

Suicide Risk and Sexual Orientation: A Critical Review

Martin Plöderl · Eric-Jan Wagenmakers · Pierre Tremblay ·
Richard Ramsay · Karl Kralovec · Clemens Fartacek ·
Reinhold Fartacek

Received: 8 July 2011 / Revised: 22 January 2012 / Accepted: 19 August 2012 / Published online: 26 February 2013
© Springer Science+Business Media New York 2013

Abstract Many studies have reported higher rates of suicide attempts among sexual minority individuals compared with their heterosexual counterparts. For suicides, however, it has been argued that there is no sexual orientation risk difference, based on the results of psychological autopsy studies. The purpose of this article was to clarify the reasons for the seemingly discrepant findings for suicide attempts and suicides. First, we reviewed studies that investigated if the increased suicide attempt risk of sexual minorities resulted from biased self-reports or less rigorous assessments of suicide attempts. Second, we reanalyzed the only two available case–control autopsy studies and challenge their original “no difference” conclusion by pointing out problems with the interpretation of significance tests and by applying Bayesian statistics and meta-analytical procedures. Third, we reviewed register based and clinical studies on the association of suicides and sexual orientation. We conclude that studies of both

suicide attempts and suicides do, in fact, point to an increased suicide risk among sexual minorities, thus solving the discrepancy. We also discuss methodological challenges inherent in research on sexual minorities and potential ethical issues. The arguments in this article are necessary to judge the weight of the evidence and how the evidence might be translated into practice.

Keywords Suicide · Sexual orientation · Homosexuality · Sexual minority · Bayesian statistics

Introduction

Many individual studies, several study reviews, and two meta-analyses have concluded that sexual minority individuals report higher rates of suicide attempts than heterosexuals (e.g., Bagley & Tremblay, 2000; Haas et al., 2011; Kann et al., 2011; King et al., 2008; Lewis, 2009; Marshal et al., 2011; McDaniel, Purcell, & D’Augelli, 2001; Meyer, 2003; Plöderl, Sauer, & Fartacek, 2006; Russell, 2003). In this article, we use the term “sexual minority” to refer to individuals with a non-heterosexual self-identification (gay, lesbian, bisexual, unsure, queer), non-heterosexual behavior, or non-heterosexual attraction. In the most extensive literature overview (Ramsay & Tremblay, 2012a), the increased risk was found in nearly all studies conducted in many locations worldwide that used different sampling procedures, varying definitions of sexual orientation, or type of publication (peer reviewed papers, books, dissertations, reports, etc.).

Concerning suicides among sexual minority individuals, however, results appear to be inconclusive. It has been stated that there is no evidence for an increased risk for suicides among sexual minority individuals, mainly based on a limited number of psychological autopsy studies (Renaud, Berlim, Begolli,

M. Plöderl · K. Kralovec · C. Fartacek · R. Fartacek
Suicide Prevention Research Program, Institute of Public Health,
Paracelsus Private Medical University, Salzburg, Austria

M. Plöderl (✉) · K. Kralovec · C. Fartacek · R. Fartacek
Sonderauftrag für Suizidprävention, Christian-Doppler-Klinik,
Ignaz-Harrer Str. 79, 5020 Salzburg, Austria
e-mail: m.ploederl@salk.at

M. Plöderl · C. Fartacek
University Institute of Clinical Psychology, Christian Doppler
Clinic, Salzburg, Austria

E.-J. Wagenmakers
Department of Psychology, University of Amsterdam, Amsterdam,
The Netherlands

P. Tremblay · R. Ramsay
Faculty of Social Work University of Calgary, Calgary, AB,
Canada

McGirr, & Turecki, 2010; Rich, Fowler, Young, & Blenkush, 1986; Shaffer, Fisher, Hicks, Parides, & Gould, 1995).¹ Thus, the conclusions about suicides clearly contrast with the conclusions about suicide attempts. This contrast is surprising and paradoxical, given that a suicide attempt is the strongest risk factor for a future suicide (Harris & Barraclough, 1997; Owens, Wood, Greenwood, Hughes, & Dennis, 2005).

The article's objective is to clarify the discrepancy of results for suicides and suicide attempts in relation to sexual orientation by considering studies that differentiated the seriousness of suicide attempts, by reanalyzing the data from psychological autopsy studies, and by including studies with other methodological approaches. Several reviews have noted the discrepancy (e.g., Haas et al., 2011; McDaniel et al., 2001; Muehrer, 1995), but we present additional arguments that are necessary to understand the seemingly paradoxical findings. Moreover, there are unique problems inherent in researching hidden populations that need to be taken into account for data interpretation. Finally, we discuss ethical concerns about the impact of suicide-related research findings on sexual minorities. Clarifying these issues is important given that the question "Are sexual minority individuals at increased risk for suicide?" has been answered in the literature with "yes," "no," and "not sure." As a result, sexual minority status has been deemed an important risk factor for suicide by some and doubted or ignored by others. Furthermore, mainstream youth and adult studies often lack sexual orientation information and sexual minorities have not always been acknowledged in suicide prevention programs. Our article explores and clarifies the weight of the evidence, how this evidence should be interpreted given the inherent methodological problems, and how the evidence may be translated into practice in light of ethical concerns.

Evidence for Suicide Attempts

As noted, numerous studies have reported elevated self-reported attempted suicide incidences among sexual minority individuals, compared with heterosexual counterparts, this being at odds with findings of seemingly not elevated suicides.

The discrepancy may be due to the caveats apparent in the studies about suicide attempts and sexual orientation, such as questionable representativeness of the study samples (e.g., from self-help groups), the lack of control groups, or definition problems for both suicide attempts and sexual orientation (Muehrer, 1995; Savin-Williams, 2001). However, these caveats dominating older studies have been overcome in many studies published since 1997. They feature improved methods

such as using birth cohorts, twin registries, prospective designs, representative and large-scaled adolescent and adult surveys, matching lesbian, gay, and bisexual (LGB) individuals with their heterosexual siblings, and using multiple definitions of sexual orientation (Haas et al., 2011; King et al., 2008; McDaniel et al., 2001; Plöderl et al., 2006; Russell, 2003).

Another explanation for the discrepancy is that the attempted suicide data lacked validity due to problems associated with self-reports (Plöderl, Kralovec, Yazdi, & Fartacek, 2011). It is known that, especially among adolescents, self-reported suicide attempts are often not "actual" suicide attempts or serious suicide attempts, these being "false positives" (Meehan, Lamb, Saltzman, & O'Carroll, 1992). This would only be problematic, however, if the validity of the self-reported suicide attempts varied by sexual orientation, as it was reported in only one but widely cited study (Savin-Williams, 2001), where the suicide attempt difference between heterosexual and LGB participants was no longer statistically significant after eliminating the false positives. Savin-Williams postulated that this may have been caused by sexual minority youth subscribing to a "suffering suicidal" script, i.e., sexual minority youth will exaggerate their reports of suicide attempts which were not serious because they assume that "suicide is a rite of passage for being young and gay" (Savin-Williams, 2001, p. 989).

A closer look at this study, however, leads to a problem discussed in greater detail below: the lack of statistical power. Whereas it was true that, among the female sample, eliminating false positive suicide attempts decreased the sexual orientation difference substantially, the "true suicide attempts" difference approached statistical significance in the male sample: 2% (1 of 61) among heterosexual males and 9% (5 of 53) among sexual minority males attempted suicide, resulting in $OR = 6.2$, 95% $CI = 0.7-300.0$, $p = .095$ (Fisher's exact test, two-sided, calculated from tabulated data in Ramsay & Tremblay, 2012a). The study, however, has a low observed power of 44%; in other words, the risk for a Type II error (falsely rejecting the hypothesis of a non-zero difference) is 61%. The appropriate sample size to achieve a power of 80% with $\alpha = .05$ in a two-sided Fisher test is $n = 300$ with 50% sexual minority individuals (see below for calculation details). Therefore, the study's conclusions should be qualified. Indeed, the results could be used to support the hypothesis that, among men, non-heterosexuals are at an increased risk for suicide attempts, even after using a more rigorous classification system of suicide attempts—an interpretation that contrasts with the interpretation of Savin-Williams. Two studies have directly applied Savin-Williams' method of separating true suicide attempts from false positives with follow up items, but did not replicate the findings, i.e., the sexual orientation differences remained comparable or even increased after eliminating false positive suicide attempts (Plöderl & Fartacek, 2005; Plöderl et al., 2010).

Several other questionnaire or interview-based studies that used more rigorous definitions of suicide attempts still found

¹ Many of the cited studies in this paper would not have been located via a systematic literature search, basically because "homosexuality" or related terms (sexual orientation, bisexuality, gay, lesbian, men who have sex with men etc.) do not appear in the title or the abstract (e.g., Beskow, 1979; Motto, Heilbron, & Juster, 1985; Qin, Agerbo, & Mortensen, 2003; Rothberg, Fagan, & Shaw, 1990).

significantly increased suicide attempt rates among sexual minorities (Bagley & Tremblay, 1997; Ramsay & Tremblay, 2012b; Wichstrom & Hegna, 2003). In addition, there are many large-scaled youth risk behavior surveys that assessed self-reported suicide attempts with and without medical treatment. In the majority of these studies, the sexual orientation differences in self-reported suicide attempt rates remained or even increased for more serious forms of suicide related behavior (Kann et al., 2011; Ramsay & Tremblay, 2012b). On the basis of a meta-analysis of mostly random adolescent surveys, Marshal et al. (2011) summarized the results: For sexual minorities, “[d]isparities increased with the increase in the severity of suicidality (ideation [$OR = 1.96$], intent/plans [$OR = 2.20$], suicide attempts [$OR = 3.18$], suicide attempts requiring medical attention [$OR = 4.17$]). Effects did not vary across gender, recruitment source, and sexual orientation definition” (p. 115). Suicide attempts requiring medical attention were classified as true suicide attempts by Savin-Williams (2001) and these random survey results essentially refuted the suffering-script thesis based on low-count non-random study samples.

The possible bias inherent in self-reported suicide attempts can also be estimated by comparing same-area results from questionnaire-based surveys with clinical interviews results known to produce much lower and more accurate “attempted suicide” estimates. In Chicago, studies with both methodologies have been available to compare yearly “attempted suicide” rates. For homosexually oriented adolescents, the interview-based Mustanski, Garofalo, and Emerson (2010) study compared with the Chicago 2003/2005 Youth Risk Behavior Surveys results (paper questionnaire) produced yearly attempted suicide rates of 6.5 % and 31.0 %, respectively, for an over-reporting factor of 5. When comparing results for all adolescents (about 95 % heterosexual), however, the over-reporting factor is 9: 1.3 % versus 11.8 % for yearly attempted suicide rates produced by the Project on Human Development in Chicago Neighborhoods 2000–2002 (interviews) versus the Chicago 2003/2005 Youth Risk Behavior Surveys (paper questionnaire). This indicates that the over-reporting of self-reported attempted suicides in paper questionnaire is less for sexual minority youth, compared to heterosexual youth, thus suggesting the reverse of the suffering script thesis (for calculations and references, see Ramsay & Tremblay, 2012a).

The “intent to die,” deemed the most important criterion to distinguish suicide attempts from other suicide related behavior (Silverman, Berman, Sanddal, O’Carroll, & Joiner, 2007), has rarely been used in studies of the suicide risk of sexual minorities. The rare exceptions again found that using this definition resulted in significant sexual orientation differences (Bagley & Tremblay, 1997; D’Augelli et al., 2005; Plöderl et al., 2010).

In summary, the hypothesis that self-reports about suicide attempts of sexual minority individuals are less valid than the heterosexual ones is not strongly supported by the available

data. In fact, the sexual orientation differences hold true or even increase for the more serious forms of suicide attempts. Thus, if the sexual orientation differences remain significant for more serious forms of suicide attempts or even increase as reported in most adult studies and studies using data from the Youth Risk Behavior Surveys, sexual orientation risk difference for suicides could be expected.

Evidence for Suicides from Psychological Autopsy Studies

Suicide attempts remain a controversial surrogate for suicides (Wortzel, Gutierrez, Homaifar, Breshears, & Harwood, 2010). Therefore, it is important to validate a risk or protective factor by testing the association between the factor and suicides. However, determining the association of suicide rates with sexual orientation is extremely challenging. From a statistical viewpoint, there is a “power struggle,” because both suicides and a sexual minority status are rare, thus requiring very large samples to obtain adequate statistical power. Unfortunately, sexual orientation variables are only rarely assessed in psychological autopsy studies and it is usually absent in coroners’ assessments. In the few cases when sexual orientation has been assessed after a suicide via third parties (e.g., family member or close friends), the validity of this assessment is uncertain, because even close family members would often remain unaware of the sexual minority status of the deceased. This is especially apparent during the coming out period, where, on average, several years pass between the awareness of the sexual minority status and coming out to significant others (Fox, 1995). However, suicide risk likely peaks in this closeted period because of commonly experienced isolation and fearing the negative consequences of coming out (Cass, 1979; D’Augelli, Hershberger, & Pilkington, 1998, 2001; Martin & Hetrick, 1988; Meyer, 2003; Radkowski & Siegel, 1997). When interpreting psychological autopsy studies it is, therefore, important to take into account the likely underestimates for those with a non-heterosexual orientation.

Psychological autopsy studies have used two analytic strategies to shed light on the association between sexual orientation and suicide. One strategy was to compare the proportion of sexual minority members in autopsy studies with a population base rate; the other strategy was to compare the proportion of sexual minority individuals who died by suicide with the proportion of sexual minority members of a matched living control group.

Comparing the Proportion of Sexual Minority Members among Those Who Died by Suicide with the Proportion in the General Population

An often cited study with this methodology is the psychological autopsy study of Rich et al. (1986), who classified 11 % of adult males who died by suicide in San Diego as

homosexual, defined by predominantly or exclusively homosexual relationships or self-identification as homosexual. Rich et al. stated that this seems to be comparable to the base rate of homosexuality in the population, but also acknowledged that the true base rate is unknown. In recent representative population samples of the U.S., the proportion of self-identified homosexual individuals were reported to be considerably lower (men: 1.5–4.2 %; women: 0.9–1.8 %) (Chandra, Mosher, Copen, & Sionean, 2011, Table 16). Thus, the 11 % reported in the Rich et al. (1986) study exceeds the base rate, an argument raised by McDaniel et al. (2001). On the other hand, lesbians were not detected among the female suicide victims, thus causing Rich et al. to speculate that being lesbian might be a protective factor for suicide. However, the base rate of homosexual males or females in the reference population of San Diego was unknown.

In British Columbia, 81 children and youth died by suicide in the 2003–2007 five-year period (British Columbia Child Death Review Unit & BC Coroner Service, 2008). Of the 66 cases that were investigated with the psychological autopsy method, four (6.1 %) children and youth identified as gay, lesbian, or bisexual. There were also three children and youth who were judged to have been questioning their sexual orientation in the months prior to death. Adding these questioning children and youth to the total raises the percentage up to 10.6 %. Furthermore, there was insufficient information to determine the youth's sexual orientation in 16 cases. The 11 % estimate for gay, lesbian, bisexual, or questioning youth closely resembles the percentage reported in the Rich et al. study of adult males noted above. However, in contrast to the conclusion reached by Rich et al., the authors of the British Columbia report concluded that “gay, lesbian and bisexual children and youth, as well as those who were questioning their sexuality, were at increased risk of suicide” (p. vii). The conclusion was made with a comparison to demographic results from a province-wide population-based high school student survey, where only 2–4 % identified as gay, lesbian, or bisexual. Thus, similar results of two studies are deemed as supporting or contradicting evidence for an increased sexual minority suicide risk. Nonetheless, the conclusions of the BC study seem more plausible because it included all individuals who died by suicide in the province and the comparison was made with a base rate drawn from a representative sample from the same region, plus also taking into account the likely conservative estimation of group difference: there would be a larger underreporting bias in the autopsy study, compared with the control group based on anonymous self-reporting in the provincial survey.

There are additional autopsy studies not mentioned in most reviews. One Austrian study investigated all police recorded suicides in the county of Salzburg between 1978 and 1979. About two percent (2.2 %, 2 of 90) males were classified as having been homosexual and none of 36 female counterparts

(Mitterauer, 1981). An Irish study (Irish Departments of Public Health, 2001) investigated 807 suicides between 1997 and 1998. Sexual orientation was not known in over one-third of cases, but was recorded for 502 deceased (102 women and 400 men). The percentage of nonheterosexually classified individuals was 3.2 %. Only one woman was classified as bisexual and none as homosexual; and 2.3 % (9 men) were bisexual and 1.5 % (6) were homosexual. In the Alaska Injury Prevention Center (2007) study on 426 suicides between 2003 and 2006, the percentage of individuals who died by suicide and who were in a same-sex relationship was 4 %. Furthermore, 18 % had sexual relationship problems not further specified, which may have included sexual orientation problems. In a Swedish study of suicides in a defined region and time frame, 3 % (5 of 161) urban men and 1 % (1 of 110) rural men (2 % total) were classified as homosexual (Beskow, 1979). Finally, in a U.S.-military study of 212 suicides that occurred between 1985 and 1986, 2 % were deemed to have had a sexual deviation, likely including homosexuality (Rothberg, Fagan, & Shaw, 1990). Thus, it seems that the latter studies found a proportion of sexual minority individuals among those who died by suicide that is comparable with the proportion in the general population.

As noted, psychological autopsy studies have important limitations, including the unknown base rate of sexual minority members, geographic variations of the proportion of sexual minority members, and non-disclosed sexual minority status. Also, the use of different dimensions of sexual orientation (sexual behavior, attraction, and self-identification) influences the base rate of homosexuality that is used for comparison (Plöderl et al., 2006).

Another problem is that population estimates for sexual minorities are based on self-reports of study participants who choose to disclose their sexual orientation to researchers whereas the determination of sexual orientation in autopsy studies is based on informants' speculations, inferences, and observations. Thus, the actual proportion of sexual minority individuals is likely underestimated in autopsy studies. Indeed, not one sexual minority individual was identified via informants among two samples (Renaud et al., 2010; Shaffer et al., 1995) of living adolescents ($n = 147$, $n = 55$, respectively). This differs from the rate of self-identified homosexual or bisexual individuals in adult U.S.-population studies of about 3–8 % (Chandra et al., 2011, Table 16), about 2 % in the Canadian adult population (Bolton & Sareen, 2011; Brennan, Ross, Dobinson, Veldhuizen, & Steele, 2010; Steele, Ross, Dobinson, Veldhuizen, & Tinnmouth, 2009), and around 5 % in representative school-based adolescent U.S.-samples (Kann et al., 2011; Reis & Saewyc, 1999). Given the small sample sizes of the two autopsy studies, however, the underreporting bias can only be estimated with imprecision and future studies would be beneficial to quantify the bias.

Comparing the Proportion of Sexual Minority Individuals in Those Who Died by Suicide with Their Proportion in a Living Control Group

Assessing sexual orientation in psychological autopsy studies is problematic due to the likely underreporting bias. Nonetheless, the bias can be adjusted for by using the autopsy method (having one's sexual orientation determined by selected informants) for both a group of individuals who died by suicide *and* a living control group. To date, only two studies have used this methodology (Renaud et al., 2010; Shaffer et al., 1995) and, given their importance, a detailed review and reanalysis is required.

In Shaffer et al. (1995), 120 adolescent under the age 20 year who died by suicide were compared with 147 matched living controls in the greater New York City metropolitan area. There were three individuals classified as homosexual among those who died by suicide and none among the controls. Shaffer et al. stated that “In spite of opportunity for biased reporting, it is concluded that this study finds no evidence that suicide is a common characteristic of gay youth” (p. 64) and that “...the data here suggest that the painful experience of establishing a gay orientation does not lead disproportionately to suicide” (p. 71). The more recent study by Renaud et al. (2010) compared 55 suicide victims from the province of Quebec with 55 matched living controls, finding 4 individuals classified as having sexual minority status among the suicide group and none among the controls. Renaud et al. concluded that “In our sample, same-sex sexual orientation and gender identity issues do not appear to be more prevalent among youth who die by suicide, compared with youth recruited from the general population” (p. 29). Given the importance of these two studies, we will review and reanalyze them with alternative statistical methods.

Meta-analytic and Bayesian reanalysis of Shaffer et al. (1995) and Renaud et al. (2010)

Significance Testing and Power Problems

Using one-sided Fisher's Exact Tests² for the data in the two studies, differences between the two groups were marginally statistically significant ($p = .09$ in Shaffer et al. and $p = .06$ in Renaud et al.). One male youth in the Shaffer et al. study

committed suicide with a gay male youth and they were found dead holding hands, yet he was classified as heterosexual. Three additional males were described as having been teased because of effeminacy. If only one of the four cases had, in fact, been homosexually oriented, which is likely given the evidence, the group difference would then have been statistically significant ($p = .04$). Similarly, in Renaud et al., if only one additional individual had been classified as non-heterosexual, the difference would have become statistically significant ($p = .03$). Had these possible outcomes occurred, the study conclusions would have been the opposite; that is, sexual minority members *are* overrepresented among those dying by suicide. The counterintuitive finding that one additional case can change the overall outcome of a study is related to significance testing with low statistical power. Even assuming that there was no underreporting of sexual minority status and that the samples were representative of the population, the conclusions would be related to problematic interpretations of significance tests. This happens because “A non-significant result is no proof for the truth of the null-hypothesis” (Bortz, 1993, p. 114, translated by the first author); or “A p value indicates the evidence against the null hypothesis. It is not possible to observe the data and corroborate the null hypothesis; one can only fail to reject it” (Wagenmakers, 2007, p. 795).

Problematic interpretations of significance test results can occur by not considering statistical power (probability that a test will yield significant results if there are differences), effect size (magnitude of the observed difference), and the β -error (probability of falsely accepting the null hypothesis), which were not provided in the studies. The observed statistical power was low in both studies: 35 % in the Shaffer et al. and 37 % in the Renaud et al. studies, if the observed group differences are used as estimates of the population difference in one-sided Fisher exact tests (with $\alpha = .05$ and sample sizes similar to that in the two studies). The power of the two studies is thus much lower than the typically recommended power of 80 %. As a consequence, the risk of a β -error (Type II error) is high in these studies (63–65 %), because the β -error is directly related to statistical power ($\beta = 1 - \text{power}$). In this case, a Type II error means that one falsely concludes that the proportion of sexual minority members is similar among individuals dying by suicide and living controls. Rather, the correct conclusion from the results of the two studies is that the null-hypothesis (similar proportions of sexual minority member in both groups) was not rejected. In scientific inquiry, absence of evidence is not the same as evidence of absence; that is, the conclusion that the data support the null-hypothesis requires a consideration of power. Specifically, such conclusions are problematic because “in the case of unknown and probably low power, a non-significant result signifies that no conclusion should be drawn; that is, one should not affirm the null hypothesis with an uncontrolled

² Fisher's exact test has been reported to be unnecessarily conservative for the case of two independent binomial distributions (e.g., Lyderson, Fagerland, & Laake, 2009). The application of more powerful tests, such as Barnard's unconditional test, the mid- p Value, or the Fisher-Boschloo test nearly always produce statistically significant group differences in the Renaud et al. (2010) study (one-sided or two-sided testing), and in most cases of the Shaffer et al. (1995) study for the one-sided tests. Due to limited space, we provided this information online (Footnote 3).

error rate (beta error) and that the experiment probably was a waste of time and money” (Sedlmeier & Gigerenzer, 1989, p. 312). Unfortunately, considering appropriate power has not substantially improved over the years in scientific publications (Balkin & Sheperis, 2011; Chan & Altman, 2005; Sedlmaier & Gigerenzer, 1989).

Null-hypothesis testing without considering statistical power and effect size can be misleading because even a small and clinically meaningless group difference becomes statistically significant with increasing sample size. Similarly, in the case of a very small effect it is no surprise that a study is underpowered. This would undermine the arguments above. Therefore, we will now consider the effect-sizes of the two autopsy studies. Odds ratios and risk ratios are direct measures of effect sizes, but due to empty cells in the control groups in the two studies, they cannot be calculated in the traditional way. A common strategy (continuity correction) is to add a constant to all cell entries (e.g., 0.5) to enable the calculation of odds-ratios (e.g., Sweeting, Sutton, & Lambert, 2004). With this strategy, substantial and clinical meaningful group differences are produced for the two studies: $OR = 8.79$ (95% $CI = 0.45–171.82$) in Shaffer et al. and $OR = 9.70$ (95% $CI = 0.51–184.63$) in Renaud et al. However, the confidence intervals are wide due to the small samples and must be interpreted with caution.

Meta-Analysis

Considerable resources are needed to conduct psychological autopsy studies with sufficient identifiable sexual minority individuals to generate the statistical power required for meaningful significance testing. By using meta-analysis to combine single studies that have insufficient statistical power, the “power-struggle” or lack of power in the two studies can be reduced. However, this is not without problems if there are zeros in the contingency tables because of possible biases resulting from continuity corrections: the addition of a small constant to all table cells (Subbiah & Srinivasan, 2008; Sweeting et al., 2004). Tian et al. (2009) developed an alternative meta-analytic approach without continuity corrections, thus avoiding biases and allowing for more valid inferences. With this procedure, the proportion differences of the Shaffer et al. and Renaud et al. studies in combination became statistically significant in two-sided tests ($p < .05$) except with the Fisher’s test ($p = .06$) which is known to be unnecessarily conservative^{2,3} (see Fig. 1). Notably, the Tian

³ Information can be obtained upon request from the authors. The original submission was accompanied with an additional file that included the R- and BUGS-codes, results for unconditional tests, and further information. It can be retrieved from <http://www.pmu.ac.at/de/1367.htm>, <http://www.youth-suicide.com/>, or from <http://people.ucalgary.ca/~ramsay/adolescent-gay-lesbian-suicide-risk.htm>. The latter webpage includes an in depth analysis of the statistical problems that we address in this article.

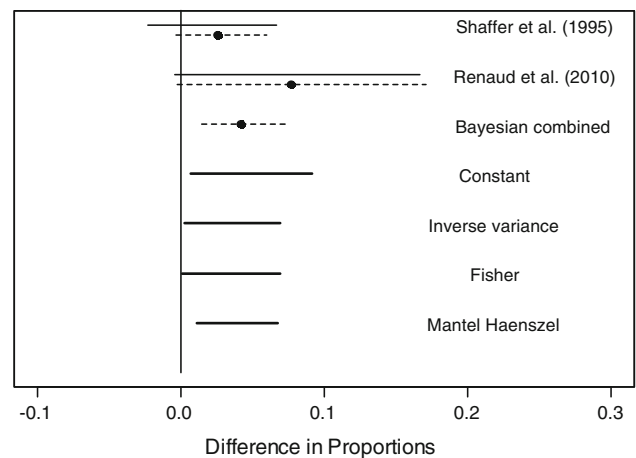


Fig. 1 Proportion differences for sexual minority members among those who died by suicide and living controls. Solid slim horizontal lines denote the 95% confidence intervals for proportion differences in the two individual studies (Renaud et al., 2010; Shaffer et al., 1995), calculated with the Tian et al. (2009) procedure. Dotted horizontal lines depict the 95% Bayesian credible intervals, calculated as described in the text, with the black dot indicating the mean of the distribution. Solid thick horizontal lines depict the 95% confidence intervals of the meta-analytically combined risk differences, with four different methods, based on the Tian et al. (2009) procedure

et al. procedure is more conservative in comparison with the common continuity correction strategy³ and the Bayesian results that are presented in the next section.

In summary, the meta-analytic combination of the two studies suggests that sexual minority members are overrepresented among individuals dying by suicide compared with living controls and this conclusion is at odds with the “no-difference” interpretation of the study authors.

Bayesian Analysis

Bayesian methods have become increasingly popular and recommended as an alternative to p value hypothesis testing (Kruschke, 2011; Wagenmakers, 2007). With Bayesian parameter estimation, researchers can directly quantify the uncertainty about a parameter of interest (in this case, the proportion difference of sexual minority members among those dying by suicide and living controls) and avoid relying on significance levels. Bayesian models capitalize on different forms of prior knowledge, which is entered in the model via prior distributions, making the results more plausible. This is particularly relevant in clinical studies where there are relatively few data points but extensive prior knowledge (for demonstrations of different prior distributions, see Kruschke, 2011; Wagenmakers, 2007).

Moreover, with Bayesian *hypothesis testing*, one can overcome problems of null-hypothesis significance testing. Specifically, the so called Bayes Factor (henceforth BF_{10}) can be used to quantify how many times more likely the observed data would

have occurred under the alternative hypothesis H_1 versus the null hypothesis H_0 (Jeffreys, 1961; Kass & Raftery, 1995; Wagenmakers, 2007; Wagenmakers, Wetzels, Borsboom, & van der Maas, 2011). With an ordinal classification schema ranging from “anecdotal” to “extreme,” the BF_{10} can then be categorized to express how strong the data support one hypothesis over the other (e.g., Jeffreys, 1961; Wagenmakers et al., 2011, Table 1). A BF_{10} ranging between 1 and 3 can be interpreted as *anecdotal* evidence in favor of H_1 (nonzero group difference), from 3 to 10 as *substantial* evidence in favor of H_1 . A BF_{10} between 0.33 and 1 can be interpreted as *anecdotal* evidence in favor of H_0 (zero group difference), from 0.10 to 0.33 as *substantial* evidence in favor of H_0 .

Bayesian Methodology

We used WinBUGS Version 1.4.3 (Lunn, Thomas, Best, & Spiegelhalter, 2000) in combination with R Version 2.12.1 (R Development Core Team, 2010) and the necessary packages (R2WinBUGS, polyspline) for the Bayesian analysis.³ For the calculation of the differences of two binomials and the BF_{10} , we used the procedure suggested by Lee and Wagenmakers (2010, Chapter 16.1). Power calculations were made with G*Power Version 3.1.2 (Faul, Erdfelder, Lang, & Buchner, 2007).

Bayesian Results

Parameter estimation: Combining the results of the two studies resulted in a Bayesian 95 % credible interval of the proportion difference $\Delta = 0.01\text{--}0.08$ ($M = 0.04$). This means that given the data, the proportion difference lies between 1 % and 8 % with a probability of .95; this positive difference is consistent with the notion that, compared with living controls, sexual minority members are overrepresented among individuals dying by suicide (Figs. 1, 2, Table 1) and that the Bayesian results are at odds with a “no-difference” interpretation. The Bayesian results for the individual studies are suggestive but not as strong as the results for the combined studies.

Bayesian hypothesis testing: The BF_{10} of the two combined studies suggest substantial evidence in favor of H_1 (more sexual minority members among individuals dying by suicide compared with living controls) over H_0 (no difference) for one-sided and two-sided Bayesian hypothesis tests (Table 1). Even with the uninformative, implausible prior distribution, there is anecdotal strength.

In summary, the Bayesian parameter estimation for both studies indicates that sexual minority members are overrepresented among individuals dying by suicide compared with living controls and the Bayesian Hypothesis test reveals that this evidence is substantial.

The Shaffer et al. and Renaud et al. studies are important because their design controlled for the underreporting bias apparent in other psychological autopsy studies. However, as

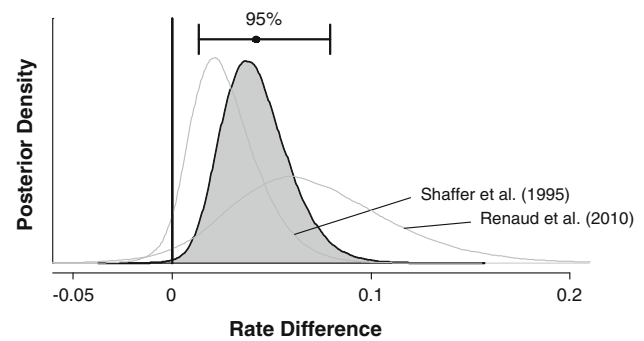


Fig. 2 Bayesian posterior distributions of the two individual studies (Renaud et al., 2010; Shaffer et al., 1995) depicted with grey lines. The shaded area represents the posterior distribution of the two studies combined, with the 95 % credible interval depicted above. The mean is given as a dot. The Bayesian “credible interval” or “probability interval” has a simpler interpretation than the classical confidence interval: the estimated proportion difference falls in the credible interval with a probability .95, given the observed data (Lynch, 2007, p. 58)

we have demonstrated, the original interpretations and conclusions in these studies are problematic, given the lack of statistical power, the near statistically significant results reported in the studies, the inherent high risk for incorrectly accepting the “no difference” hypothesis (β -error), and the statistically significant and clinically meaningful results occurring after the meta-analytical or Bayesian combination of studies. In stark contrast to the original study interpretations, the reanalysis of the two very important autopsy suicides does point to a statistical and clinically meaningful increased suicide risk among sexual minority individuals.

Evidence for Suicides From Other Studies

Other methodological approaches have also been used to examine the association between suicide rates and sexual orientation. An elevated risk for suicides was reported by a Danish study that used national registers and thus overcame self-report problems (Qin, Agerbo, & Mortensen, 2003). In this study, individuals in registered same-sex partnerships had an approximately three-fold increased risk for having died by suicide compared with individuals in heterosexual marriages. A recent update of this study with a longer study period and separate analysis by gender revealed an eight-fold statistically significant increased suicide risk among sexual minority males and a 1.5 fold, statistically non-significant risk for sexual minority women (Mathy, Cochran, Olson, & Mays, 2009). Riggle, Rostosky, and Horne (2010) reported that sexual minority members in legally recognized partnerships were the most psychologically well-adjusted, followed by those in non-registered committed partnership, those in dating relationships, and single participants. This finding, when considered with evidence that Denmark is one of the countries with the most positive attitudes towards gay men

Table 1 Results from Bayesian analysis

Study	Posterior distribution of the proportion differences			Bayes factor BF_{10}			
				Uninformative prior ^a		Truncated prior ^b	
	Mean	95 % Credible interval		Two-sided	One-sided	Two-sided	One-sided
Shaffer et al. (1995)	0.03	0.00	0.07	0.17	0.32	0.33	0.33
Renaud et al. (2010)	0.08	0.00	0.17	0.73	1.43	1.39	1.41
Combined	0.04	0.01	0.08	2.50	5.26	5.56	5.56

Note Simulations were carried out using WinBUGS with 100,000 samples. A BF_{10} ranging between 1 and 3 can be interpreted as *anecdotal* evidence in favor of H_1 (nonzero group difference), from 3 to 10 as *substantial* evidence in favor of H_1 . A BF_{10} between 0.33 and 1 can be interpreted as *anecdotal* evidence in favor of H_0 (zero group difference), from 0.10 to 0.33 as *substantial* evidence in favor of H_0

^a Delta, with uninformative prior beta-distributions, i.e., every proportion (0–100 %) of sexual minority members is assumed to be equally likely

^b Delta, with more plausible, truncated prior beta-distributions, i.e. assuming a maximum of 15 % sexual minority individuals among the living control group and 50 % among those who died by suicide

and lesbians (European Commission, 2008, p. 57), makes it possible that the relative suicide risk among the overall non-Danish sexual minority members is higher in adulthood, in addition to the likely elevated adolescent suicide risk.

In a recent U.S. prospective study with a large male sample that also assessed homosexual behavior (Cochran & Mays, 2011), no participant who reported having had sex with men ($n = 85$) was found to have died of suicide in the study period compared with 18 (0.3 %) men who reported having had sex with women only ($n = 5,292$). With an eightfold increase of risk as in the Danish study, one would expect to find about one male who died by suicide in the sexual minority group as assumed by Cochran and Mays. An inspection of the Bayesian posterior distribution of the proportion difference suggests that the posterior distribution peaks around the zero difference ($M = 0.01$) with a substantial credible interval (0.00–0.04), which is understandable given the low statistical power of the study. To detect an hypothetical 8-fold increase of suicide risk (as reported in the Danish study) with a one-sided Fisher test, given the observed 0.3 % suicides among heterosexuals and $0.3 \times 8 = 2.4$ % suicides in the sexual minority group and the observed proportion of sexual minority members (85 of 5292), a sample of about 10,000 participants is required (with about 160 sexual minority members) to achieve a power of 80 %. The given sample has a power of 57 % to detect such an effect; in other words, the risk of making a Type II error is $\beta = .43$. The conclusion of Cochran and Mays that “mortality risk from non-HIV-related causes, including suicide, was not elevated among MSM” (p. e4) is thus problematic, due to low statistical power. The expected proportion difference ($2.4 - 0.3 \% = 2.1 \%$ or 0.021) actually lies in the central part of the credible interval of the Bayesian posterior distribution, leading to the conclusion that the results of Cochran and Mays (2011) are definitely not in “stark contradiction,” as highlighted by Haas et al. (2011, p. 17).

Finally, there are studies of suicide risk among psychiatric patients that should be mentioned for completeness, noting that psychiatric patients are not representative of the general

sexual minority population. Nonetheless, having a homosexual or bisexual orientation was one of the strongest predictor for future suicides among psychiatric patients (Martin, Cloninger, Guze, & Clayton, 1985; Motto, Heilbron, & Juster, 1985) and was overrepresented among near-lethal suicides (Weyrauch, Roy-Byrne, Katon, & Wilson, 2001) and suicide attempters with resulting severe spinal cord injuries (Lombardi, Mondaini, Iazzetta, Macchiarella, & Del Popolo, 2008). Although these studies are rarely cited, they are nonetheless important to consider in a clinical context. Similarly, in nonclinical population based studies, a sexual minority status turned out to be one of the strongest predictors of suicide attempts within a range of other risk factors (Gratz, 2006; Jiang, Perry, & Hesser, 2010; Kisch, Leino, & Silverman, 2005; O’Connor, Rasmussen, & Miles, 2009; Olshen et al., 2007; Whitlock & Knox, 2007; Wichstrøm, 2009).

Limitations Inherent in Research on Sexual Minorities

Older studies reporting on the association of sexual orientation and suicide risk have been criticized for methodological reasons, particularly sampling issues and the assessment of sexual orientation and suicide attempts. More recent studies overcame most of these problems by using more varied definitions of sexual orientations, random samples, and more rigorous definitions of suicide attempts. However, some problems may never be overcome. For example, non-response bias is a problem that became apparent in one study: three times (16.8 vs. 5.1 %) more men who had sex with men were among those who initially refused to participate in a household survey (Centers for Disease Control and Prevention, 1991), with the prevalence of suicide attempts remaining unknown among these individuals. Fewer sexual minority members disclose their homosexual behavior to interviewers compared with computer based methods (Villaruel et al., 2006). Thus, in many studies, non-disclosed

sexual minority individuals would be incorrectly classified as heterosexual. It is possible that non-disclosed sexual minority individuals or those who refuse study participation may be at increased risk for suicide, a reasonable hypothesis given the negative psychological impact of a concealed stigma (Pachankis, 2007). On the other hand, those who report their sexual orientation may also be more willing to report suicide-related thoughts and behaviors than those not disclosing their sexual orientation, leading to an inflated estimation of suicide risk. In addition, the study of rather rare events, such as suicides and serious suicide attempts, combined with a sexual minority orientation require very large samples to achieve sufficient statistical power. Many researchers therefore collapse sexual minority subgroups into one category (e.g., homosexual, bisexual, mostly heterosexual, questioning, transgender individuals), which has been criticized because there may be notable differences in mental health problems between these groups (Savin-Williams, 2008). With subgroups, however, the major problem remains as to where one draws the line between a heterosexual or non-heterosexual orientation (McCabe, Hughes, Bostwick, Morales, & Boyd, 2012; Plöderl et al., 2010). For these and other reasons, it has been suggested that there is no sampling design which can overcome all of these problems (Meyer & Wilson, 2009). At best, we can speculate about the direction of possible biases and more research on the biases is required.

Therefore, it is useful to validate the results with multi-method approaches (e.g., by sampling from the general population and also from sexual minority communities). In the future, it is hoped that national surveys, such as CDC's Youth Risk Behavior Survey, will routinely include sexual orientation measures. If convenience samples include many individuals from self-help groups or counseling groups, the results may overestimate suicide attempt rates (Savin-Williams & Ream, 2003). But this may not be a problem for convenience samples in general, because a meta-analytic review of probability and convenience samples reported similar results or even smaller risk differences for convenience samples (Meyer, 2003, Fig. 3). The most exhaustive collation of published and unpublished international studies on the association of suicide attempts and sexual orientation with different methodologies has produced a very consistent picture: nearly all studies found increased incidences of self-reported suicide attempts among sexual minorities (Ramsay & Tremblay, 2012a).

For the association of suicide and sexual orientation, methodological problems are even more difficult to overcome, as discussed above, including the following problem reported by Dorais and Lajeunesse (2004): "Second scenario [for some gay male suicide attempters studied]: Instead of revealing his homosexuality, the young male attempts suicide so that he will take his secret with him and hide forever the desires perceived to be so shameful. 'If my attempt to kill myself had succeeded, no one would have ever known that it was because of my

homosexual orientation. My parents would have blamed it on family problems and on the break-up with my girlfriend" (pp. 40–41). Hopefully, future psychological autopsy studies will routinely assess sexual orientation, so that our knowledge and understanding is improved and for inclusion in meta-analyses. Studies could also be designed to estimate the underreporting bias (e.g., by using the psychological autopsy method determining their sexual orientation via informants) when studying severe suicide attempts and comparing results with suicide attempter self-reports. This will require resources and time; however, despite increased methodological efforts, biases cannot be ruled out, but only incrementally reduced.

Those who seek to translate research into practice must face the critical question concerning what to do with evidence that is inconclusive because of the inherent methodological problems and such studies may even be classified as low quality, as done by the Australian Government Department of Health and Ageing (2008). In their review, it was concluded that "based upon results of (scarce) studies conducted to date, suicide rates do not appear to be increased among the gay and lesbian populations" (p. 67). We think it is important to be aware that, in certain fields, such as in sexual minority research, for the many reasons noted in this article, the evidence cannot reach top quality status. We nonetheless believe that if incontrovertible evidence is lacking, the available evidence should be judiciously evaluated when a particular group may be at heightened risk. This is an ethical position explored in the next section. Perhaps the inherent methodological problems are the reason why sexual minority issues are completely lacking even in a recent major suicide textbook (Wasserman & Wasserman, 2009), or that only methodological problems were discussed, without considering the mass of studies that indicate an increased suicide risk (Miller & Eckert, 2009). As we have demonstrated above, improved evaluation of the data leads to the conclusion that sexual orientation is likely a risk factor for suicide.

Ethical Issues

What are the costs of falsely concluding that sexual minority individuals have a higher risk for suicide? Perhaps this will result in sexual minority individuals being stigmatized and this may even contribute to a suffering script (Savin-Williams, 2001) which could lead LGB youth to believe that it is the norm to be at risk for suicide, a concern for which there is no credible evidence. Of note, most sexual minority individuals do *not* attempt or even die by suicide; despite the increased risk (we thank one anonymous reviewer that we should not forget to stress this). Suicide is also not the norm even in the well known high-risk groups such as severely depressed patients or individuals who already attempted suicide.

An additional cost of falsely attributing suicide risk to a specific group may be that limited and valuable resources in

suicide prevention are wasted. On the other hand, falsely assuming that sexual orientation is not an important suicide risk factor may lead to inattention to a very serious mental health issue for which there is supporting evidence. This can produce silence in textbooks and therefore not having suicide prevention efforts directed at a higher risk group, a tragically costly situation referred to by Haas et al. (2011): “The consistency of the data pointing to elevated risk of suicide and mental health problems among sexual minority people argues for taking action now rather than awaiting more research evidence” (p. 23). It should be noted that suicide prevention programs for sexual minorities are still not evidence-based and that studies are required to show that evidence-based suicide prevention programs are also effective for sexual minorities.

Unfortunately, the arguments quickly go beyond the data into ethics or politics. It has been suggested, for example, that research about the elevated suicide risk among sexual minorities is used to garner resources (Savin-Williams, 2008) or as evidence for the pathological nature of homosexuality (e.g., Whitehead, 2009). However, we are not aware of a serious discussion of the costs of false conclusions, such as untreated psychological distress or even prevented suicides.

Furthermore, considering the risks and costs of falsely assuming an increased suicide risk (or the absence of an increased risk) among a certain population is important for planning future studies and related significance tests. The Neyman–Pearson approach explicitly addressed the issue of carefully balancing α -levels and β -levels to quantify the risk of making a Type I error, in this case falsely assuming that there is a sexual orientation difference of suicide risk; and a Type II error (falsely assuming that there is no sexual orientation difference of suicide risk). Only with adequate statistical power, Type I and Type II errors can be controlled. Thus, ethical concerns can enter into the statistical level. We have shown that critical studies on suicides focused mostly on the Type I error and largely ignored possible Type II errors. Our analyses strongly suggest that the risk of a Type II error (erroneously concluding that there is no sexual orientation risk difference) was high in the methodologically most important psychological autopsy studies (Renaud et al., 2010; Shaffer et al., 1995).

We did not discuss the reasons for the increased suicide problem among sexual minorities. Current scientific models point to the damaging effects of sexual minority stress (Hatzenbuehler, 2009; Hong, Espelage, & Krall, 2011; Meyer, 2003). For example, the minority stress model of Meyer (2003) conceptualizes that, in addition to general stressors, minority specific stressors cause mental health problems. Such stressors include distal minority stress, for example actual discrimination and violence; and proximal stressors, such as hiding one’s sexual minority status, fear of coming out, or devaluing one’s sexual orientation (internalized homophobia). The negative impact of these stressors can be buffered by social support and by coping abilities and are influenced by contextual factors, such as

prominence, valence or integration of the minority status. Besides stressors that are explicitly related to a sexual minority status, it turned out that childhood gender nonconformity is a factor that increases suicide risk even before coming out (e.g., Plöderl & Fartacek, 2009). Finally, HIV is both associated with suicide risk and, among men, sexual minority status (Catalan et al., 2011). More research is needed to explore how much of the suicide risk may be attributable to HIV among non-heterosexual men. The risk for HIV and for suicide are likely related through common factors (e.g., internalized homophobia) that are involved both in the development of mental health problems and in risky sexual behavior (Newcomb & Mustanski, 2010, 2011).

Minority stressors have been associated with mental health problems, including suicidality, not only among sexual minority individuals but also among heterosexual individuals assumed to be homosexual and targeted for related harassment and abuses (Murphy, 2007; Reis & Saewyc, 1999, Table 4). Future studies may, therefore, benefit from a focus on all who experience sexual minority stress, independent of one’s sexual self-identity (Tremblay & Ramsay, 2000). For a related reanalysis of the Shaffer et al. and Renaud et al. studies, see Tremblay, Plöderl, and Ramsay (2012).

Minority stress models can explain mental health problems among sexual minorities in general; however, it has still to be investigated why some sexual minority individuals specifically develop suicide risk. Therefore, it is necessary to simultaneously apply both established suicide models and minority stress models in future research.

Conclusion

Given the evidence presented, sexual minority individuals are at greater risk for suicides and suicide attempts, compared to their heterosexual counterparts. We demonstrated that the often noted discrepancy between sexual minority suicide (no risk difference) and suicide attempt (apparent risk difference) stemmed from questionable interpretations of psychological autopsy studies. For the two adolescent autopsy studies which are most important due to their case–control design, the discrepancy was caused by interpretations (no greater risk for sexual minorities) based on problematic understanding of statistical significance tests, interpretations that should be reversed given the results from alternative statistical procedures, such as more powerful tests,² Bayesian statistics, and meta-analysis.

In addition, we discussed the challenge of interpreting sexual minority suicide research because of past methodological problems that have been greatly reduced in the past 15 years. It was also important to elaborate on the ethical dilemma involved when translating inherently imperfect research into suicide prevention practice. Our closer look at the existing suicide data, combined with the results of published meta-analyses and review papers, leads to the

conclusion that, because sexual minorities are at risk for suicide and suicide attempts, there should be an ethical suicide prevention imperative to target sexual minorities.

Acknowledgments We thank Lu Tian, Simon Jackman, and Antonio Martín-Andrés for helping us with statistical issues and we also thank Anthony D’Augelli for his feedback on a draft of the article.

References

- Alaska Injury Prevention Center. (2007). *Alaska suicide follow-back study. Final report study period September 1, 2003 to August 31, 2006*. Retrieved from http://www.hss.state.ak.us/suicideprevention/pdfs_sspc/sspcfollback2-07.pdf.
- Australian Government Department of Health and Ageing. (2008). *Research and evidence in suicide prevention*. Retrieved from <http://www.livingisforeveryone.com.au/uploads/docs/LIFE-research-web.pdf>.
- Bagley, C., & Tremblay, P. (1997). Suicidal behaviors in homosexual and bisexual males. *Crisis, 18*, 24–34.
- Bagley, C., & Tremblay, P. (2000). Elevated rates of suicidal behavior in gay, lesbian, and bisexual youth. *Crisis, 21*, 111–117.
- Balkin, R. S., & Sheperis, C. J. (2011). Evaluating and reporting statistical power in counseling research. *Journal of Counseling & Development, 9*, 268–272.
- Beskow, J. (1979). Suicide in mental disorder in Swedish men. *Acta Psychiatrica Scandinavica, 277*(Suppl.), 1–138.
- Bolton, S. L., & Sareen, J. (2011). Sexual orientation and its relation to mental disorders and suicide attempts: Findings from a nationally representative sample. *Canadian Journal of Psychiatry, 56*, 35–43.
- Bortz, J. (1993). *Statistik für Sozialwissenschaftler*. Berlin: Springer.
- Brennan, D. J., Ross, L. E., Dobinson, C., Veldhuizen, S., & Steele, L. S. (2010). Men’s sexual orientation and health in Canada. *Canadian Journal of Public Health, 101*, 255–258.
- British Columbia Child Death Review Unit & BC Coroner Service. (2008). *A five-year retrospective review of child and youth suicide in B.C.* Retrieved from <http://www.pssg.gov.bc.ca/coroners/child-death-review/docs/cdru-suicidereportfull.pdf>.
- Cass, V. C. (1979). Homosexual identity formation: A theoretical model. *Journal of Homosexuality, 4*, 219–235.
- Catalan, J., Harding, R., Sibley, E., Clucas, C., Croome, N., & Sherr, L. (2011). HIV infection and mental health: Suicidal behavior—Systematic review. *Psychology, Health & Medicine, 16*, 588–611.
- Centers of Disease Control (CDC). (1991). Pilot study of a household survey to determine HIV seroprevalence. *Morbidity and Mortality Weekly Report, 40*, 1–5.
- Chan, A. W., & Altman, D. G. (2005). Epidemiology and reporting of randomised trials published in PubMed journals. *Lancet, 365*, 1159–1162.
- Chandra, A., Mosher, W. D., Copen, C., & Sionean, C. (2011, June 10). *Sexual behavior, sexual attraction, and sexual identity in the United States: Data from the 2006–2008 National Survey of Family Growth. National health statistics reports; no 36*. Hyattsville, MD: National Center for Health Statistics. Retrieved from www.cdc.gov/nchs/data/nhsr/nhsr036.pdf.
- Cochran, S. D., & Mays, V. M. (2011). Sexual orientation and mortality among US men aged 17 to 59 years: Results from the National Health and Nutrition Examination Survey III. *American Journal of Public Health, 101*, 1133–1138.
- D’Augelli, A. R., Grossman, A. H., Salter, N. P., Vasey, J. J., Starks, M. T., & Sinclair, K. O. (2005). Predicting the suicide attempts of lesbian, gay, and bisexual youth. *Suicide and Life-Threatening Behavior, 35*, 646–660.
- D’Augelli, A. R., Hershberger, S. L., & Pilkington, N. W. (1998). Lesbian, gay, and bisexual youths and their families: Disclosure of sexual orientation and its consequences. *American Journal of Orthopsychiatry, 68*, 361–371.
- D’Augelli, A. R., Hershberger, S. L., & Pilkington, N. W. (2001). Suicidality patterns and sexual orientation-related factors among lesbian, gay, and bisexual youths. *Suicide and Life-Threatening Behavior, 31*, 250–264.
- Dorais, M., & Lajeunesse, S. L. (2004). *Dead boys can’t dance: Sexual orientation, masculinity and suicide* (P. Tremblay, Trans.). Montreal: McGill-Queens University Press.
- European Commission. (2008, July). *Discrimination in the European Union: Perceptions, experiences and attitudes. Special Eurobarometer 296*. Retrieved from http://ec.europa.eu/public_opinion/archives/ebs/ebs_296_en.pdf.
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191.
- Fox, R. C. (1995). Lesbian, gay, and bisexual identities over the lifespan: Psychological perspectives. In A. R. D’Augelli & C. P. Patterson (Eds.), *Lesbian, gay, and bisexual identities over the lifespan: Psychological perspectives* (pp. 48–86). New York: Oxford University Press.
- Gratz, K. L. (2006). Risk factors for deliberate self-harm among female college students: The role and interaction of childhood maltreatment, emotional inexpressivity, and affect intensity/reactivity. *American Journal of Orthopsychiatry, 76*, 238–250.
- Haas, A. P., Eliason, M., Mays, V. M., Mathy, R. M., Cochran, S. D., & D’Augelli, A. R.,... Clayton, P. J. (2011). Suicide and suicide risk in lesbian, gay, bisexual, and transgender populations: Review and recommendation. *Journal of Homosexuality, 58*, 10–51.
- Harris, E. C., & Barraclough, B. (1997). Suicide as an outcome for mental disorders. A meta-analysis. *British Journal of Psychiatry, 170*, 205–228.
- Hatzenbuehler, M. (2009). How does sexual minority stigma “get under the skin”? A psychological mediation framework. *Psychological Bulletin, 135*, 707–730.
- Hong, J. S., Espelage, D. L., & Krall, M. J. (2011). Understanding suicide among sexual minority youth in America: An ecological systems analysis. *Journal of Adolescence, 34*, 885–894.
- Irish Departments of Public Health. (2001). *Suicide in Ireland. A national study*. Retrieved from http://www.nosp.ie/suicide_in_ireland.pdf.
- Jeffreys, H. (1961). *Theory of probability*. Oxford: Oxford University Press.
- Jiang, Y., Perry, D. K., & Hesser, J. E. (2010). Adolescent suicide and health risk behaviors: Rhode Island’s 2007 Youth Risk Behavior Survey. *American Journal of Preventive Medicine, 38*, 551–555.
- Kann, L., Olsen, E. O., McManus, T., Kinchen, S., Chyen, D., Harris, W. A.,... Centers for Disease Control and Prevention (CDC). (2011). Sexual identity, sex of sexual contacts, and health-risk behaviors among students in grades 9–12—Youth risk behavior surveillance, selected sites, United States, 2001–2009. *MMWR, 60*, 1–133. Retrieved from <http://www.cdc.gov/mmwr/pdf/ss/ss6007.pdf>.
- Kass, R. E., & Raftery, A. E. (1995). Bayes factors. *Journal of the American Statistical Association, 90*, 377–395.
- King, M., Semlyen, J., Tai, S. S., Killaspy, H., Osborn, D., Popelyuk, D., & Nazareth, I. (2008). A systematic review of mental disorder, suicide, and deliberate self harm in lesbian, gay and bisexual people. *BMC Psychiatry, 8*, 70. doi:10.1186/1471-244X-8-70.
- Kisch, J., Leino, E. V., & Silverman, M. M. (2005). Aspects of suicidal behavior, depression, and treatment in college students: Results from the spring 2000 National College Health Assessment Survey. *Suicide and Life-Threatening Behavior, 35*, 3–13.

- Kruschke, J. K. (2011). Bayesian assessment of the null values via parameter estimation and model comparison. *Perspectives on Psychological Science*, 6, 299–312.
- Lee, M. D., & Wagenmakers, E. J. (2010, August 23). *A course in Bayesian graphical modeling for cognitive science*. Retrieved from <http://www.ejwagenmakers.com/BayesCourse/BayesBookWeb.pdf>.
- Lewis, N. M. (2009). Mental health in sexual minorities: Recent indicators, trends, and their relationships to place in North America and Europe. *Health and Place*, 15, 1029–1045.
- Lombardi, G., Mondaini, N., Iazzetta, P., Macchiarella, A., & Del Popolo, G. (2008). Sexuality in patients with spinal cord injuries due to attempted suicide. *Spinal Cord*, 46, 53–57.
- Lunn, D. J., Thomas, A., Best, N., & Spiegelhalter, D. (2000). WinBUGS—A Bayesian modelling framework: Concepts, structure, and extensibility. *Statistics and Computing*, 10, 325–337.
- Lydersen, S., Fagerland, M. W., & Laake, P. (2009). Recommended tests for association in 2×2 tables. *Statistics in Medicine*, 28, 1159–1175.
- Lynch, S. M. (2007). *Introduction to applied Bayesian statistics and estimation for social scientists*. Berlin: Springer.
- Marshall, M. P., Dietz, L. J., Friedman, M. S., Stall, R., Smith, H. A., McGinley, J., Thoma, B. C., ... Brent, D. A. (2011). Suicidality and depression disparities between sexual minority and heterosexual youth: A meta-analytic review. *Journal of Adolescent Health*, 49, 115–123.
- Martin, R. L., Cloninger, C. R., Guze, S. B., & Clayton, P. J. (1985). Mortality in a follow-up of 500 psychiatric outpatients. II. Cause-specific mortality. *Archives of General Psychiatry*, 42, 58–66.
- Martin, A. D., & Hetrick, E. S. (1988). The stigmatization of the gay and lesbian adolescent. *Journal of Homosexuality*, 15, 163–183.
- Mathy, R. M., Cochran, S. D., Olsen, J., & Mays, V. M. (2009). The association between relationship markers of sexual orientation and suicide: Denmark, 1990–2001. *Social Psychiatry and Psychiatric Epidemiology*, 46, 111–117.
- McCabe, S. E., Hughes, T. L., Bostwick, W., Morales, M., & Boyd, C. J. (2012). Measurement of sexual identity in surveys: Implications for substance abuse research. *Archives of Sexual Behavior*, 41, 649–657.
- McDaniel, J. S., Purcell, D., & D'Augelli, A. R. (2001). The relationship between sexual orientation and risk for suicide: Research findings and future directions for research and prevention. *Suicide and Life-Threatening Behavior*, 31, 84–105.
- Meehan, P. J., Lamb, J. A., Saltzman, L. E., & O'Carroll, W. O. (1992). Attempted suicide among young adults: Progress toward a meaningful estimate of prevalence. *American Journal of Psychiatry*, 149, 41–49.
- Meyer, I. H. (2003). Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: Conceptual issues and research evidence. *Psychological Bulletin*, 129, 674–697.
- Meyer, I. H., & Wilson, P. A. (2009). Sampling lesbian, gay, and bisexual populations. *Journal of Counseling Psychology*, 56, 23–31.
- Miller, D. N., & Eckert, T. L. (2009). Youth suicidal behavior: An introduction and overview. *School Psychology Review*, 38, 153–167.
- Mitterauer, B. (1981). The suicidal axis syndrome. A medico-biological study of the estimation of suicide-proneness. *Wiener Medizinische Wochenschrift*, 68(Suppl.), 1–28.
- Motto, J. A., Heilbron, D. C., & Juster, R. P. (1985). Development of a clinical instrument to estimate suicide risk. *American Journal of Psychiatry*, 142, 680–686.
- Muehrer, P. (1995). Suicide and sexual orientation: A critical summary of recent research and directions for future research. *Suicide and Life-Threatening Behavior*, 25, 72–81.
- Murphy, H. E. (2007). *Suicide risk among gay, lesbian and bisexual college youth*. Unpublished doctoral dissertation, University of Washington. Retrieved from <http://hdl.handle.net/1773/7522>.
- Mustanski, B. S., Garofalo, R., & Emerson, E. M. (2010). Mental health disorders, psychological distress, and suicidality in a diverse sample of lesbian, gay, bisexual, and transgender youths. *American Journal of Public Health*, 100, 2426–2432.
- Newcomb, M. E., & Mustanski, B. (2010). Internalized homophobia and internalizing mental health problems: A meta-analytic review. *Clinical Psychology Review*, 30, 1019–1029.
- Newcomb, M. E., & Mustanski, B. (2011). Moderators of the relationship between internalized homophobia and risky sexual behavior in men who have sex with men: A meta-analysis. *Archives of Sexual Behavior*, 40, 189–199.
- O'Connor, R. C., Rasmussen, S., Miles, J., & Hawton, K. (2009). Self-harm in adolescents: Self-report survey in schools in Scotland. *British Journal of Psychiatry*, 194, 68–72.
- Olshen, E., McVeigh, K. H., Wunsch-Hitzig, R. A., & Rickert, V. I. (2007). Dating violence, sexual assault, and suicide attempts among urban teenagers. *Archives of Pediatrics and Adolescent Medicine*, 161, 539–545.
- Owens, D., Wood, C., Greenwood, D. C., Hughes, T., & Dennis, M. (2005). Mortality and suicide after non-fatal self-poisoning: 16-year outcome study. *British Journal of Psychiatry*, 187, 470–475.
- Pachankis, P. E. (2007). The psychological implications of concealing a stigma: A cognitive-affective-behavioral model. *Psychological Bulletin*, 133, 328–345.
- Plöderl, M., & Fartacek, R. (2005). Suicidality and associated risk factors among lesbian, gay, and bisexual compared to heterosexual Austrian adults. *Suicide and Life-Threatening Behavior*, 35, 661–670.
- Plöderl, M., & Fartacek, R. (2009). Childhood gender nonconformity and childhood harassment as predictors of suicidality among gay, lesbian, bisexual, and heterosexual Austrians. *Archives of Sexual Behavior*, 38, 400–410.
- Plöderl, M., Kralovec, K., & Fartacek, R. (2010). The relation between sexual orientation and suicide attempts in Austria. *Archives of Sexual Behavior*, 39, 1403–1414.
- Plöderl, M., Kralovec, K., Yazdi, K., & Fartacek, R. (2011). A closer look at self-reported suicide attempts: False positives and false negatives. *Suicide and Life-Threatening Behavior*, 41, 1–5.
- Plöderl, M., Sauer, J., & Fartacek, R. (2006). Suizidalität und psychische Gesundheit von homo- und bisexuellen Männern und Frauen. Eine metaanalytische Zusammenfassung internationaler Zufallsstichproben [Suicidality and mental health of homosexual and bisexual men and women. A meta-analysis of international probability samples]. *Verhaltenstherapie und psychosoziale Praxis*, 117, 4–10.
- Qin, P., Agerbo, E., & Mortensen, P. B. (2003). Suicide risk in relation to socioeconomic, demographic, psychiatric, and familial factors: A national register-based study of all suicides in Denmark, 1981–1997. *American Journal of Psychiatry*, 160, 765–772.
- R Development Core Team. (2010). *R: A language and environment for statistical computing* [Software]. Vienna, Austria. Available from <http://www.r-project.org/>.
- Radkowski, M., & Siegel, L. J. (1997). The gay adolescent: Stressors, adaptations, and psychosocial interventions. *Clinical Psychology Review*, 17, 191–216.
- Ramsay, R., & Tremblay, P. (2012a). *Gay, lesbian, bisexual & transgender "attempted suicide" incidences/risks. Suicidality studies from 1970 to 2012*. Retrieved from <http://people.ucalgary.ca/~ramsay/attempted-suicide-gay-lesbian-all-studies.htm>.
- Ramsay, R., & Tremblay, P. (2012b). *Homosexually oriented people are at greater risk for more serious suicidal behaviors*. Retrieved from <http://people.ucalgary.ca/~ramsay/gay-more-risk-suicide.htm>.
- Reis, B., & Saewyc, E. (1999, May). *Eighty-three-thousand youth: Selected findings of eight population based studies as they pertain to anti-gay harassment and the safety and well-being of sexual*

- minority students. The Safe Schools Coalition of Washington. Retrieved from <http://www.safeschoolscoalition.org/83000youth.pdf>.
- Renaud, J., Berlim, M. T., Begolli, M., McGirr, A., & Turecki, G. (2010). Sexual orientation and gender identity in youth suicide victims: An exploratory study. *Canadian Journal of Psychiatry*, *55*, 29–34.
- Rich, C. L., Fowler, R. C., Young, D., & Blenkush, M. (1986). San Diego suicide study: Comparison of gay to straight males. *Suicide and Life-Threatening Behavior*, *16*, 448–457.
- Riggle, E. D., Rostosky, S. S., & Horne, S. G. (2010). Psychological distress, well-being, and legal recognition in same-sex couple relationships. *Journal of Family Psychology*, *24*, 82–86.
- Rothberg, J. M., Fagan, J., & Shaw, J. (1990). Suicide in United States Army personnel, 1985–1986. *Military Medicine*, *155*, 452–456.
- Russell, S. T. (2003). Sexual minority youth and suicide risk. *American Behavioral Scientist*, *46*, 1241–1257.
- Savin-Williams, R. C. (2001). Suicide attempts among sexual-minority youths: Population and measurement issues. *Journal of Consulting and Clinical Psychology*, *69*, 983–991.
- Savin-Williams, R. C. (2008). Then and now: Recruitment, definition, diversity, and positive attributes of same-sex populations. *Developmental Psychology*, *44*, 135–138.
- Savin-Williams, R. C., & Ream, G. L. (2003). Suicide attempts among sexual-minority male youth. *Journal of Clinical Child and Adolescent Psychology*, *32*, 509–522.
- Sedlmeier, P., & Gigerenzer, G. (1989). Do studies of statistical power have an effect on the power of studies? *Psychological Bulletin*, *105*, 309–316.
- Shaffer, D., Fisher, P., Hicks, R. H., Parides, M., & Gould, M. (1995). Sexual orientation in adolescents who commit suicide. *Suicide and Life-Threatening Behavior*, *25*, 64–71.
- Silverman, M. M., Berman, A. L., Sanddal, N. D., O'Carroll, P. W., & Joiner, T. E. (2007). Rebuilding the tower of Babel: A revised nomenclature for the study of suicide and suicidal behaviors part 2: Suicide-related ideations, communications, and behaviors. *Suicide and Life-Threatening Behavior*, *37*, 264–277.
- Steele, L. S., Ross, L. E., Dobinson, C., Veldhuizen, S., & Tinmouth, J. M. (2009). Women's sexual orientation and health: Results from a Canadian population-based survey. *Women and Health*, *49*, 353–367.
- Subbiah, M., & Srinivasan, M. R. (2008). Classification of 2×2 sparse data sets with zero cells. *Statistics and Probability Letters*, *78*, 3212–3215.
- Sweeting, M. J., Sutton, A. J., & Lambert, P. C. (2004). What to add to nothing? Use and avoidance of continuity corrections in meta-analysis of sparse data. *Statistics in Medicine*, *23*, 1351–1375.
- Tian, L., Cai, T., Pfeffer, M. A., Piankov, N., Cremieux, P. Y., & Wei, L. J. (2009). Exact and efficient inference procedure for meta-analysis and its application to the analysis of independent 2×2 tables with all available data but without artificial continuity correction. *Biostatistics*, *10*, 275–281.
- Tremblay, P., Plöderl, M., & Ramsay, R. (2012). *Adolescent gay/lesbian suicide risk. An expanded homosexuality factor in adolescent suicide*. Retrieved from <http://people.ucalgary.ca/~ramsay/adolescent-gay-lesbian-suicide-risk.htm>.
- Tremblay, P., & Ramsay, R. (2000, September). Orientations homosexuelles ou bisexuelles chez les jeunes présentant des problèmes suicidaires: recherche, problématique et propositions. *Le Vis-à-Vie*, *10*, 5–8. Retrieved from <http://web.archive.org/web/20071222142530/www.aqps.info/docs/vav/v10/v10n2-02.html>.
- Villarroel, M. A., Turner, C. F., Eggleston, E., Al-Tayyib, A., Rogers, S. M., Roman, A. M.,... Gordek, H. (2006). Same-gender sex in the United States. *Public Opinion Quarterly*, *70*, 166–196.
- Wagenmakers, E.-J. (2007). A practical solution to the pervasive problems of p values. *Psychonomic Bulletin & Review*, *14*, 779–804.
- Wagenmakers, E.-J., Wetzels, R., Borsboom, D., & van der Maas, H. L. J. (2011). Why psychologists must change the way they analyze their data: The case of ψ . *Journal of Personality and Social Psychology*, *100*, 426–432.
- Wasserman, D., & Wasserman, C. (Eds.). (2009). *Oxford textbook of suicidology and suicide prevention: A global perspective*. New York: Oxford University Press.
- Weyrauch, K. F., Roy-Byrne, P., Katon, W., & Wilson, L. (2001). Stressful life events and impulsiveness in failed suicide. *Suicide and Life-Threatening Behavior*, *31*, 311–319.
- Whitehead, N. E. (2009, April 18). *Homosexuality and mental health problems*. Retrieved from <http://narh.com/2009/04/homosexuality-and-mental-health-problems/>.
- Whitlock, J., & Knox, K. L. (2007). The relationship between self-injurious behavior and suicide in a young adult population. *Archives of Pediatrics and Adolescent Medicine*, *161*, 634–640.
- Wichstrøm, L. (2009). Predictors of non-suicidal self-injury versus attempted suicide: Similar or different? *Archives of Suicide Research*, *13*, 105–122.
- Wichstrøm, L., & Hegna, K. (2003). Sexual orientation and suicide attempt: A longitudinal study of the general Norwegian population. *Journal of Abnormal Psychology*, *112*, 144–151.
- Wortzel, H. S., Gutierrez, P. M., Homaifar, B. Y., Breshears, R. E., & Harwood, J. E. (2010). Surrogate endpoints in suicide research. *Suicide and Life-Threatening Behavior*, *40*, 500–505.