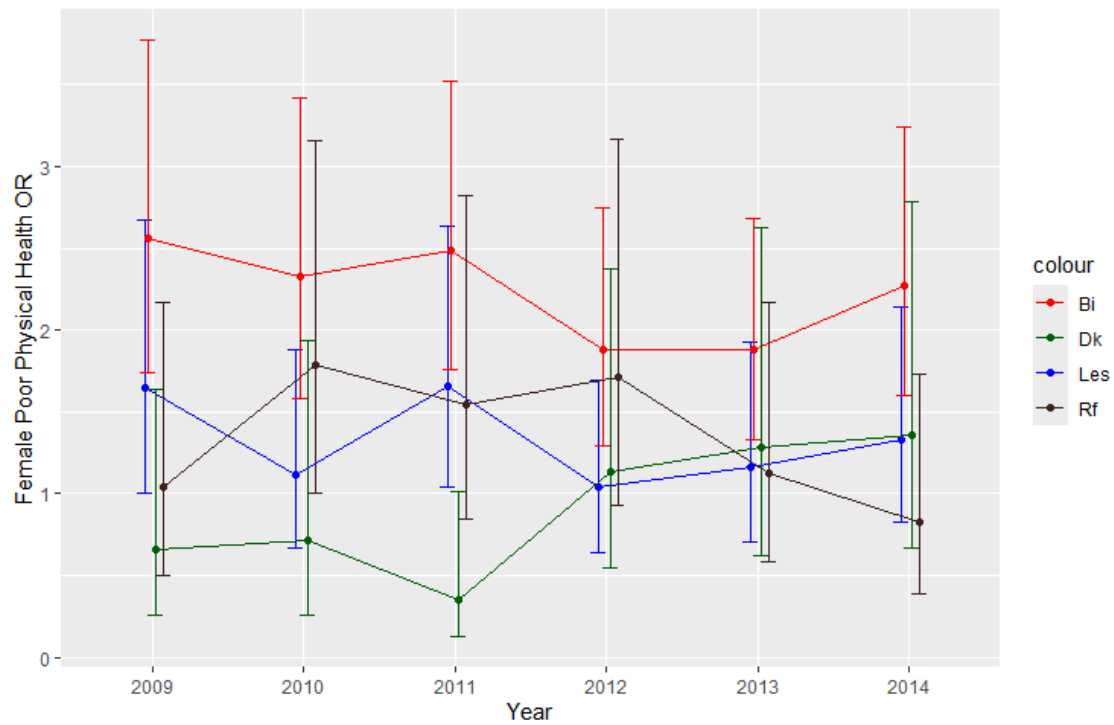


Figure 5. Odds ratio disparity over time for binge drinking for males 2009-2014

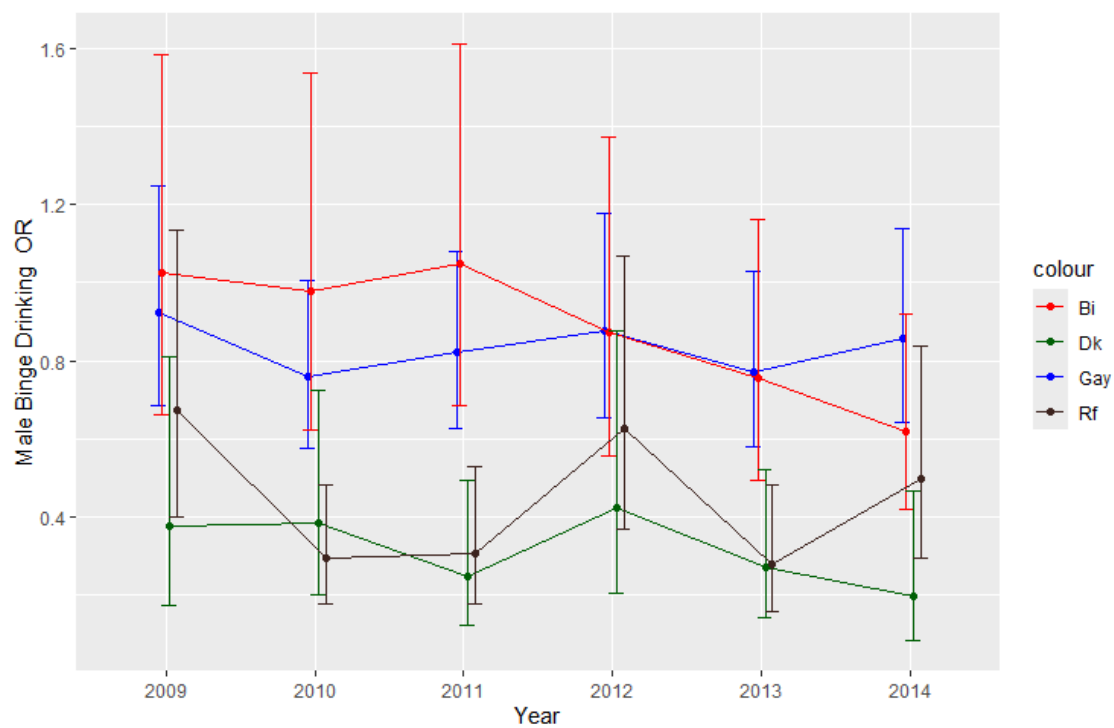


Figure 6. Odds ratio disparity over time for binge drinking for females 2009-2014

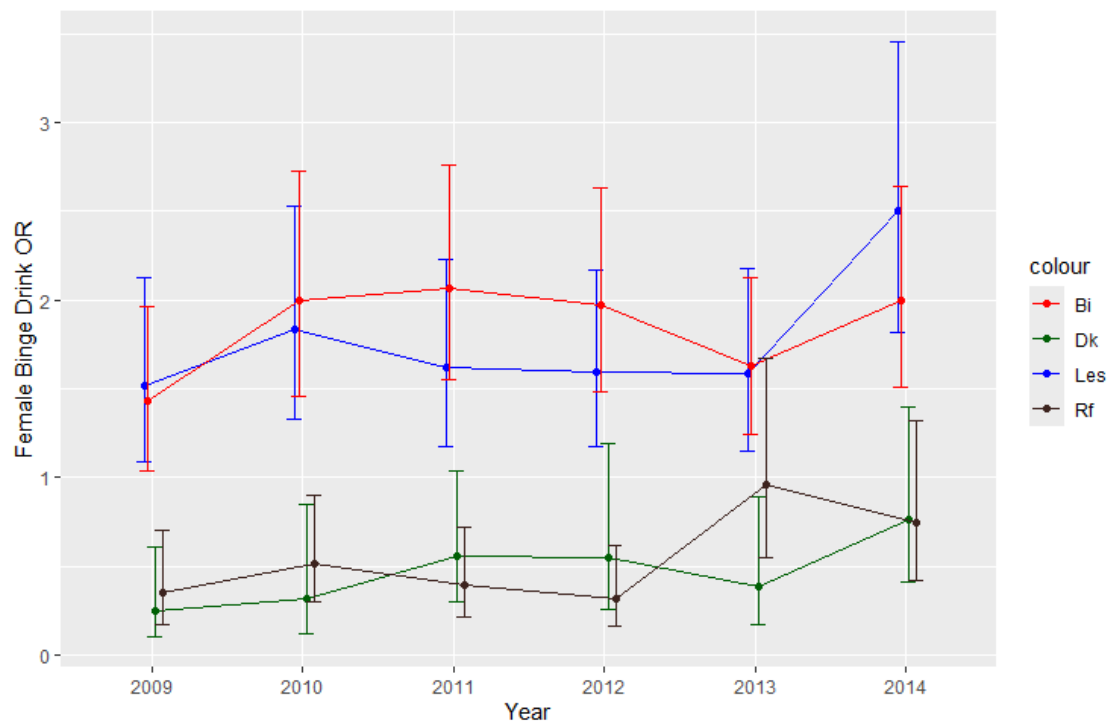


Figure 7. Odds ratio disparity over time for illicit drug use for males 2009-2014

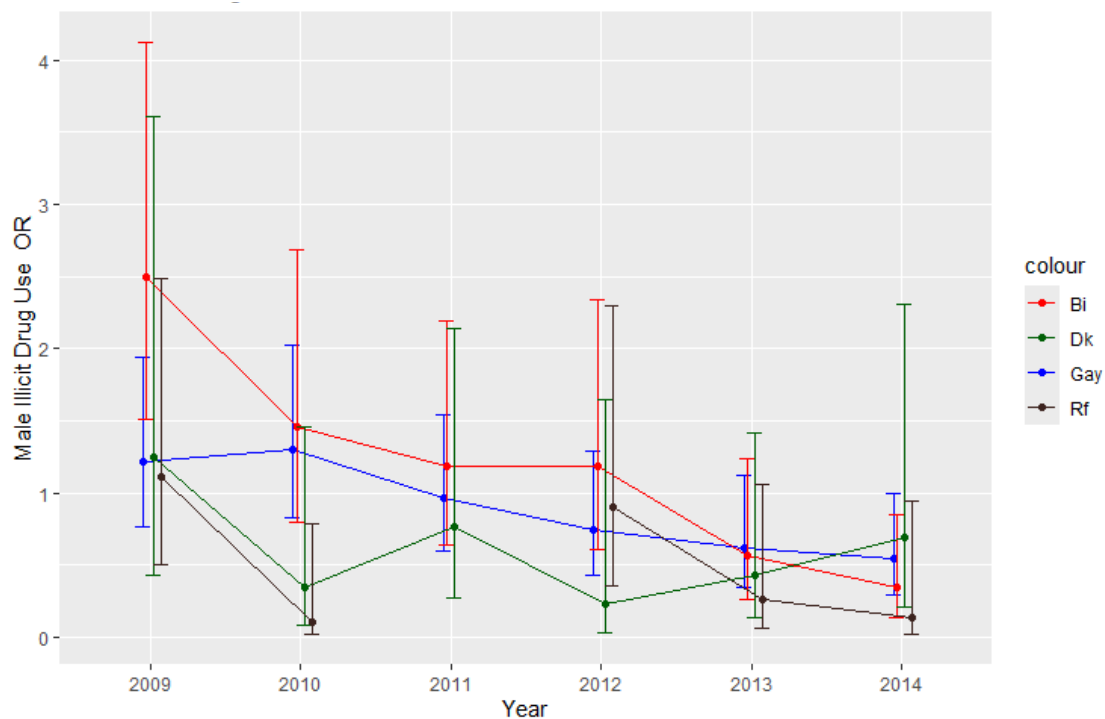


Figure 8. Odds ratio disparity over time for illicit drug use for females 2009-2014

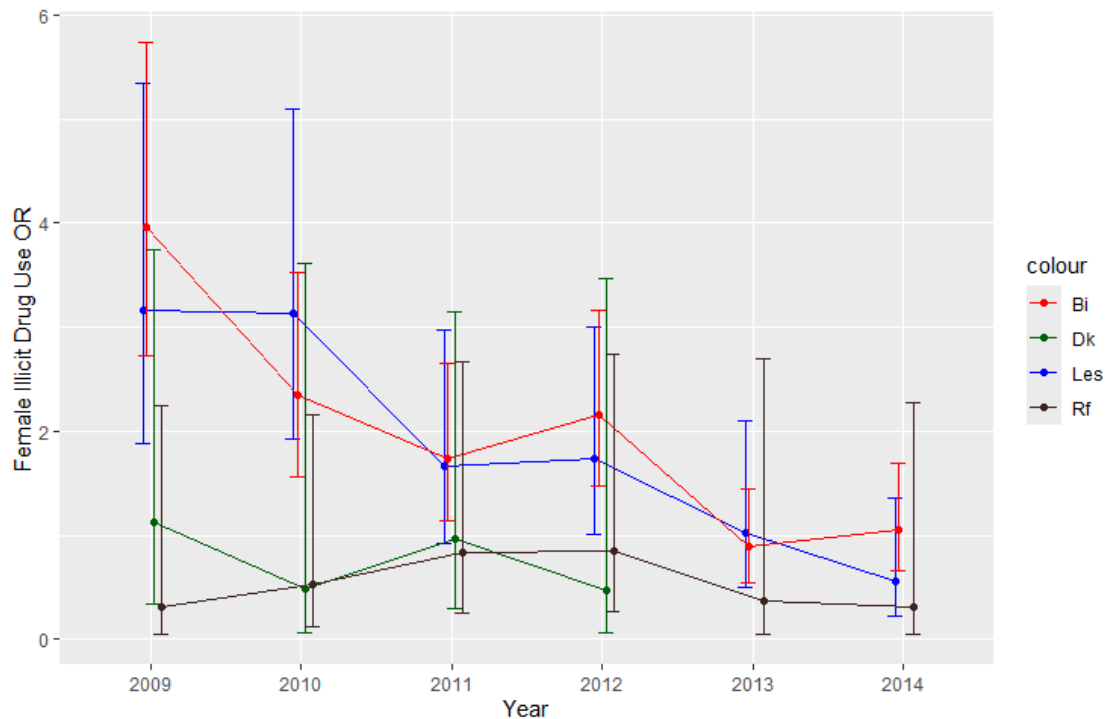


Figure 9. Odds ratio disparity over time for cannabis use for males 2009-2014

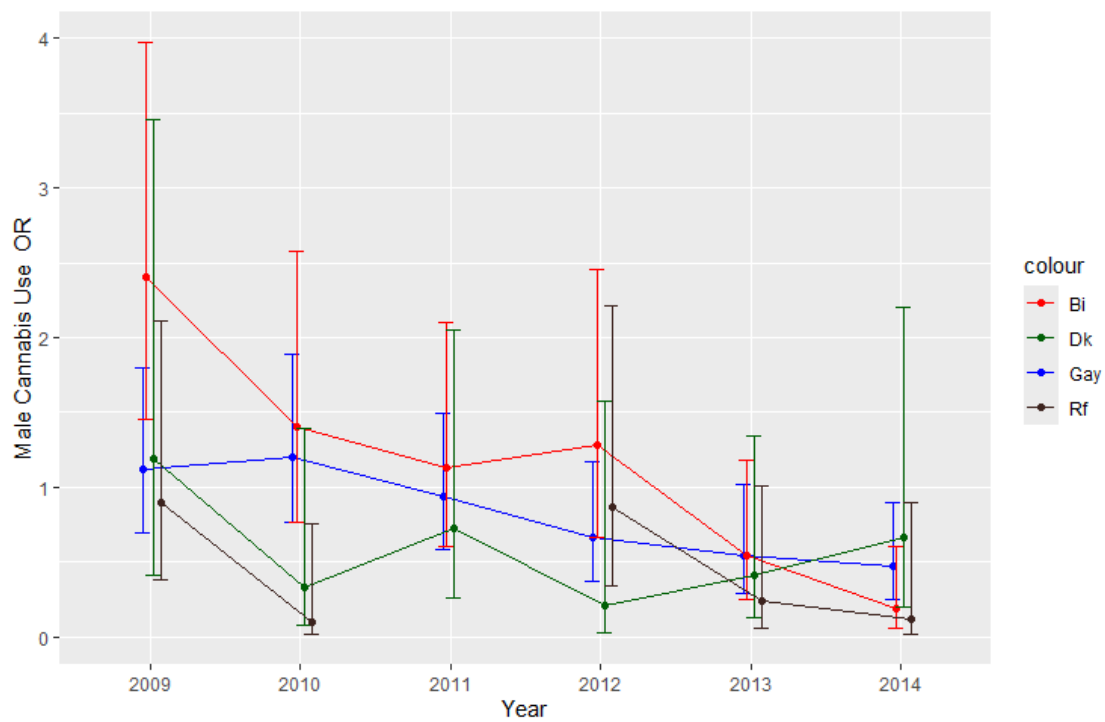


Figure 10. Odds ratio disparity over time for cannabis use for females 2009-2014

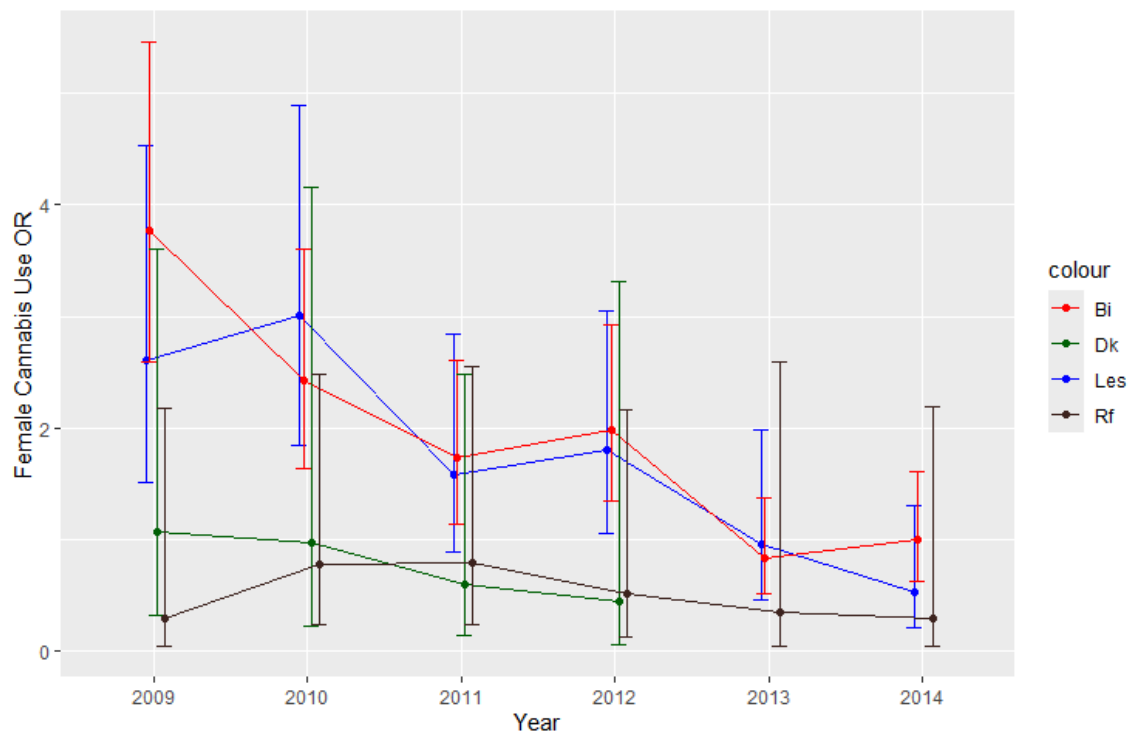


Table 4. Results for Mann-Kendall Trend Test across poor mental health, poor physical health, binge drinks, illicit drug use, and cannabis use across sex and sexual orientation for Canadians from 2009-2014

	Mental Health	Physical Health	Binge Drinks	Illicit Drug Use	Cannabis Use
Gay men	tau = 0.200 p = 0.707	tau = -0.333 p = 0.452	tau = -0.067 p = 1.000	tau = -0.867 p = 0.024	tau = -0.867 p = 0.024
Bisexual men	tau = 0.733 p = 0.060	tau = 0.600 p = 0.133	tau = -0.733 p = 0.060	tau = -0.867 p = 0.024	tau = -0.867 p = 0.024
Don't Know men	tau = -0.467 p = 0.260	tau = 0.733 p = 0.060	tau = -0.333 p = 0.452	tau = -0.200 p = 0.707	tau = -0.200 p = 0.707
Refused men	tau = -0.333 p = 0.452	tau = -0.200 p = 0.707	tau = -0.200 p = 0.707	tau = -0.400 p = 0.462	tau = -0.400 p = 0.462
Lesbian	tau = 0.333 p = 0.452	tau = -0.067 p = 1.000	tau = 0.200 p = 0.707	tau = -0.867 p = 0.024	tau = -0.733 p = 0.060
Bisexual women	tau = 0.867 p = 0.024	tau = -0.467 p = 0.260	tau = 0.200 p = 0.707	tau = -0.733 p = 0.060	tau = -0.733 p = 0.060
Don't Know women	tau = 0.333 p = 0.452	tau = 0.733 p = 0.060	tau = 0.600 p = 0.133	tau = -0.667 p = 0.308	tau = -1.000 p = 0.089429
Refused women	tau = 0.067 p = 1.000	tau = -0.333 p = 0.452	tau = 0.333 p = 0.452	tau = 0.067 p = 1.000	tau = -0.200 p = 0.707

^{Note} Data from 2009 to 2014. Model data is controlled for variables including year of birth, marital status, educational attainment, student status, self-reported ethnic minority status, employment status, rurality status, province of residence, year of interview, and federal income.

Discussion:

Our study provides details of health disparities in a broad set of health outcomes across sexual orientation using a population-representative sample of Canada. Among LGB participants, there were evidence for elevated risk of poor mental health (i.e. gay men, bisexual men, bisexual women), poor physical health (i.e. bisexual men, bisexual women), binge drinking (i.e. lesbians, bisexual women), illicit drug use (i.e. lesbians, bisexual women), and cannabis use (i.e. lesbians, bisexual women) relative to their heterosexual counterparts. While prior studies have generally highlighted worse health outcomes among sexual minorities, our study provides evidence that the level and number of health disparities vary among sexual minority groups: from gay men showing elevated risk in 1 outcome tested (i.e. poor mental health) to bisexual women who had elevated risk across all 5 outcomes tested. Furthermore, the strength

of disparity varies widely between groups: with lesbian having 76% increased odds of cannabis use relative to heterosexual women, and bisexual women having 133% increased odds.

Substance use in sexual minority women

A previous study examining the association between sexual orientation and substance use hospitalisation across Canada (also using the CCHS sample) found that while bisexual women had elevated odds of substance use hospitalizations by a factor of 2.46 compared to their heterosexual counterpart (67), no elevated risk was detected in other sexual minority groups. Given that bisexual women had elevated risk in each substance use outcome in our study, and had the largest disparities relative to their heterosexual counterparts (among all other LGB groups), it was not surprising to see that this group also had heightened risk for substance-related hospitalisation. On the other hand, lesbians in our study also exhibited increased risk for all 3 substance use outcomes (with a smaller effect size compared to bisexual women); however, there was no evidence in the prior study that the lesbian group had higher risk of hospitalizations for any substances (Hazard Ratio, HR=0.98, 95% CI 0.47 to 2.06), alcohol-related hospitalizations (HR=0.98, 95% CI 0.34 to 2.86), or illicit drugs and cannabis hospitalizations (HR=0.96, 95% 0.38 to 2.39).

The reasons that both lesbians and bisexual women both report significantly higher levels of substance use in our study, but have different risk of substance-use hospitalisation may be explained by prior research that conceptualises people who use drugs on a spectrum that runs from control to dysfunction (70). These studies typically categorise people who use drugs on a spectrum from 1) those who use drugs occasionally such as in the context of planned celebrations, and are able to balance their use with everyday responsibilities to 2) those who use drugs as a coping mechanism and have difficulties in controlling their drug use. The latter group is associated with dysfunctional substance use (or problematic substance use), such as using substances at high doses or being unable to cut back when needed, which can lead to

social and health consequences such as accidents, suicide-related behaviours, and overdose events often requiring hospitalization(71). A prior review of substance use in the LGB population found that, in general, bisexual identity was associated with increased ‘problematic substance use’ compared to those who identified exclusively as heterosexual or homosexual(72). This literature helps to explain why, among women, despite elevated risks of substance use in lesbians and bisexual women, only the bisexual group was linked to increased substance use hospitalizations. The review also highlighted evidence that men who identified as bisexual did not differ in problematic substance use compared to heterosexuals; however, the review suggests that, for men, the risk appears to arise when there is incongruence between identity and sexual behaviour (e.g. those who identify as mostly heterosexual, and had same-sex attraction). Moreover, it also suggests that, while men who identified as bisexual did differ in substance use compared to heterosexual men, there may still be increased risks hidden in the data (e.g. among those who identified as heterosexual, but had same-sex attraction).

Substance use in ‘don’t know’ and ‘refuse’ individuals

While all participants in the ‘refused’ and ‘don’t know’ had even odds of poor physical and mental health relative to their heterosexual counterparts, many reported significantly reduced odds of substance use (i.e. binge drinking, illicit drugs, and cannabis) including ‘don’t know’ men (all 3 substance outcomes), ‘refused’ men (3 substance outcomes), ‘don’t know’ women (2 outcomes), ‘refused’ women (1 outcome). These results starkly contrast with a prior study that examined substance-related hospitalisation across sexual orientation (67). More specifically, it showed that the ‘don’t know’ and ‘refused’ groups (combined into a single ‘other’ group) had elevated risk of age-adjusted incidence rates for substance-use hospitalizations, i.e. 36.03 per 100,000 person years in ‘other’ men vs. 29.03 in heterosexual men, and 17.05 in ‘other’ women vs. 16.32 in heterosexual women (67). In fully adjusted models, accounting for the effects of income, age, marital status, employment, education, and province of residence, no

differences were shown between the 'other' groups and their gender matched heterosexual counterparts for all substances examined. The discrepancy between self-reported substance use and substance use-related hospitalisation rates among the 'don't know' and 'refused' groups raises questions about the accuracy of self-reports in these groups. Further research should investigate whether social desirability bias or fear of stigma associated with substance use may affect self-reported data in groups that are also reluctant to disclose their sexual orientations.

Mental and physical health in sexual minority individuals

Among LGB men and women, all groups, except for lesbians, showed elevated odds of reporting poor mental health (with more pronounced effects in bisexual men and women, and less in gay men). A prior literature review has shown that, in most studies, LGB individuals report higher risk of mental health problems (73). However, in a controlled sibling study, involving comparison of lesbians to their heterosexual sisters found no statistically significant differences in mental health, and even found lesbians to have higher rates of self esteem (74). The author hypothesised that for lesbians, their degree of disclosure about their sexual orientation, or 'outness', may have acted as a protective factor in their study participants. Our study, based on self-reported mental health, also provides some evidence that lesbians may uniquely be protected against poor mental health among sexual minority groups.

Our study shows that while gay and lesbian individuals had similar risk of poor physical health as their heterosexual counterparts, bisexual men and women had higher risk of poor physical health. Prior studies on differences in physical health across sexual orientations had different results, which may be due to differences in how gender and sexual orientation are disaggregated. For example, a recent study using the US General Social Survey (75), found that after controlling for sociodemographic variables, no LGB groups have significant differences in their physical health over the past 30 days relative to their heterosexual counterparts; however, the study did not have gender disaggregated analyses, or used sex-interactions, to

explore sex/gender effect modification (leaving the possibility that a bisexual vs homosexual physical health difference may exist in 1 sex and not the other in their sample). In a Swedish nationally representative study (13), after statistical adjustments, LGB individuals reported higher odds of physical symptoms (e.g., pain, insomnia, dermatitis, tinnitus, intestinal problems) and conditions (e.g., diabetes, asthma, high blood pressure) compared to heterosexuals; however, the study did not disaggregate homosexual and bisexual participants, and studied sexual minority as a single group, which provided limited insights into the bisexual vs gay/lesbian differences that we found.

Our finding that bisexual individuals (and not gay/lesbians) had elevated risk of poor physical health may be explained by increased minority stress as past studies have indicated that biphobia is pervasive in heterosexual and LGBTQ+ communities (43,76), and as a result, bisexual individuals receive reduced community support and face a higher level of discrimination compared to gay/lesbian individuals (77). In a systematic review (11), minority stress has been linked to poor physical health through direct physiological stress response (e.g. immune dysregulation and allostatic load) and can modify health behaviours through distress/psychopathology. Given the elevated levels of minority stress in bisexual individuals, it is unsurprising that both mental and physical health disparities are heightened in bisexual individuals.

Changes in disparities over time (2009-2014)

The analysis of time trends has shed light on the changing dynamics of health outcomes over time and the disparities faced by various sexual orientation groups. These trends highlight the evolving nature of health disparities, though it is important to consider the potential limitations in interpreting these changes due to shifts in population composition across multiple cross-sectional periods. As such, these findings on temporal changes warrant careful consideration. Key observations include: 1) An increasing disparity in mental health issues

among bisexual women, which raises concerns given their already higher vulnerability to adverse health outcomes; 2) A significant decrease in substance use disparities among several sexual orientation groups, notably gay and bisexual men for illicit drug and cannabis use, and lesbians for illicit drug use. This decline in substance use among these groups is encouraging. However, the potential widening gap in mental health disparities among bisexual women calls for urgent, focused intervention strategies.

Limitations and strengths

There are a number of limitations in our study. First, while the study included sex, there were no measures of gender identity, and we were unable to identify health disparities in gender diverse groups including transgender and non-binary individuals. Second, sexual orientation were based on self-identification, but prior research has shown that a more comprehensive representation should include measures of attraction and sexual behaviour, with evidence showing that certain groups, including heterosexually identified men who have sex with men (78), may have even worse health outcomes compared to gay and bisexual identified men. These groups would be hidden in our study that only used LGB self-identification. Moving forward, future surveys should aim to incorporate measures for sexual attraction and gender identity to enhance the comprehensiveness of data collection.

Third, the study covered multiple years (2009-2014), and the levels of disparity across groups may have changed over these years. To help partially mitigate this concern, sensitivity tests were conducted to investigate the interaction between sexual orientation and time; however, since the data is cross-sectional (and not longitudinal), the observed changes may be driven by compositional change rather than reflecting a larger societal shift. Fourth, some groups might not openly share their substance use problems, casting doubt on the trustworthiness of their self-reports. Future studies should explore how social pressure or fear of stigma related to substance use could impact self-reported data in these groups, such as those

who did not reveal their sexual orientations. Fifth, self-reported health measures may over- or underestimate true health status due to issues like social desirability bias, recall bias, and the inability of participants to accurately quantify their health experiences (79). Finally, while the control variables were chosen based on prior literature, there may still be uncontrolled confounders leading to residual confounding.

Despite these potential limitations, our study has several notable strengths. First, we used a range of health outcomes to capture multiple dimensions of health inequities. By examining various self-rated health outcomes, ranging from physical and mental health to substance use, the study provides a more comprehensive picture of health disparities across sexual orientations in Canada to help inform health promotion strategies. Second, the use of a nationally representative sample is a strength of this study. This was supplemented by the use of population weights provided by Statistics Canada to adjust for potential discrepancies in response rates compared to characteristics found in the Canadian Census, which may improve the generalizability of our study to the Canadian population. Third, the use of disaggregated data for sex and sexual orientation helped to identify significant differences between sexual minority groups (i.e. increased risk of all health outcomes shown in bisexual women), which helps to highlight specific sexual minority subgroups for targeted interventions.

Implications

Our finding that there are disparities across all 5 health outcomes among bisexual women (and limited evidence suggesting growing disparity between bisexual women's vs heterosexual women's mental health) suggest a pressing need for tailored interventions and prevention programs that specifically address the unique challenges faced by this population. Further investigation into the factors contributing to their struggles and strategies to improve accessibility and effectiveness of support services is imperative to decrease the widening disparity gap. A previous report on supporting bisexual youth has highlighted that bisexual

women can face an increased level of prejudice and violence due to the harmful narrative that they are only experimenting with their sexuality or doing it for attention (80). The report calls for everyone to actively challenge biphobia (i.e. the fear, intolerance, or hatred of those who experience attraction to people of more than one gender). Some key opportunities to support bisexual women include: making resources on biphobia and bisexual experience available in key clinical and community settings (e.g. GP offices and community centres), and front line social and healthcare workers should have resources and referral available at times of crisis with their clients. Rainbow Health Ontario, a programme aimed to improve the healthcare system to better serve 2SLGBTQ+ (Two-Spirit, Lesbian, Gay, Bisexual, Transgender, Queer or Questioning and others) individuals, has highlighted the negative health impacts of biphobia, and responded through community collaborations (e.g. *'This is Our Community'*) to combat bisexual stigma (81). However, there is no rigorous evidence to suggest that these programs will actually help reduce bisexual stigma and improve bisexual women's health. Further research using randomised controlled trials should be conducted to evaluate the effectiveness of various campaigns to reduce stigma against bisexual individuals, and any subsequent health impacts.

Our findings also underscore the need for caution when relying on self-reported data, particularly within populations where individuals may have uncertainty or discomfort regarding their sexual orientation (i.e. the 'don't know' and 'refuse' groups). Our comparison with a prior study with linked administrative data highlighted potential discrepancies, indicating that some groups may be reluctant to disclose substance use problems. Future research should investigate whether these discrepancies extend to clinical settings. For instance, GP patient intake forms often include questions on sexual orientation (including identity and behaviours), along with substance use questions. Research on whether certain sexual orientation groups' 1) self-reported substance use vs. 2) their substance-use related acute and primary care data can be compared to assess whether the former is predictive of the latter, which can inform best practices for primary care patient intake.

Given our findings on observed persistent and sometimes worsening disparities across sexual orientations over time, it is imperative for future research to adopt longitudinal approaches. By following the same individuals over time, such research can provide valuable insights into a more nuanced perspective on the evolving health challenges faced by sexual minorities. Longitudinal studies allow for the sophisticated identification of patterns and shifts in health disparities, providing a lens through which to examine the longitudinal impacts of societal changes, healthcare interventions, and policy changes on LGB populations. Moreover, by identifying longitudinal trends over time, future research can identify areas where previous interventions may have fallen short and where there is an urgent need for tailored prevention strategies.

The finding of disparities in mental health among LGB individuals (except lesbians) compared to their heterosexual counterparts emphasises the urgent need for targeted interventions and policies to address mental health inequalities. A potential reason for the gap may be due to sexual minority patients not feeling comfortable in accessing care or have less trust in healthcare providers than their heterosexual counterparts. The 2022 Healthcare Equality Index report from the Human Rights Campaign recommends the following policies to help LGBTQ+ (lesbian, gay, bi, trans, queer or questioning, and others) patients feel more comfortable accessing health and social care services by developing 1) a LGBTQ+ patient-centred/client-centred program, 2) a LGBTQ+ inclusive patient/client non-discrimination policy; 3) a LGBTQ+ inclusive employment non-discrimination policy; 4) staff training in LGBTQ+ patient-centred/client-centred care; and 5) continuous engagement activities with LGBTQ+ community group to understand their concerns (82).

Conclusion:

In conclusion, this study sheds light on the complex landscape of health disparities across sexual orientations in Canada, employing a nationally representative sample to capture a

broad spectrum of health outcomes. It underscores the heightened vulnerability of bisexual women across all assessed health metrics, signalling an urgent call for targeted interventions to address the unique challenges they face. Moreover, the study's findings on the varying degrees of substance use and mental health disparities among sexual orientation groups illuminates the necessity for nuanced, tailored public health strategies. Through a comprehensive analysis that advances beyond the limitations of previous methodologies (e.g. using disaggregated analyses by sex and sexual minority subgroups), this research contributes significantly to our understanding of the health inequities experienced by sexual minorities. Future efforts must continue to explore these disparities longitudinally and develop/evaluate interventions that are more contextual and culturally appropriate.

Bibliography:

1. White HL, O'Campo P, Moineddin R, Matheson FI. Modeling the cumulative effects of social exposures on health: moving beyond disease-specific models. *Int J Environ Res Public Health*. 2013 Mar 25;10(4):1186–201.
2. Meyer IH. Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. *Psychol Bull*. 2003 Sep;129(5):674–97.
3. Flentje A, Heck NC, Brennan JM, Meyer IH. The relationship between minority stress and biological outcomes: A systematic review. *J Behav Med*. 2020 Oct;43(5):673–94.
4. Brooks VR. *Minority stress and lesbian women*. Lexington, Mass: Lexington Books; 1981. 219 p.
5. Meyer IH. Minority stress and mental health in gay men. *J Health Soc Behav*. 1995 Mar;36(1):38–56.
6. Trinh MH, Agénor M, Austin SB, Jackson CL. Health and healthcare disparities among U.S.

- women and men at the intersection of sexual orientation and race/ethnicity: a nationally representative cross-sectional study. *BMC Public Health*. 2017 Dec;17(1):964.
7. Lund EM, Burgess CM. Sexual and Gender Minority Health Care Disparities: Barriers to Care and Strategies to Bridge the Gap. *Prim Care*. 2021 Jun;48(2):179–89.
 8. Schuler MS, Prince DM, Breslau J, Collins RL. Substance Use Disparities at the Intersection of Sexual Identity and Race/Ethnicity: Results from the 2015-2018 National Survey on Drug Use and Health. *LGBT Health*. 2020;7(6):283–91.
 9. Hatzenbuehler ML. How does sexual minority stigma “get under the skin”? A psychological mediation framework. *Psychol Bull*. 2009 Sep;135(5):707–30.
 10. Semlyen J, King M, Varney J, Hagger-Johnson G. Sexual orientation and symptoms of common mental disorder or low wellbeing: combined meta-analysis of 12 UK population health surveys. *BMC Psychiatry*. 2016 Dec;16(1):67.
 11. Lick DJ, Durso LE, Johnson KL. Minority Stress and Physical Health Among Sexual Minorities. *Perspect Psychol Sci*. 2013 Sep;8(5):521–48.
 12. Mays VM, Juster RP, Williamson TJ, Seeman TE, Cochran SD. Chronic Physiologic Effects of Stress Among Lesbian, Gay, and Bisexual Adults: Results From the National Health and Nutrition Examination Survey. *Psychosom Med*. 2018 Jul;80(6):551–63.
 13. Bränström R, Hatzenbuehler ML, Pachankis JE. Sexual orientation disparities in physical health: age and gender effects in a population-based study. *Soc Psychiatry Psychiatr Epidemiol*. 2016 Feb;51(2):289–301.
 14. Pakula B, Shoveller J, Ratner PA, Carpiano R. Prevalence and Co-Occurrence of Heavy Drinking and Anxiety and Mood Disorders Among Gay, Lesbian, Bisexual, and Heterosexual Canadians. *Am J Public Health*. 2016 Jun;106(6):1042–8.
 15. Jun HJ, Webb-Morgan M, Felner JK, Wisdom JP, Haley SJ, Austin SB, et al. Sexual orientation and gender identity disparities in substance use disorders during young adulthood in a United States longitudinal cohort. *Drug Alcohol Depend*. 2019

Dec;205:107619.

16. Lachowsky NJ, Dulai JJS, Cui Z, Sereda P, Rich A, Patterson TL, et al. Lifetime Doctor-Diagnosed Mental Health Conditions and Current Substance Use Among Gay and Bisexual Men Living in Vancouver, Canada. *Subst Use Misuse*. 2017 May 12;52(6):785–97.
17. Ross LE, Bauer GR, MacLeod MA, Robinson M, MacKay J, Dobinson C. Mental health and substance use among bisexual youth and non-youth in Ontario, Canada. *PloS One*. 2014;9(8):e101604.
18. Amaro H, Sanchez M, Bautista T, Cox R. Social vulnerabilities for substance use: Stressors, socially toxic environments, and discrimination and racism. *Neuropharmacology*. 2021 May;188:108518.
19. Hernandez LM, Blazer DG, Institute of Medicine (U.S.), editors. *Genes, behavior, and the social environment: moving beyond the nature/nurture debate*. Washington, DC: National Academies Press; 2006. 368 p.
20. Wilson MN, Asbridge M, Woolcott C, Langille DB. Sexual orientation and alcohol-related harms in Canadian youth. *Can J Public Health*. 2018 Apr;109(2):233–41.
21. Owens B, Mills S, Lewis N, Guta A. Work-related stressors and mental health among LGBTQ workers: Results from a cross-sectional survey. Lathabhavan R, editor. *PLOS ONE*. 2022 Oct 25;17(10):e0275771.
22. Frost DM. The Benefits and Challenges of Health Disparities and Social Stress Frameworks for Research on Sexual and Gender Minority Health: Benefits and Challenges. *J Soc Issues*. 2017 Sep;73(3):462–76.
23. Hatzenbuehler ML, Nolen-Hoeksema S, Erickson SJ. Minority stress predictors of HIV risk behavior, substance use, and depressive symptoms: Results from a prospective study of bereaved gay men. *Health Psychol*. 2008 Jul;27(4):455–62.
24. Hickson F, Davey C, Reid D, Weatherburn P, Bourne A. Mental health inequalities among gay and bisexual men in England, Scotland and Wales: a large community-based

- cross-sectional survey. *J Public Health*. 2016 Apr 26;fdw021.
25. Barger BT, Obedin-Maliver J, Capriotti MR, Lunn MR, Flentje A. Characterization of Substance Use among Underrepresented Sexual and Gender Minority Participants in the Population Research in Identity and Disparities for Equality (Pride) Study. *Subst Abuse*. 2021 Jan;42(1):104–15.
 26. Hequembourg AL, Panagakis C. Maximizing respondent-driven sampling field procedures in the recruitment of sexual minorities for health research. *SAGE Open Med*. 2019 Jan;7:205031211982998.
 27. Tyrer S, Heyman B. Sampling in epidemiological research: issues, hazards and pitfalls. *BJPsych Bull*. 2016 Apr;40(2):57–60.
 28. Frost DM, LeBlanc AJ. Nonevent stress contributes to mental health disparities based on sexual orientation: Evidence from a personal projects analysis. *Am J Orthopsychiatry*. 2014 Sep;84(5):557–66.
 29. Lieb W, Vasan RS. Scientific Contributions of Population-Based Studies to Cardiovascular Epidemiology in the GWAS Era. *Front Cardiovasc Med*. 2018 Jun 7;5:57.
 30. Klitzman RL, Greenberg JD, Pollack LM, Dolezal C. MDMA ('ecstasy') use, and its association with high risk behaviors, mental health, and other factors among gay/bisexual men in New York City. *Drug Alcohol Depend*. 2002 Apr;66(2):115–25.
 31. Chum A, Nielsen A, Teo C. Sleep problems among sexual minorities: a longitudinal study on the influence of the family of origin and chosen family. *BMC Public Health*. 2021 Dec;21(1):2267.
 32. Bell K, Rieger E, Hirsch JK. Eating Disorder Symptoms and Proneness in Gay Men, Lesbian Women, and Transgender and Gender Non-conforming Adults: Comparative Levels and a Proposed Mediation Model. *Front Psychol*. 2019 Jan 8;9:2692.
 33. Van Der Star A, Bränström R. Acceptance of sexual minorities, discrimination, social capital and health and well-being: a cross-European study among members of same-sex and

- opposite-sex couples. *BMC Public Health*. 2015 Dec;15(1):812.
34. Nielsen A, Azra KK, Kim C, Dusing GJ, Chum A. Is the association between sexual minority status and suicide-related behaviours modified by rurality? A discrete-time survival analysis using longitudinal health administrative data. *Soc Sci Med*. 2023 May;325:115896.
35. Perales F, Campbell A. Health Disparities Between Sexual Minority and Different-Sex-Attracted Adolescents: Quantifying the Intervening Role of Social Support and School Belonging. *LGBT Health*. 2020 Apr 1;7(3):146–54.
36. Chum A, Kim C, Nielsen A, Dusing GJ, O'Campo P, Matheson FI, et al. Disparities in Suicide-Related Behaviors Across Sexual Orientations by Gender: A Retrospective Cohort Study Using Linked Health Administrative Data. *Am J Psychiatry*. 2023 Jun 7;appi.ajp.20220763.
37. Blosnich JR, Farmer GW, Lee JGL, Silenzio VMB, Bowen DJ. Health Inequalities Among Sexual Minority Adults. *Am J Prev Med*. 2014 Apr;46(4):337–49.
38. McCabe SE, Hughes TL, Bostwick WB, West BT, Boyd CJ. Sexual orientation, substance use behaviors and substance dependence in the United States. *Addiction*. 2009 Aug;104(8):1333–45.
39. Jeffries WL. Beyond the Bisexual Bridge. *Am J Prev Med*. 2014 Sep;47(3):320–9.
40. Feinstein BA, Dyar C. Bisexuality, Minority Stress, and Health. *Curr Sex Health Rep*. 2017 Mar;9(1):42–9.
41. Operario D, Gamarel KE, Grin BM, Lee JH, Kahler CW, Marshall BDL, et al. Sexual Minority Health Disparities in Adult Men and Women in the United States: National Health and Nutrition Examination Survey, 2001–2010. *Am J Public Health*. 2015 Oct;105(10):e27–34.
42. Roberts TS, Horne SG, Hoyt WT. Between a Gay and a Straight Place: Bisexual Individuals' Experiences with Monosexism. *J Bisexuality*. 2015 Oct 2;15(4):554–69.
43. Dodge B, Herbenick D, Friedman MR, Schick V, Fu TC (Jane), Bostwick W, et al. Attitudes toward Bisexual Men and Women among a Nationally Representative Probability Sample of

- Adults in the United States. Hoffmann H, editor. PLOS ONE. 2016 Oct 26;11(10):e0164430.
44. Firestein BA, editor. *Bisexuality: the psychology and politics of an invisible minority*. Thousand Oaks: Sage Publications; 1996. 329 p.
 45. Bécares L, Kneale D. Inequalities in mental health, self-rated health, and social support among sexual minority young adults during the COVID-19 pandemic: analyses from the UK Millennium Cohort Study. *Soc Psychiatry Psychiatr Epidemiol*. 2022 Oct;57(10):1979–86.
 46. Jabson JM, Farmer GW, Bowen DJ. Stress mediates the relationship between sexual orientation and behavioral risk disparities. *BMC Public Health*. 2014 Dec;14(1):401.
 47. Rice CE, Vasilenko SA, Fish JN, Lanza ST. Sexual minority health disparities: an examination of age-related trends across adulthood in a national cross-sectional sample. *Ann Epidemiol*. 2019 Mar;31:20–5.
 48. King B. Vital Signs: Current Cigarette Smoking Among Adults Aged ≥ 18 Years—United States, 2005–2010. *JAMA*. 2011 Nov 2;306(17):1857–60.
 49. Chum A, Kaur S, Teo C, Nielsen A, Muntaner C, O’Campo P. The impact of changes in job security on mental health across gender and family responsibility: evidence from the UK Household Longitudinal Study. *Soc Psychiatry Psychiatr Epidemiol*. 2022 Jan;57(1):25–36.
 50. Burke JF, Sussman JB, Kent DM, Hayward RA. Three simple rules to ensure reasonably credible subgroup analyses. *BMJ*. 2015 Nov 4;h5651.
 51. Sandfort TGM, Bakker F, Schellevis FG, Vanwesenbeeck I. Sexual Orientation and Mental and Physical Health Status: Findings From a Dutch Population Survey. *Am J Public Health*. 2006 Jun;96(6):1119–25.
 52. Canadian Community Health Survey (CCHS) Annual component User guide 2010 and 2009–2010 Microdata files [Internet]. Statistics Canada; 2011. Available from: https://www23.statcan.gc.ca/imdb-bmdi/pub/document/3226_D7_T9_V8-eng.pdf
 53. Lavrakas P. *Encyclopedia of Survey Research Methods* [Internet]. 2455 Teller Road, Thousand Oaks California 91320 United States of America: Sage Publications, Inc.;

- 2008 [cited 2023 Jul 29]. Available from:
<https://methods.sagepub.com/reference/encyclopedia-of-survey-research-methods>
54. Canadian Community Health Survey, 2013-2014: Annual Component [Internet]. Statistics Canada; 2017. Available from:
<https://gsg.uottawa.ca/data/open/csi/cchs-82M0013-E-2013-2014-Annual-component.pdf>
 55. Statistics Act [Internet]. Sect. 1970-71-72, c. 15, s. 1. Available from:
<https://laws-lois.justice.gc.ca/eng/acts/S-19/FullText.html>
 56. Privacy Act [Internet]. Sect. 1980-81-82-83, c. 111, Sch. II “1.” Available from:
<https://laws-lois.justice.gc.ca/eng/acts/P-21/page-1.html#h-397172>
 57. Access to Information Act [Internet]. Sect. 1980-81-82-83, c. 111, Sch. I “1.” Available from:
<https://laws-lois.justice.gc.ca/eng/acts/A-1/page-1.html#h-176>
 58. Dharma C, Bauer GR. Understanding sexual orientation and health in Canada: Who are we capturing and who are we missing using the Statistics Canada sexual orientation question? *Can J Public Health*. 2017 Jan;108(1):e21–6.
 59. Ahmad F, Jhajj AK, Stewart DE, Burghardt M, Bierman AS. Single item measures of self-rated mental health: a scoping review. *BMC Health Serv Res*. 2014 Dec;14(1):398.
 60. DeSalvo KB, Bloser N, Reynolds K, He J, Muntner P. Mortality prediction with a single general self-rated health question: A meta-analysis. *J Gen Intern Med*. 2006 Mar;21(3):267–75.
 61. Manor O, Matthews S, Power C. Dichotomous or categorical response? Analysing self-rated health and lifetime social class. *Int J Epidemiol*. 2000 Feb;29(1):149–57.
 62. Lundberg O, Manderbacka K. Assessing reliability of a measure of self-rated health. *Scand J Soc Med*. 1996 Sep;24(3):218–24.
 63. Alcohol’s Effects on Health: Research-based information on drinking and its impact. *Drinking Levels Defined* [Internet]. National Institute on Alcohol Abuse and ALCOHOLISM; 2023. Available from:

<https://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/moderate-binge-drinking>

64. McNeely J, Cleland CM, Strauss SM, Palamar JJ, Rotrosen J, Saitz R. Validation of Self-Administered Single-Item Screening Questions (SISQs) for Unhealthy Alcohol and Drug Use in Primary Care Patients. *J Gen Intern Med*. 2015 Dec;30(12):1757–64.
65. Reliability of Key Measures in the National Survey on Drug Use and Health [Internet]. 2010 Feb. (Substance Abuse and Mental Health Services Administration.). Available from: <https://www.samhsa.gov/data/sites/default/files/2k6ReliabilityP/2k6ReliabilityP.pdf>
66. Postal codes [Internet]. Canada Post; 2022. Available from: <https://www.canadapost-postescanada.ca/cpc/en/support/articles/addressing-guidelines/postal-codes.page>
67. Dusing GJ, Kim C, Nielsen A, Chum A. Disparities in alcohol- and substance-related hospitalizations and deaths across sexual orientations in Canada: a longitudinal study. *Public Health*. 2024 Jan;226:32–8.
68. Azra KK, Nielsen A, Kim C, Dusing GJ, Chum A. Investigating suicide related behaviours across sexual orientation and neighbourhood deprivation levels: A cohort study using linked health administrative data. Moradi G, editor. *PLOS ONE*. 2023 Mar 29;18(3):e0282910.
69. Gates GJ. How Many People are Lesbian, Gay, Bisexual and Transgender? UCLA Williams Inst [Internet]. 2011 Apr 1; Available from: <https://escholarship.org/uc/item/09h684x2>
70. Askew R. Functional fun: Legitimising adult recreational drug use. *Int J Drug Policy*. 2016 Oct;36:112–9.
71. McLellan AT. Substance Misuse and Substance use Disorders: Why do they Matter in Healthcare? *Trans Am Clin Climatol Assoc*. 2017;128:112–30.
72. Green KE, Feinstein BA. Substance use in lesbian, gay, and bisexual populations: an update on empirical research and implications for treatment. *Psychol Addict Behav J Soc Psychol Addict Behav*. 2012 Jun;26(2):265–78.

73. Wittgens C, Fischer MM, Buspavanich P, Theobald S, Schweizer K, Trautmann S. Mental health in people with minority sexual orientations: A meta-analysis of population-based studies. *Acta Psychiatr Scand*. 2022 Apr;145(4):357–72.
74. Rothblum ED, Factor R. Lesbians and Their Sisters as a Control Group: Demographic and Mental Health Factors. *Psychol Sci*. 2001 Jan;12(1):63–9.
75. Burton C. Self-Reported Health Among Sexual Minorities in the United States. 2021 Aug; Available from: <https://dc.etsu.edu/cgi/viewcontent.cgi?article=5436&context=etd>
76. Weiss JT. GL vs. BT: The Archaeology of Biphobia and Transphobia within the U.S. Gay and Lesbian Community. In: *Journal of Bisexuality* [Internet]. *Journal of Bisexuality*; 2004. p. 25–55. Available from: Weiss, Jillian Todd, GL vs. BT: The Archaeology of Biphobia and Transphobia within the U.S. Gay and Lesbian Community (January 15, 2004). *Journal of Bisexuality*, Vol. 3, pp. 25-55, 2004 , Available at SSRN: <https://ssrn.com/abstract=1649428>
77. Salway T, Ross LE, Fehr CP, Burley J, Asadi S, Hawkins B, et al. A Systematic Review and Meta-Analysis of Disparities in the Prevalence of Suicide Ideation and Attempt Among Bisexual Populations. *Arch Sex Behav*. 2019 Jan;48(1):89–111.
78. Rapid Response: Sexual health of heterosexually-identified men who have sex with men [Internet]. Toronto, ON: Ontario HIV Treatment Network; 2014. Available from: <https://www.ohntn.on.ca/wp-content/uploads/sites/9/2014/12/RR92-Hetero-MSM.pdf>
79. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *J Multidiscip Healthc*. 2016;9:211–7.
80. How to Support BISEXUAL YOUTH Ways to Care for Young People Who Are Attracted to More Than One Gender [Internet]. The Trevor Project; Available from: <https://www.thetrevorproject.org/wp-content/uploads/2020/09/How-to-Support-Bisexual-Youth.pdf>
81. bisexual health rainbow health ontario [Internet]. Rainbow Health Ontario; 2024. Available from: <https://www.rainbowhealthontario.ca/bisexual-health/>

82. Healthcare Equality Index 2022. Human Rights Campaign Foundation; 2022.
83. Standing against homophobia, transphobia and biphobia [Internet]. Statistics Canada; 2022 [cited 2023 Dec 7]. Available from:
<https://www150.statcan.gc.ca/n1/pub/45-28-0001/2021001/article/00031-eng.htm>
84. Booker CL, Rieger G, Unger JB. Sexual orientation health inequality: Evidence from Understanding Society , the UK Longitudinal Household Study. *Prev Med*. 2017 Aug;101:126–32.
85. Schuler MS, Rice CE, Evans-Polce RJ, Collins RL. Disparities in substance use behaviors and disorders among adult sexual minorities by age, gender, and sexual identity. *Drug Alcohol Depend*. 2018 Aug;189:139–46.
86. Krehely J. How to Close the LGBT Health Disparities Gap [Internet]. American Progress; 2009. Available from:
<https://www.americanprogress.org/article/how-to-close-the-lgbt-health-disparities-gap/>
87. Lesbian, Gay, and Bisexual Behavioral Health: Results from the 2021 and 2022 National Surveys on Drug Use and Health [Internet]. Substance Abuse and Mental Health Services Administration; 2023. Available from:
<https://www.samhsa.gov/data/sites/default/files/reports/rpt41899/2022NSDUHLGGBrief061623.pdf>
88. Dusing GJ, Kim C, Nielsen A, Chum A. Disparities in alcohol and substance-related hospitalizations and deaths across sexual orientations in Canada: a longitudinal study [Internet]. Open Science Framework; 2023 Jul [cited 2023 Aug 18]. Available from:
<https://osf.io/q4sm7>
89. Arnold BF, Hogan DR, Colford JM, Hubbard AE. Simulation methods to estimate design power: an overview for applied research. *BMC Med Res Methodol*. 2011 Dec;11(1):94.

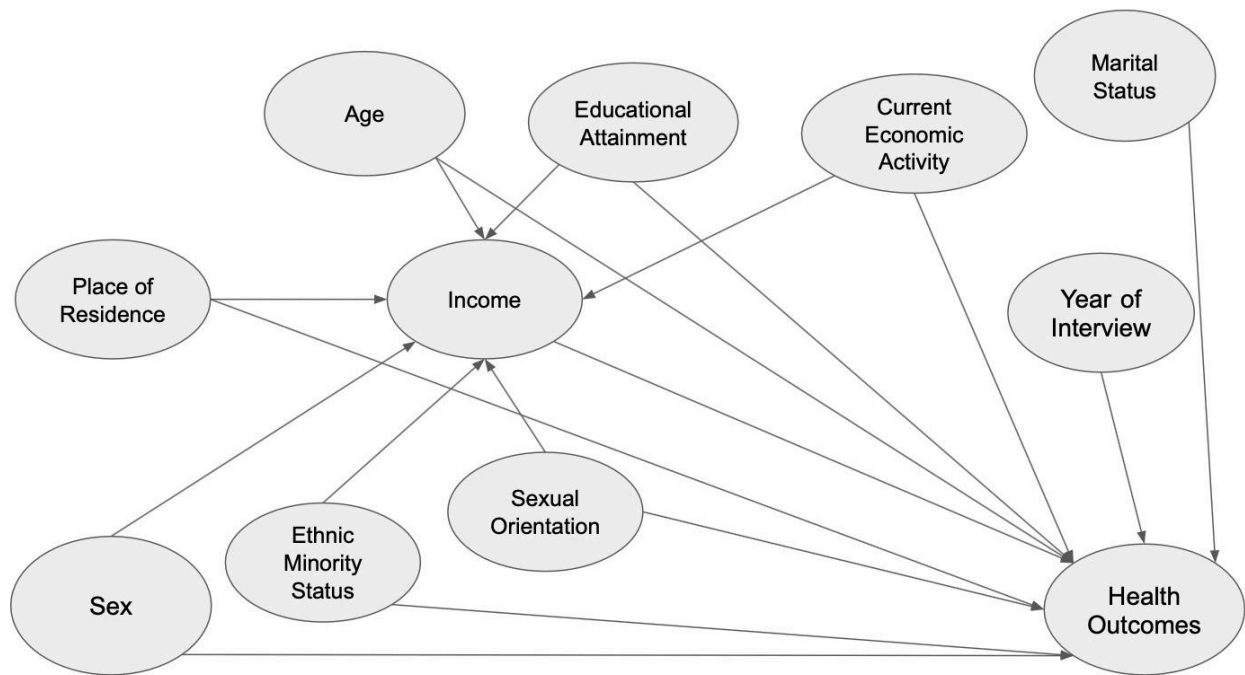
Appendix A

Table A1: Prior studies with their similar corresponding control variables for each health outcome

	Control Variables									
	Age	Married	Student Status	Education	Ethnicity	Employment	Rurality	Province/State	Year of Interview	Income
Mental Health (Nielsen et al 2023 (34))	x	x		x	x		x	NA: Single Region Study	x	
Mental Health (Chum et al 2023 (36))	x	x		x	x		x	NA: Single Region Study		
Mental Health (Azra et al 2023 (68))	x	x		x	x		x	NA: Single Region Study	x	
Substance Use (Dusing et al 2023 (88))	x	x	x	x		x		x	x	x
Physical Health (Bränström et al 2016 (13))	x	x			x		x	x		x

Note: 'x' indicates an article uses the corresponding control variable

Figure A1. Directed Acyclic Graph Depicting Potential Relationships Between Exposures and Health Outcomes.



Appendix B

Table B1. Weighted number of item non-response (including don't know and refused) for all variables

Variable	Item non-response, N (% of total responses)
Poor Mental Health	19,000 (0.10%)
Poor Physical Health	13,000 (0.07%)
Cannabis Use	84,000 (0.42%)
Illicit Drug Use	33,000 (0.17%)
Binge Drank Alcohol	80,000 (0.40%)
Married	29,000 (0.15%)
Has Completed Post-Secondary Education	126,000 (0.63%)
Current Student	0 (0.00%)
Ethnicity	827,000 (4.14%)
Employed in Last Year	3,000 (0.02%)
Lives Rural	0 (0.00%)
Year of Interview	0 (0.00%)
Residing Region	0 (0.00%)
Income Quintile	898,000 (4.49%)

^{Note} **Data pooled from 2009 to 2014, total weighted sample size n=19,980,000 individuals.**

Appendix C

Sample Size Calculations for the study.

Sample Size Calculation: Statistical analyses are performed using Stata 17 (StataCorp LLC, College Station, TX, USA). 95% confidence intervals with two-tailed tests were used. A simulation method (89) was used to generate robust estimates of the necessary sample size to achieve ample statistical power (i.e. alpha of 0.05 and minimum 1-beta of 0.80) using paramtest package in Rstudio 1.1.45666. Calculations were based on differences identified between LGB vs heterosexual individuals from prior studies: 1) sexual minorities reported poor or fair self-rated mental health 2-4 times higher than heterosexual individuals(83), with the latter reporting poor/fair self-rated mental health in 11% within nationally-representative Canadian samples; 2) LGB individuals reported binge drinking 36% more compared to heterosexuals (15% vs 11%)(84); 3) sexual minorities reporting 2 times higher past-year cannabis use than heterosexuals (25% vs 50%)(85); 4) six percent more of heterosexual individuals reported having excellent or very good health compared to LGB individuals (83% vs 77%)(86), and 5) sexual minority males and females were 2-3 times more likely to use illicit drugs compared to their heterosexual counterparts in the past year, with prevalence between 43 to 50% among LGB subgroups(87). Based on these differences, we wanted to determine sample size necessary to detect a difference between heterosexual and LGB groups using 50% of the pooled CCHS sample (to account for sex stratified analyses). We specified a predefined poisson regression model predicting the relative risk of each outcome as stated above using generated data. Since power is the long-run frequency of finding a significant result when there is a true effect, for each iteration, we created each outcome variable by defining its relationship to sexual orientation, e.g. 3x higher chance for poor/fair self-rated mental health in LGB vs heterosexual. Covariates were included given the known information from table 1 (e.g. proportion non-white was 24%), and mean age and income (and their corresponding standard deviations) for male

and female sexual minority groups were also generated using the `rnorm` functions given information from the table. Using the `paramtest` package, we ran the pre-defined simulations starting with a sample size of $n=10,000$, increasing n by 5000 every 100 iterations. We collated the 100 results at every sample size from 10,000 to 75,000 individuals (i.e. 50% of the CCHS sex-specific sample), with 2.5% of each sample defined as sexual minority individuals. At $n=75,000$, power ranged from 0.92 (92/100 simulated models returned a significant difference between sexual minority vs. heterosexuals for self-rated physical health) and up to 0.99+ (for self-rated mental health, binge drinking alcohol, past-year illicit drug use, and past-year cannabis use). Survey weights as provided by Statistics Canada are applied to all models to ensure generalizability of the models to the Canadian population.

Appendix D

Table D1. Male poisson risk ratios and unimputed odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians

Sexual Orientation	Risk Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Model	Poisson models		Unimputed models	
	Model 1c: Poor Mental Health (Male)		Model 1d: Poor Mental Health (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.48 (1.13-1.92)	0.004	1.68 (1.21-2.35)	0.002
Bisexual	2.20 (1.77-2.74)	0.000	2.58 (1.81-3.67)	0.000
Don't Know	0.97 (0.56-1.67)	0.900	0.94 (0.44-2.02)	0.871
Refuse	1.21 (0.64-2.30)	0.557	1.46 (0.53-4.02)	0.459
	Model 2c: Poor Physical Health (Male)		Model 2d: Poor Physical Health (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.17 (0.92-1.49)	0.198	1.27 (0.92-1.75)	0.150
Bisexual	1.49 (1.08-1.81)	0.010	1.56 (1.05-2.31)	0.027
Don't Know	0.69 (0.44-1.09)	0.110	0.65 (0.33-1.27)	0.208
Refuse	1.13 (0.67-1.92)	0.639	1.63 (0.74-3.60)	0.223
	Model 3c: Binge Drinks Alcohol (Male)		Model 3d: Binge Drinks Alcohol (Male)	
Heterosexual	Reference		Reference	
Homosexual	0.98 (0.91-1.05)	0.557	0.88 (0.71-1.09)	0.256
Bisexual	0.98 (0.87-1.10)	0.710	0.97 (0.67-1.42)	0.887
Don't Know	0.56 (0.39-0.81)	0.002	0.27 (0.15-0.49)	0.000
Refuse	0.63 (0.47-0.84)	0.001	0.37 (0.21-0.64)	0.000
	Model 4c: Uses Illicit Drugs (Male)		Model 4d: Uses Illicit Drugs (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.14 (0.84-1.56)	0.398	1.10 (0.73-1.65)	0.649
Bisexual	1.26 (0.89-1.79)	0.187	1.39 (0.85-2.28)	0.192
Don't Know	0.18 (0.09-0.34)	0.000	0.11 (0.04-0.28)	0.000
Refuse	0.46 (0.24-0.88)	0.020	0.32 (0.12-0.83)	0.019

	Model 5c: Uses Cannabis (Male)		Model 5d: Uses Cannabis (Male)	
Heterosexual	Reference		Reference	
Homosexual	1.11 (0.80-1.55)	0.525	1.13 (0.73-1.74)	0.594
Bisexual	1.16 (0.82-1.64)	0.397	1.24 (0.76-2.01)	0.386
Don't Know	0.17 (0.09-0.33)	0.000	0.10 (0.04-0.27)	0.000
Refuse	0.41 (0.21-0.82)	0.012	0.25 (0.09-0.71)	0.009

Note Data pooled from 2009 to 2014, total weighted sample size n=19,980,000 individuals. Adjusted models are controlled for variables including year of birth, marital status, educational attainment, student status, self-reported ethnic minority status, employment status, rurality status, province of residence, year of interview, and federal income.

Table D2. Female poisson risk ratios and unimputed odds ratios for poor physical health, poor mental health, binge drinking, using illicit drugs, and using cannabis across sex and sexual orientation for Canadians

Sexual Orientation	Risk Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Model	Poisson models		Unimputed models	
	Model 6c: Poor Mental Health (Female)		Model 6d: Poor Mental Health (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.26 (0.96-1.65)	0.090	1.33 (0.95-1.86)	0.099
Bisexual	2.64 (2.21-3.17)	0.000	3.47 (2.64-4.57)	0.000
Don't Know	1.03 (0.63-1.68)	0.904	1.18 (0.61-2.29)	0.627
Refuse	1.30 (0.78-2.18)	0.317	0.88 (0.41-1.90)	0.749
	Model 7c: Poor Physical Health (Female)		Model 7d: Poor Physical Health (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.13 (0.87-1.46)	0.369	1.22 (0.86-1.73)	0.267
Bisexual	2.00 (1.65-2.41)	0.000	2.53 (1.89-3.40)	0.000
Don't Know	0.87 (0.56-1.36)	0.532	0.69 (0.36-1.33)	0.266
Refuse	1.16 (0.71-1.89)	0.563	1.35 (0.58-3.16)	0.492
	Model 8c: Binge Drinks Alcohol (Female)		Model 8d: Binge Drinks Alcohol (Female)	
Heterosexual	Reference		Reference	

Homosexual	1.20 (1.08-1.33)	0.001	1.53 (1.14-2.05)	0.005
Bisexual	1.21 (1.13-1.30)	0.000	1.61 (1.28-2.03)	0.000
Don't Know	0.50 (0.35-0.70)	0.000	0.33 (0.21-0.54)	0.000
Refuse	0.67 (0.45-1.00)	0.050	0.58 (0.26-1.32)	0.196
	Model 9c: Uses Illicit Drugs (Female)		Model 9d: Uses Illicit Drugs (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.74 (1.27-2.38)	0.001	1.85 (1.26-2.71)	0.002
Bisexual	2.08 (1.61-2.67)	0.000	2.32 (1.62-3.30)	0.000
Don't Know	0.30 (0.09-0.99)	0.047	0.22 (0.04-1.17)	0.076
Refuse	0.69 (0.21-2.21)	0.526	0.48 (0.14-1.67)	0.249
	Model 10c: Uses Cannabis (Female)		Model 10d: Uses Cannabis (Female)	
Heterosexual	Reference		Reference	
Homosexual	1.68 (1.22-2.31)	0.002	1.79 (1.21-2.64)	0.003
Bisexual	2.07 (1.62-2.65)	0.000	2.36 (1.66-3.34)	0.000
Don't Know	0.36 (0.13-1.03)	0.056	0.31 (0.08-1.16)	0.081
Refuse	0.66 (0.21-2.09)	0.476	0.45 (0.12-1.62)	0.220

^{Note} Data pooled from 2009 to 2014, total weighted sample size n=19,980,000 individuals. Adjusted models are controlled for variables including year of birth, marital status, educational attainment, student status, self-reported ethnic minority status, employment status, rurality status, province of residence, year of interview, and federal income.