Lifetime Prevalence of Suicide Attempts Among Sexual Minority Adults by Study Sampling Strategies: A Systematic Review and Meta-Analysis

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Background. Previous reviews have demonstrated a higher risk of suicide attempts for lesbian, gay, and bisexual (LGB) persons (sexual minorities), compared with heterosexual groups, but these were restricted to general population studies, thereby excluding individuals sampled through LGB community venues. Each sampling strategy, however, has particular methodological strengths and limitations. For instance, general population probability studies have defined sampling frames but are prone to information bias associated with underreporting of LGB identities. By contrast, LGB community surveys may support disclosure of sexuality but overrepresent individuals with strong LGB community attachment.

Objectives. To reassess the burden of suicide-related behavior among LGB adults, directly comparing estimates derived from population- versus LGB community–based samples.

Search methods. In 2014, we searched MEDLINE, EMBASE, PsycInfo, CINAHL, and Scopus databases for articles addressing suicide-related behavior (ideation, attempts) among sexual minorities.

Selection criteria. We selected quantitative studies of sexual minority adults conducted in nonclinical settings in the United States, Canada, Europe, Australia, and New Zealand.

Data collection and analysis. Random effects meta-analysis and meta-regression assessed for a difference in prevalence of suicide-related behavior by sample type, adjusted for study or sample-level variables, including context (year, country), methods (medium, response rate), and subgroup characteristics (age, gender, sexual minority construct). We examined residual heterogeneity by using τ^2.

Main results. We pooled 30 cross-sectional studies, including 21 201 sexual minority adults, generating the following lifetime prevalence estimates of suicide attempts: 4% (95% confidence interval [CI] = 3%, 5%) for heterosexual respondents to population surveys, 11% (95% CI = 8%, 15%) for LGB respondents to population surveys, and 20% (95% CI = 18%, 22%) for LGB respondents to community surveys (Figure 1). The difference in LGB estimates by sample type persisted after we accounted for covariates with meta-regression. Sample type explained 33% of the between-study variability.

Author's conclusions. Regardless of sample type examined, sexual minorities had a higher lifetime prevalence of suicide attempts than heterosexual persons; however, the magnitude of this disparity was contingent upon sample type. Community-based surveys of LGB people suggest that 20% of sexual minority adults have attempted suicide.

Public health implications. Accurate estimates of sexual minority health disparities are necessary for public health monitoring and research. Most data describing these disparities are derived from 2 sample types, which yield different estimates of the lifetime prevalence of suicide attempts. Additional studies should explore the differential effects of selection and information biases on the 2 predominant sampling approaches used to understand sexual minority health. (*Am J Public Health*. 2016;106:e1–e12. doi:10.2105/AJPH.2016.303088)

PLAIN-LANGUAGE SUMMARY

Lesbian, gay, and bisexual (LGB) people are more likely than heterosexual people to attempt suicide during their lifetime. Public health leaders and health care providers need an accurate estimate of the scope of this problem to prioritize and improve suicide prevention programs. Such estimates, however, have been difficult to achieve because LGB people may not be accurately identified or included in all types of studies. In this review, we combined published reports to arrive at a better estimate of how many LGB adults have attempted suicide. We found that as many as 20% of, or 1 in 5, LGB adults have attempted suicide during their lifetimes. The estimate is higher than previously thought, and higher within studies based in LGB community venues than within broad population surveys that include heterosexual and LGB respondents but require LGB persons to disclose their LGB identity. This research suggests that the type of study we use affects how we estimate the number of LGB persons who experience health issues—in this case, suicide attempts. We need more studies to understand why study type matters in this regard and to better identify groups within LGB communities who are most affected by suicide.

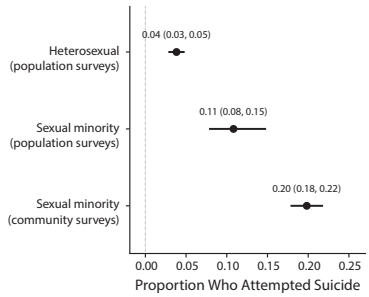

FIGURE 1—Lifetime Prevalence of Suicide Attempts by Sexual Identity and Sample Type

Sexual minorities are a diverse population, comprising those whose nonheterosexual identity (e.g., lesbian, gay, bisexual [LGB]), attractions, or behaviors make them vulnerable to social stigma related to heterosexual norms and practices.[1,2] In North America, sexual minorities experience multiple health inequities relative to heterosexual persons, including higher rates of violence, sexually transmitted infections, HIV/AIDS, substance or tobacco use, depression, anxiety, and suicide-related behavior.[3–5] An accurate quantification of the burden of these health outcomes is critical to prioritizing prevention policies and programs, monitoring changes in health status over time, and further studying the particular causes of the disparities.[6]

Epidemiological evidence for health disparities among sexual minorities has come from 1 of 2 distinct sampling methods: general population surveys, which yield predominantly heterosexual samples, and LGB community–based surveys, which yield exclusively LGB samples.[7,8] General population surveys are typically administered by government research organizations, and use probability sampling within a defined sampling frame. To identify sexual minorities within these surveys, respondents must self-report an LGB identity or same-gender sexual behaviors or attractions.[7] By contrast, community-based surveys are typically administered by—or in collaboration with—LGB community organizations; these surveys recruit sexual minorities through LGB venues, either in-person (e.g., bars, businesses, events) or online (e.g., LGB Web sites).[9]

Each of these methods has particular strengths and limitations. By using a defined sampling frame, population surveys are representative with respect to geography and other defined selection factors. However, because there is no enumeration of sexual minorities, it remains unclear to what extent these surveys recruit sexual minority subsamples that are representative of the true sexual minority source population.[7] Population surveys are furthermore prone to underreporting (misclassification) of sexual minority identity or behaviors, because of their stigmatized status.[10] The degree of this misclassification is not well understood, though in a 2011 Canadian survey of 8382 community-recruited gay and bisexual men, 30% indicated they would be unwilling to disclose their sexual orientation to a government interviewer.[11]

By contrast, community-based studies obviate this form of information bias—by definition all respondents are sexual minorities—but may be more susceptible to selection bias than general population surveys, depending on how the samples are recruited.[7] Some studies have found evidence that venue-based LGB community surveys tend to overrepresent gay- or lesbian-identified, urban, and high-income sexual minorities.[12] The direction of selection bias in community-based samples notably depends on the outcome and its relationship to selection factors.[12]

Numerous epidemiological studies over the past 40 years have identified an association between sexual minority status and suicide-related behavior—most often measured as self-reported history of suicide attempt.[13] One meta-analysis found that 11.6% of sexual minorities (n = 4845) had attempted suicide during their lifetime, a prevalence 2.5 times greater than that among heterosexuals.[14] This study applied especially strict inclusion criteria, and consequently included only 4 studies in the pooled estimate. Another review was restricted to youths (aged < 21 years) and found a slightly higher, though comparable effect estimate (odds ratio = 3.18 for suicide attempts).[15] Both of these meta-analyses excluded LGB community–based samples.[14,15]

In light of the methodological trade-offs between population and community-based samples—and corresponding potential for bias—this systematic review and meta-analysis aimed to reassess the burden of suicide-related behavior among sexual minorities, directly comparing estimates derived from general population versus community-based samples. The primary objective was to estimate the prevalence of suicide attempts among sexual minorities sampled from general population and community-based surveys. A secondary objective was to examine other study- or sample-level characteristics that may explain some of the heterogeneity in this outcome. Consistent with the ecosocial theory of disease distribution,[16] and intersectionality frameworks,[17] sexual minority inequities in health outcomes are expected to vary by time, place, and intersecting social categories (such as gender). Given distinct age-related patterns in the frequency and fatality of suicide attempts (i.e., suicide attempts are more common during adolescence, whereas fatal suicide rates increase with age[18,19]), and because patterns of suicide-related risk among sexual minority adults remain understudied and poorly understood in particular,[13] our systematic review excluded studies that were restricted to youths or adolescents.

METHODS

Reporting for this systematic review follows the PRISMA statement on standardized reporting of systematic reviews and meta-analyses.[20] The protocol was registered in the PROSPERO database (no. CRD42014013203).

We searched the following biomedical, psychology, and social science databases on August 12, 2014: MEDLINE, EMBASE, PsycInfo, CINAHL (excluding MEDLINE), and Scopus (social science). Searches selected the intersection of articles addressing suicide-related behavior and those reporting on sexual minorities (the latter were identified by using a broad set of search terms [e.g., lesbian, gay, bisexual, homosexuality, sexual orientation]; detailed strategies are shown in Box A, available as a supplement to the online

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version of this article at http://www.ajph.org). We used indexed subject headings where possible; otherwise we performed keyword searches. We imposed no calendar-year limits because year of study was a covariate of interest.

We included quantitative studies published in English-language, peer-reviewed journals. Eligible studies were conducted in a community or population (nonclinical) setting, reported prevalence of suicide attempts or suicide-related ideation (thoughts), and included identifiable sexual minorities of all ages (i.e., studies not limited to youths). Studies were restricted to Canada, United States, Europe, Australia, and New Zealand, because of these countries' comparable—though still varied—societal attitudes toward homosexuality[21] (criteria are in Box B, available as a supplement to the online version of this article at http://www.ajph.org).

We de-duplicated retrieved records by using RefWorks (ProQuest, Ann Arbor, MI). We individually reviewed titles and abstracts to remove articles without primary data, case reports, qualitative studies, and studies that failed to meet eligibility criteria based on details included in the abstract. Two authors (T. S. H., L. B.) independently reviewed all full texts of the remaining articles in detail to confirm eligibility. Agreement between reviewers was high ($\kappa = 0.96$); disagreements were resolved by consensus. If data from a single study were reported across multiple publications, we selected only 1 report, giving preference to reports that included subgroups of interest (see the next paragraphs). Reference lists of included publications were manually reviewed to identify additional studies not retrieved from the literature databases.

Data Extraction

We extracted the following data from all studies selected for inclusion.

Outcomes. Primary outcomes were self-reported suicide attempts, past 12 months or lifetime (measured separately). Secondary outcomes were self-reported suicide-related ideation, past 12 months or lifetime. Suicide attempts were preferred to suicide-related ideation because the former are considered better proxies for suicide deaths and have more valid and reliable measurement properties than the less-specific marker of suicide-related ideation.[22,23]

Study-level contextual variables. We extracted median year of survey and country for each study. If not reported, we imputed median year for an individual study by subtracting the median difference between publication year and median year of study for all other studies included in analysis from the publication year of the individual study.

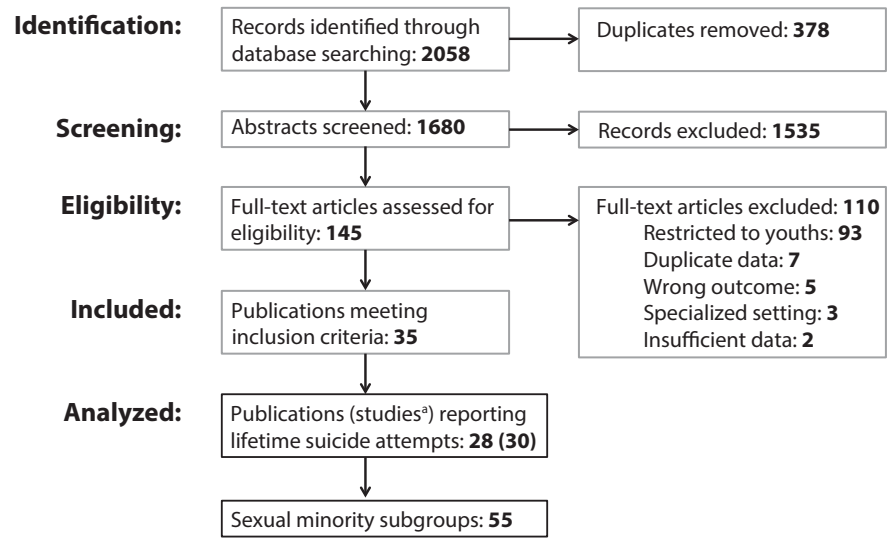
Study-level methodological ("risk of bias") variables. We extracted sample type (population, community), sample mechanism (random, convenience, snowball, respondent-driven), medium (telephone interview, in-person interview, self-administered online, self-administered by paper), and response rate for each study.

Subgroup-level variables. Most studies reported outcome data for multiple subgroups by gender and sexual minority category (e.g., gay men, bisexual men, lesbian women, bisexual women). For each subgroup, we extracted the mean age at interview (more frequently reported than median age), gender, and sexual minority definitions. We categorized sexual minority constructs as follows: lesbian or gay; bisexual; lesbian, gay, or bisexual (for studies that did not stratify results among these categories); and other (i.e., classifications independent of sexual orientation or identity, such as those attracted to or sexually active with persons of the same gender). If reported, we also extracted data for heterosexual subgroups (including those exclusively attracted to or sexually active with members of the opposite gender).

Because sampling category was a primary variable of interest, and because traditional risk-of-bias scales do not address the particular methodological concerns with this study topic, we did not use a risk-of-bias scale. Rather, we used risk-of-bias variables (sample type, sample mechanism, medium, and response rate) as covariates in the analysis. This approach is consistent with the Meta-analysis of Observational Studies in Epidemiology guidelines.[24]

Analysis

The principal summary measure of this meta-analysis is a proportion. To increase statistical power and improve the representativeness of this meta-analysis, we only included outcomes reported in more than 50% of studies in the meta-analysis. Proportions were double-arcsine transformed by using the Freeman–Tukey method to ensure that the full confidence intervals (CIs) fell between 0 and 1.[25,26] The unit of analysis was subgroup, as defined previously, given that subgroups varied with regard to some of the



[a]Two publications reported results from 2 separate studies.

FIGURE 2—Flowchart of Studies Screened and Included in a 2014 Systematic Review and Meta-Analysis of Suicide-Related Behavior in Sexual Minority Populations

factors of interest (i.e., gender, sexual minority construct or category, and age). We conducted analysis in 2 steps. First, random-effects meta-analysis generated pooled estimates for each of the following subgroups: heterosexual respondents from population samples; sexual minority respondents from population samples; and sexual minority respondents from community-based samples. We selected random effects a priori because heterogeneity was expected, and inference about the factors that modify this effect was a primary objective of the study. We used the DerSimonian–Laird approach to account for between-study variability.[27]

Second, we used meta-regression to assess the relationship between sample type and the outcome, while accounting for other study-level and subgroup-level covariates listed previously.[28] We excluded covariates with missing values or analyzed them in separate multivariable models. We also used meta-regression to determine how much variability was accounted for by these covariates (secondary objective). We applied the Knapp and Hartung adjustment in all multivariable models.[29] We evaluated covariate associations based on coefficients (unstandardized; b) and 95% CIs. We examined residual heterogeneity by using τ^2, R^2 (= [$\tau^2_{\text{null model}}$—$\tau^2_{\text{multivariable model}}$]/$\tau^2_{\text{null model}}$), I^2, and the Cochran Q test ($P < .05$ considered statistically significant).[29] We used a funnel plot, along with the Egger test for asymmetry, to assess for publication bias.[30] We completed analyses in R version 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria) by using the metafor package.[29]

RESULTS

We reviewed 1680 unduplicated titles and abstracts, resulting in 145 full texts, of which 36 met the eligibility criteria (Figure 2).[4,31–64] The most common reasons for exclusion were youth-restricted samples (85%) and duplicate data (6%). The 36 eligible reports included data from 38 distinct studies. Six of these (16%) reported on suicide attempts in the past 12 months, 31 (82%) on lifetime suicide attempts, 19 (50%) on suicide-related ideation in the past 12 months, and 4 (11%) on lifetime suicide-related ideation. On this basis, we only carried forward the lifetime suicide attempts outcome for meta-analysis.[31–36,38–40,42,44,46–61,63,64] One study had an unclear sample type (i.e., used a mixture of population-based and community-based sampling methods) and we therefore excluded it from further analysis.[58] The resulting 30 studies included 55 sexual minority subgroups and 21 201 sexual minority respondents, which formed the basis of analysis.

Study Characteristics

All 30 studies were cross-sectional surveys. Nine were population-based, and 21 were community-based. Of the 9 population

TABLE 1—Characteristics of Studies Included in a 2014 Systematic Review of Suicide-Related Behavior in Sexual Minority Populations, by Sample Type: United States, Canada, and Western Europe

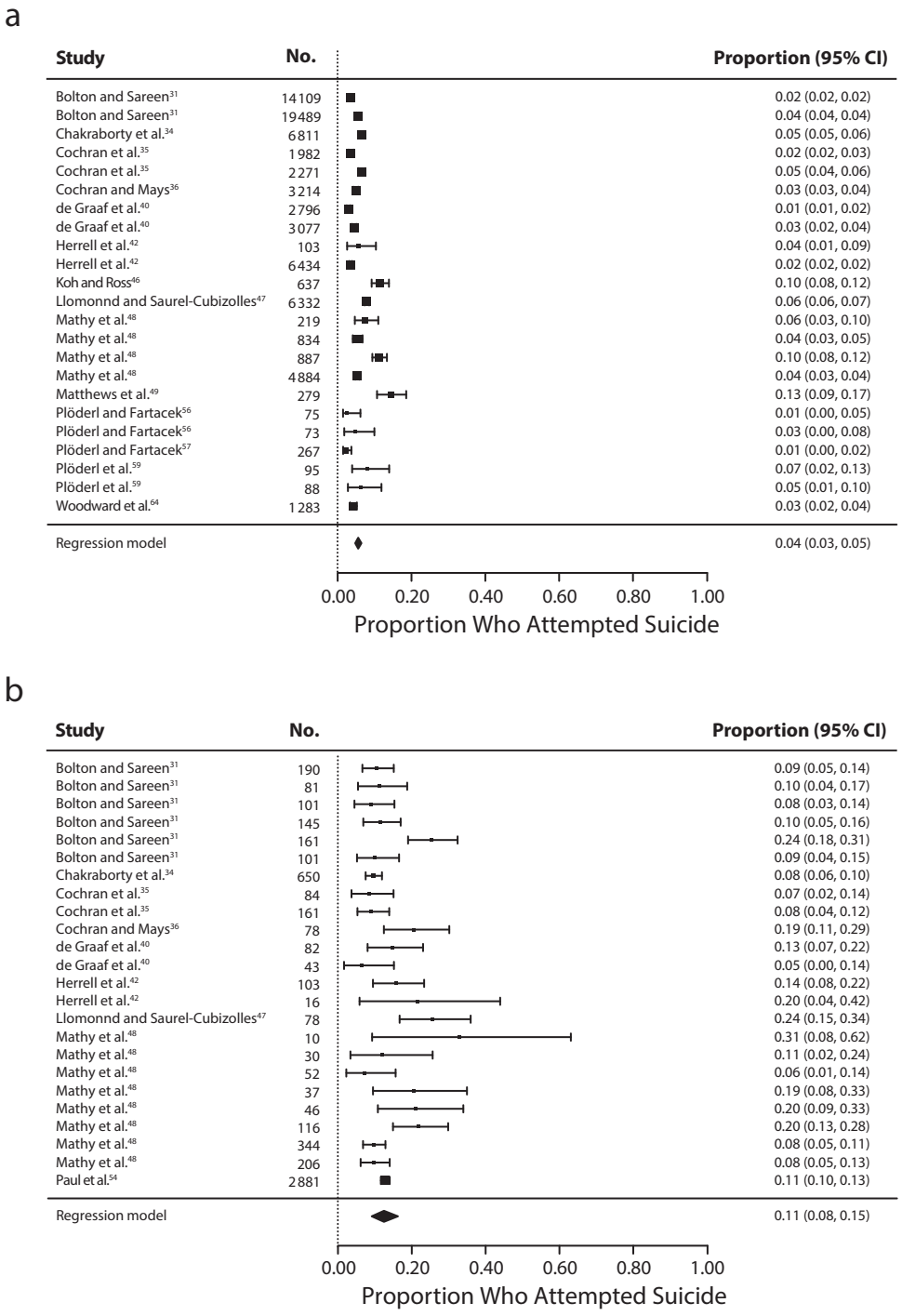
Variables	Population Surveys (n = 9), No. (%) or Mean (Range)	Community Surveys (n = 21), No. (%) or Mean (Range)
Sampling mechanism		
Random or stratified random	8 (89)	0 (0)
Convenience	1 (11)	20 (95)
Snowball	0 (0)	1 (5)
Medium		
In-person interview	5 (56)	0 (0)
Phone interview	3 (33)	0 (0)
Self-administered by computer	0 (0)	2 (10)
Self-administered online	1 (11)	3 (14)
Self-administered by paper	0 (0)	14 (67)
Self-administered online or by paper	0 (0)	2 (10)
Response rate, %[a]	0.72 (0.57, 0.82)	0.48 (0.24, 0.73)
Country or region		
United States	5 (56)	12 (57)
Canada	1 (11)	1 (5)
Western Europe	3 (33)	8 (38)
Median year of survey	1999 (1991, 2007)	1999 (1985, 2008)
Mean age of sample, y[b]	41.4 (38.6, 43.0)	32.7 (25.3, 41.1)
Sexual minority sample size	242 (10, 2881)	497 (27, 2401)

Note. Population surveys refer to general population surveys: these studies are typically administered by government research organizations, use defined probability sampling frames that yield predominantly heterosexual samples, and rely upon self-disclosure to identify sexual minorities. Community surveys refer to lesbian, gay, and bisexual (LGB) community–based surveys: these studies are typically administered by or in collaboration with LGB organizations and recruit sexual minorities through predominantly LGB venues.

[a]Response rate was not reported for 2 of 9 population surveys and 13 of 21 community surveys.

[b]Mean age was not reported for 6 of 9 population surveys and 7 of 21 community surveys.

surveys, 8 used a random (or stratified or multistage random) sampling mechanism; only 1 used a convenience sampling mechanism. Of the 21 community surveys, 20 used convenience sampling, and 1 used snowball sampling. Because of the lack of variability in sampling mechanism, we did not include this variable in further analysis. The medium for data collection (interviewer vs self-administered) was highly correlated with sample type: all but 1 population survey relied upon an interviewer to collect data, whereas



Note. CI = confidence interval.

FIGURE 3—Forest Plots of Proportion Reporting Lifetime Suicide Attempts Among (a) Heterosexual Respondents to Population Surveys, (b) Sexual Minority Respondents to Population Surveys, and (c) Sexual Minority Respondents to Community Surveys: 2014 Systematic Review

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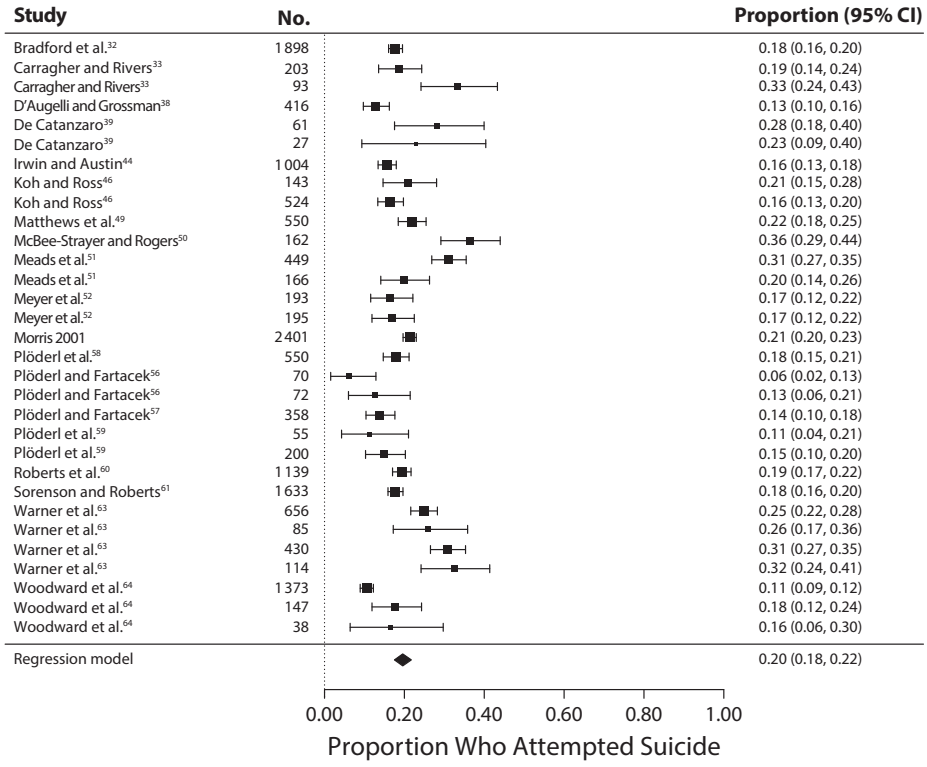

FIGURE 3—*continued*

all of the community surveys were self-administered. Response rates were only reported for 15 studies but tended to be higher on average for population surveys than for community surveys. Finally, community surveys recruited more sexual minority participants on average (497 vs 242 in population samples).

More than half of the studies (17 of 30, 57%) were conducted in the United States, 2 (7%) were conducted in Canada, and 11 (37%) in Western Europe. The median year of the surveys ranged from 1995 to 2008, with no difference between the 2 sample types. Community samples tended to include younger participants (mean age = 33 years vs 41 years in population samples), though mean age was only reported in 17 studies (Table 1; Table A, available as a supplement to the online version of this article at http://www.ajph.org).

Meta-analysis and Meta-regression

Pooled estimates of the proportion who attempted suicide during their lifetime were 0.04 (95% CI = 0.03, 0.05) for heterosexual respondents in population surveys (n = 76 239 individuals), 0.11 (95% CI = 0.08, 0.15) for sexual minority respondents in population surveys (n = 5796 individuals), 0.20 (95% CI = 0.18, 0.22) for sexual minority respondents in community surveys (n = 15 405 individuals; Figure 3a–c), and 0.17 (95% CI = 0.14, 0.20) for sexual minority respondents in both sample types combined (n = 21 201). A funnel plot of the outcome among sexual minority subgroups appeared symmetrical (Figure A, available as a supplement to the online version of this article at http://www.ajph.org; Egger test $P = .85$).

Community sample type, self-administration of surveys, and female subgroups were all significantly associated with a higher proportion of lifetime suicide attempts among sexual minorities in univariate meta-regression models (Table 2). Sexual minorities measured with non–identity-based constructs (e.g., based on sexual behavior or attraction) were also significantly associated with a lower proportion of lifetime suicide attempts. Calendar year and response rate were inversely associated with the outcome (note: calendar time was not associated with the outcome in a separate analysis of heterosexual subgroups from the same studies; data not shown). Mean age at interview was not significantly associated with the outcome, although data completion was low; because of the large amount of missing data, we did not include this variable in multivariable models. Gender and response rate were also missing for a large proportion of studies; thus, we included these variables in separate multivariable models. Neither was significantly associated with the outcome in multivariable models.

The association of sample type remained after we adjusted for covariates (year, country, and sexual minority construct; Table 3, model 1); the coefficient was only slightly reduced (from 0.100 to 0.096), and the association remained statistically significant. Because of its correlation with sample type, we did not include survey medium

TABLE 2—Association Between Study or Sample-level Characteristics and Proportion Reporting Lifetime Suicide Attempts Among Sexual Minority Persons: 2014 Systematic Review, United States, Canada, and Western Europe

Characteristic	Data Completion, No. (%)	Frequency No./Total No. (%), or Mean (Range)	Univariate, b (95% CI)	τ^2	$R^{2\%}$	$I^{2\%}$	Q_E (*df*)
Community sample (Ref = population)	55 (100)	31/55 (56)	0.100 (0.059, 0.142)	0.0039	32.8	85.9	340.1* (53)
Year	55 (100)	2000 (1985, 2008)	−0.005 (−0.009, −0.001)	0.0057	1.7	89.0	479.6* (53)
Country (Ref = United States)	55 (100)	32/55 (58)		0.0056	3.4	89.2	482.0* (52)
Canada		6/55 (11)	0.032 (−0.064, 0.128)				
Western Europe		17/55 (31)	0.047 (−0.003, 0.098)				
Sexual minority construct (Ref = lesbian or gay)	55 (100)	23/55 (42)		0.0053	8.6	87.3	402.2* (51)
Bisexual		10/55 (18)	0.013 (−0.052, 0.078)				
Lesbian, gay, or bisexual[a]		11/55 (20)	−0.026 (−0.085, 0.033)				
Other[b]		11/55 (20)	−0.071 (−0.135, −0.007)				
Self-administered survey (Ref = interviewer)	55 (100)	39/55 (71)	0.091 (0.044, 0.138)	0.0044	24.1	85.9	375.6* (53)
Male gender (Ref = female)	48 (87)	22/48 (46)	−0.055 (−0.100, −0.010)	[c]	[c]	[c]	[c]
Response rate	26 (47)	0.62 (0.24, 0.82)	−0.184 (−0.349, −0.020)	[c]	[c]	[c]	[c]
Mean age of sample, y	28 (51)	34.0 (25.3, 43.0)	−0.006 (−0.015, 0.002)	[c]	[c]	[c]	[c]

Note. b = average change in proportion; CI = confidence interval; *df* = degrees of freedom; Q_E = Cochran *Q* test for residual heterogeneity; Ref = reference level of factor variables. Mixed-effects meta-regression using DerSimonian–Laird approach. The sample size was n = 55 subgroups.

[a]Lesbian, gay, and bisexual identities not reported as separate subgroups.

[b]Other measure of nonheterosexual attraction or behavior (i.e., attracted to or sexually active with members of same gender).

[c]Measures of heterogeneity for inclusion of gender, response rate, and mean age cannot be compared with other models because they include fewer studies or subgroups (see Data Completion column).

*$P < .05$.

(interviewer vs self-administration) in the same model as sample type. Medium was not significantly associated with proportion of lifetime suicide attempts after we adjusted for covariates (model 2).

Thirty-five percent of the total variability between studies (τ^2) was explained by inclusion of the 4 covariates in model 1 (sample type, year, country, and sexual minority construct; Table 3). Most of this variability was explained by a single covariate: sample type ($R^2 = 0.33$; Table 2). Even after we included the 4 covariates in model 1, I^2 remained high (82%), and the Cochran *Q* test was statistically significant, suggesting that other variables not included in this analysis may explain some of the residual heterogeneity.

DISCUSSION

This systematic review demonstrates a high burden of suicide-related behavior—as measured by lifetime suicide attempts—among sexual minority adults in North America and Western Europe. The pooled estimate, however, was contingent upon the method by which participants were sampled. When we used general population surveys, we estimated that 11% (95% CI = 8%, 15%) of sexual minorities had attempted suicide. By contrast, use of community-based surveys that recruit sexual minorities through LGB venues resulted in a pooled estimate of 20% (95% CI = 18%, 22%). The difference between these 2 sample types persisted after we accounted for other study-level characteristics, including survey year, country, sexual minority construct, and gender. Community-based samples have been excluded from previously published meta-analyses on this topic[14,15]; therefore, this review highlights the need for sexual minority health researchers to better characterize the ways in which sample type, or other related methodological factors, influence our understanding of sexual minority health disparities.

Interpretation of Findings

To interpret this discrepancy in burden of suicide-related behavior estimates among sexual minorities, we provide a detailed review of the biases that differentially affect these 2 sampling methods. Both suicide-related behavior and sexual minority status are stigmatized in the North American and European contexts, and as such are generally underreported in health research,[10,11,18,65] thus creating information bias (i.e., misclassification). Presumably, suicide is equally stigmatized in both the general and LGB population, and suicide-related behavior is commonly underreported because of a social desirability bias, with varying magnitude of misclassification depending on the context and population.[18,65,66] This would suggest that suicide attempt misclassification will be nondifferential between general and LGB populations; however, the greater reliance upon interviewer administration in general population surveys may lead to greater misclassification of suicide attempts with this study design.[66]

By contrast, sexual minority status is likely more stigmatized when measured in a general population context than when measured within the LGB community—especially given that general population surveys require disclosure of LGB versus heterosexual identity or status, whereas LGB community

TABLE 3—Multivariable Mixed-Effects (Meta-Regression) Models Examining Associations Between Study or Sample-level Characteristics and Proportion Reporting Lifetime Suicide Attempts Among Sexual Minority Persons: 2014 Systematic Review, United States, Canada, and Western Europe

Characteristic	Null Model (No Covariates)	Multivariable Model 1, b (95% CI)	Multivariable Model 2, b (95% CI)	Multivariable Model 3, b (95% CI)
Community sample (Ref = population)[a]	NA	0.096 (0.033, 0.158)	NI	0.092 (0.023, 0.160)
Year	NA	−0.005 (−0.010, −0.001)	−0.006 (−0.011, −0.002)	−0.004 (−0.008, 0.001)
Country (Ref = United States)	NA			
Canada	NA	0.007 (−0.097, 0.110)	−0.034 (−0.141, 0.072)	0.023 (−0.078, 0.124)
Western Europe	NA	0.046 (−0.006, 0.099)	0.061 (0.006, 0.116)	0.063 (0.007, 0.120)
Sexual minority construct (Ref = lesbian or gay)	NA			
Bisexual	NA	0.069 (0.001, 0.137)	0.048 (−0.022, 0.119)	0.067 (0.001, 0.134)
Lesbian, gay, or bisexual[b]	NA	−0.018 (−0.076, 0.040)	−0.011 (−0.074, 0.051)	−0.024 (−0.086, 0.037)
Other[c]	NA	−0.002 (−0.081, 0.078)	−0.020 (−0.113, 0.074)	0.014 (−0.070, 0.097)
Self-administered survey (Ref = interviewer)[a]	NA	NI	0.067 (−0.011, 0.144)	NI
Male gender (Ref = female)[d]	NA	NI	NI	−0.034 (−0.080, 0.013)
Measures of heterogeneity				
τ^2	0.0058	0.0038	0.0043	[e]
R^2%	NA	34.5	25.9	[e]
I^2%	89.5	82.0	84.1	[e]
Q_E (*df*)	513.6 (54)*	261.0 (47)*	294.9 (47)*	[e]

Notes. b = average change in proportion; CI = confidence interval; df = degrees of freedom; NA = not applicable; NI = not included in model; Q_E = Cochran *Q* test for residual heterogeneity. Mixed-effects meta-regression using DerSimonian–Laird approach. The sample size was n = 55 subgroups.

[a]Sample type (community vs population) and medium (self- vs interviewer-administered) characteristics were highly correlated and therefore not included in the same multivariable models.

[b]Lesbian, gay, and bisexual identities not reported separately in analysis.

[c]Other measure of nonheterosexual attraction or behavior (i.e., attracted to or sexually active with members of same gender).

[d]Included in separate multivariable model because of missingness.

[e]Measures of heterogeneity for model including gender cannot be compared with other models because of missing data (gender only available for 48 of 55 subgroups).

*$P < .05$; P values determined by Cochran Q test for residual heterogeneity.

surveys are usually branded as such—making general population surveys more vulnerable to misclassification of sexual minority status than LGB community surveys.

In addition, suicide and LGB misclassification errors might be jointly related, resulting in differential misclassification.[67] For example, if those who are reluctant to report a sexual minority identity are also more likely to have attempted suicide, this would create a differential misclassification effect. This is plausible in light of studies that suggest that sexual minorities experience the highest risk of suicide attempts before coming out (i.e., expressing an LGB identity).[52,68–71] A combination of information biases related to underreporting of sexual minority status—particularly relevant to general population surveys—and underreporting of history of suicide-related behavior—relevant to both population and community study designs though potentially greater in interviewer-administered general population surveys—provides one likely interpretation of the results observed in this systematic review (i.e., pooled lifetime suicide attempt prevalence estimates of 11% in general population surveys and 20% in LGB community surveys).

In fact, the results observed in this systematic review are most consistent with differential misclassification of suicide attempts assuming greater misclassification in general population surveys (column F, Table 4), or a combination of differential misclassification of suicide attempts and misclassification of sexual minority status in general population surveys (column G, Table 4). It is notable that neither nondifferential misclassification of suicide attempts nor misclassification of sexual minority status is sufficient on its own to produce the disparity observed between population- and community-based suicide estimates in this study (columns C–E, Table 4; Box C, available as a supplement to the online version of this article at http://www.ajph.org).

Selection biases also warrant consideration in relation to the observed discrepancy by sample type. Survival bias is a limitation of all cross-sectional studies of suicide and thus cannot explain the difference between general population and LGB community sampling strategies. However, other forms of selection bias related to the sampling frame and willingness to participate may render these 2 sample types incomparable. Whereas general population surveys usually apply a sampling frame that is representative with respect to geography, LGB community surveys tend to rely upon convenience or other targeted sampling strategies.[8] Studies attempting to characterize the representativeness of LGB venue-based samples suggest

TABLE 4—Hypothetical Effects of Information Bias on Estimates of Burden of Suicide Attempts Among Sexual Minorities and Consistency With Observed Pooled Estimates From a 2014 Meta-Analysis of Observational Studies: United States, Canada, and Western Europe

			Reclassified Estimates				
Variable	(A) Hypothetical "Bias-Free" Estimates[a]	(B) Observed Estimates	(C) Nondifferential[b] Misclassification of Sexual Minority Status	(D) Differential[c] Misclassification of Sexual Minority Status	(E) Nondifferential[d] Misclassification of Suicide Attempts	(F) Differential[e] Misclassification of Suicide Attempts	(G) Differential[c] Misclassification of Sexual Minority Status (GP only) and Differential[e] Misclassification of Suicide Attempts
Sensitivity values							
Suicide attempts	$Se_{GP} = 1.00$ $Se_{LGB} = 1.00$	?	. . .	. . .	$Se_{GP} = 0.80$ $Se_{LGB} = 0.80$	$Se_{GP} = 0.44$ $Se_{LGB} = 0.80$	$Se_{GP} = 0.28$ $Se_{LGB} = 0.80$
Sexual minority status	Se = 1.00	?	Se = 0.70	$Se_{D-} = 0.70$ $Se_{D+} = 0.28$	. . .	. . .	$Se_{D-} = 0.70$ $Se_{D+} = 0.28$
General population survey							
Suicide attempts, no.	25	11	18	7	20	11	7
Sexual minorities, no.	100	100	70	60	100	100	60
Prevalence	0.25	0.11	0.25	0.11	0.20	0.11	0.11
Consistent with observed?				X		X	X
LGB community survey							
Suicide attempts, no.	25	20	NA	NA	20	20	20
Sexual minorities, no.	100	100	NA	NA	100	100	100
Prevalence	0.25	0.20	NA	NA	0.20	0.20	0.20
Consistent with observed?					X	X	X

Note. ? = unknowable sensitivity values; D- = in absence of outcome (history of suicide attempt); D+ = in presence of outcome (history of suicide attempt); GP = as applied to general population surveys; LGB = as applied to lesbian, gay, and bisexual community surveys; NA = not applicable; Se = sensitivity (or proportion of individuals correctly classified as sexual minorities, or with history of suicide attempt). See Box C for full explanatory text.

[a]All calculations are based on a hypothetical survey free of information bias, in which 25/100 = 0.25 sexual minorities have attempted suicide.

[b]Nondifferential with respect to outcome (history of suicide attempt).

[c]Assuming greater misclassification (lower Se) in the presence of outcome (history of suicide attempt).

[d]Nondifferential with respect to sample type (GP vs LGB).

[e]Assuming greater misclassification (lower Se) for general population surveys.

that urban community venue–based studies tend to oversample those with a gay identity, those who live in urban centers, and those with higher income, although each of these depends on the particular sample, and recruitment venues used.[12] As each of these factors is associated with lower risk of suicide-related behavior, however, these particular selection factors are also unlikely to explain the higher proportion found in our analysis: (1) gay- or lesbian-identified individuals have a lower average risk of lifetime suicide attempts than other sexual minority subgroups—notably bisexual persons (Table 2) and (2) urban residence and higher income likewise tend to be associated with lower rates of suicide-related behavior in general population studies.[72,73]

Our review emphasizes that when it comes to the health of sexual minorities, both context (i.e., place and time)[16] and intersecting social positions[17] matter. The higher proportion of suicide attempts among bisexual respondents in this meta-analysis is noteworthy (Table 3). A recent systematic review compared suicide-related behavior between bisexual people and both lesbian or gay and heterosexual counterparts, and concluded that, although suicide-related behavior was consistently higher relative to heterosexual comparators, differences between bisexual and lesbian or gay groups were mixed.[74] Our study expands on these findings by suggesting that bisexual people experience higher risk of suicide attempts than gay- or lesbian-identified people, even after we accounted for the study sample type. Finally, the temporal decrease in proportion of sexual minorities who report having attempted suicide in their lifetime is a novel finding. To the extent that suicide-related behavior among sexual minorities is explained by overt stigma and related minority stress,[75–77] this finding may reflect shifting societal attitudes toward sexual minorities in North America and Europe.[78] More significantly, it underscores that sexual minority health is context-dependent and therefore may be amenable to change through improved societal conditions (e.g., institutional policies).[79]

Limitations

This systematic review is limited by survival bias, unmeasured and residual confounding, residual heterogeneity in pooled estimates, and publication bias. The outcome used in this study was self-reported suicide attempts. Although this measure is preferred to suicide ideation as a proxy for suicide mortality, it is an imperfect proxy.[22,23] Self-reported suicide attempts are inconsistent over one's lifetime and furthermore may not

have been life-threatening; the extent to which this limitation affects estimates of suicide burden remains a source of debate.[80,81] Furthermore, suicide attempts can only be reported by those who survive. The resulting survival bias is a common limitation of studies of suicide-related behavior but particularly affects cross-sectional studies, the design of all 30 studies included in this review.

We attempted to account for differences across studies and sample subgroups by using meta-regression. Ultimately, only 6 study- or subgroup-level characteristics were consistently measured across all 30 studies. This analysis is therefore limited by unmeasured and residual confounding. Both interview age and response rate were associated with sample type but were not reported in enough studies to include these covariates in multivariable models; these potential confounders could therefore, at least partially, explain the observed association between sample type and prevalence of suicide attempts. (Exploratory models including only sample type and interview age, and sample type and response rate, respectively, did not decrease the coefficient estimate for sample type, although statistical significance was lost.)

Furthermore, the measures of geography (categorized by country) and sexual minority construct likely were insufficiently precise to fully account for the heterogeneity of suicide-related behavior, as evidenced by the high degree of residual heterogeneity in fully adjusted meta-regression models ($I^2 = 82\%$). Eleven of the 55 sexual minority subgroups were measured on the basis of same-gender attraction or sexual experience; these behavioral constructs imply distinct pathways and risk factors from those based on identity, and other researchers have cautioned against combining or comparing these constructs.[82] Identifying individual and study-level sources of heterogeneity is a priority area for research on this topic, as others have noted.[13,15]

Publication bias affects all systematic reviews.[24] The funnel plot and Egger test did not indicate significant asymmetry in the results of this meta-analysis, suggesting minimal impact of publication bias on the observed findings. We did not include gray literature in this review, which may have provided studies showing a lower prevalence of suicide-related behavior, nor did we include reports published in non-English languages. Lastly, the generalizability of this review is limited by the geographic and age-related restrictions applied; thus, our findings may not apply to countries outside North America and Western Europe, nor to younger populations.

Implications

In North America, and in the United States in particular, more federally funded surveys are beginning to collect data on sexual minority status to further understand sexual minority health disparities.[5] These national health surveys are now being linked with administrative health data, including vital statistics (mortality) records.[83] Researchers need a comprehensive understanding of the biases affecting these data, as well as those affecting LGB community–based data, so they may critically appraise and interpret the results from these studies. To this end, quantitative bias analysis may allow researchers to model the differential effects of selection and information biases.[84,85] To enable these analyses, more population health data on LGB people—from both types of samples—is required.[86]

This review both strengthens and extends the body of evidence concerning suicide attempts among sexual minorities. Although most previous research has focused on youths[15] (Figure 2), we estimated an elevated prevalence of suicide attempts based on a pooled sample of 21 201 sexual minority adults. Furthermore, our analysis suggests a higher lifetime prevalence of sexual minority suicide attempts (17%) than estimated by a previous meta-analysis (12% among n = 4845 sexual minorities) that excluded LGB community–derived samples.[14] Recent empirical studies support the use of both structural (e.g., public policy aimed at decreasing the experiences and impact of sexual stigma and related discrimination[87,88]) and individual-level (e.g., LGB-affirmative cognitive–behavioral therapy[89]) interventions to prevent psychological distress and, in turn, suicide, among sexual minorities.[13,77] Previous research demonstrates that among adults—in both general[90,91] and LGB populations[92]—a lifetime history of suicide attempts increases the subsequent risk of repeat attempts, some fatal. In accordance, both sets of interventions are needed over the entire life course to reduce the ongoing risk in sexual minority adults. AJPH

CONTRIBUTORS

T. Salway Hottes originated and designed the study, conducted the analyses, and wrote the first draft of the article. T. Salway Hottes and L. Bogaert reviewed all full texts of articles to assess for eligibility in analyses. D. Gesink, A. E. Rhodes, and D. J. Brennan provided supervision to the first author and assisted with analysis and interpretation of results. All authors reviewed and contributed to drafting the article and approved the final article.

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No protocol approval was necessary for this study because no human participants were involved.

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