Sexual orientation and adolescent substance use: a meta-analysis and methodological review[*]

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Abstract

Aims—Several decades of research have shown that lesbian, gay and bisexual (LGB) adults are at high risk for substance use and substance use disorders (SUDs). These problems may often start prior to young adulthood; however, relatively little is known about risk for substance use in LGB adolescents. The primary aims of this paper were to conduct a meta-analysis of the relationship between sexual orientation and adolescent substance use and a systematic review and critique of the methodological characteristics of this literature.

Methods—Medical and social science journals were searched using Medline and PsychInfo. Studies were included if they tested the relationship between sexual orientation and adolescent substance use. Eighteen published studies were identified. Data analysis procedures followed expert guidelines, and used National Institutes of Health (NIH)-sponsored meta-analysis software.

Results—LGB adolescents reported higher rates of substance use compared to heterosexual youth (overall odds ratio = 2.89, Cohen's d = 0.59). Effect sizes varied by gender, bisexuality status, sexual orientation definition and recruitment source. None of the studies tested mediation and only one tested moderation. One employed a matched comparison group design, one used a longitudinal design, and very few controlled for possible confounding variables.

Conclusions—The odds of substance use for LGB youth were, on average, 190% higher than for heterosexual youth and substantially higher within some subpopulations of LGB youth (340% higher for bisexual youth, 400% higher for females). Causal mechanisms, protective factors and alternative explanations for this effect, as well as long-term substance use outcomes in LGB youth, remain largely unknown.

Keywords

Adolescence; alcohol; bisexual; drugs; gay; lesbian; meta-analysis; sexual minority; sexual orientation; youth

INTRODUCTION

Several decades of research have shown that there are high rates of substance use and substance use disorders in lesbian, gay and bisexual (LGB) adults [1-3], and recent evidence suggests that these higher rates may have their origins in adolescence. For example, some large, well-designed studies with representative samples show high rates of substance use in LGB youth compared to heterosexual youth [4]. However, compared to LGB adults, much less is known about substance use disparities among LGB adolescents, and large gaps exist in the literature in understanding who is most vulnerable within the LGB adolescent community. One trend in the literature shows that lesbians or bisexual females are at higher risk for substance use than are gay or bisexual adolescent males, for example, and some studies support this hypothesis [5-7]. However, other studies have found stronger effects for boys than for girls [8], did not test gender differences [9-11] or found no gender differences [12,13]. Moreover, most studies examined differences in rates between boys and girls but did not test formally an interaction between sexual orientation and gender in predicting substance use outcomes. Thus, conclusions about the role of gender in risk for substance use in LGB youth are unclear.

Methodological challenges introduced by studying hidden populations may also have an impact on the interpretation of the effects of sexual orientation on LGB youth substance use. For example, some studies have operationalized sexual orientation using self-identification or self-labeling methods [14], others have relied on self-reports of same-sex romantic or sexual attraction [5] and others have defined sexual orientation strictly in terms of past behavior [13]. These measurement differences might have important implications for interpreting and generalizing the results [15]; therefore, examining their role in the estimation of risk for LGB youth is paramount. In addition to how sexual orientation was operationalized, studies varied by whether or not they measured bisexuality status, and whether or not they tested differences between lesbian and gay youth versus bisexual youth in terms of their rates of substance use. These studies seem to have found a relatively consistent pattern of effects, suggesting that bisexual youth are at greater risk for substance use [9,13,16]. However, none of these studies tested bisexuality status formally as a moderator, raising questions about the statistical validity of the effect. Finally, different recruitment mechanisms were used across studies that may also have an impact on the demographic make-up of the participants (e.g. school-based samples versus homeless samples), hence the size of the observed effects and their generalizability; however, little is known about how the recruitment source affects differential rates of substance use in these studies.

In addition to concerns about the internal validity of these studies, there are also concerns about their external validity. In particular, very little research with LGB youth has been conducted outside of the United States, raising questions about the generalizability of the US findings, thus the universality of the problem. One of the most prominent theoretical and explanatory frameworks of LGB health risk is the 'minority stress' model [17], which proposes that LGB health disparities can be explained in large part by stressors induced by a hostile, homophobic culture which often results in a life-time of harassment, maltreatment, discrimination and victimization. While there is ample evidence to suggest that hostility, discrimination and violence towards LGB individuals are universal phenomena [18], international LGB health sciences research is limited.

The primary goals of this paper were therefore four-fold. First, we conducted a meta-analysis to address a simple but important question: are sexual minority (LGB) youth at significantly higher risk for substance use and abuse than are heterosexual youth? To this end, we examine the overall effect size collapsing across all studies and subgroups in order to compare the average relative rates of substance use between LGB youth and heterosexual youth. Secondly,

we describe the characteristics of the distribution of effect sizes across studies including the mean, range and variability with the goal of understanding the heterogeneity of these effects. Thirdly, we conduct moderator analyses in an attempt to examine important individual and methodological characteristics (including country of origin) that might have an impact on the relationship between sexual orientation and adolescent substance use. Meta-analysis is a useful tool in accomplishing these goals, because it: (i) facilitates a relatively objective and systematic process for gathering, summarizing and describing the empirical literature to date; (ii) can reveal patterns of effects across studies that might otherwise be obscured or remain untested; (iii) is considered much less vulnerable to systematic bias than reviews that rely on 'vote counting' procedures or other methods that depend solely on the significance tests of individual studies which may be underpowered or might have limited external validity; and (iv) allows for tests of moderation by combining effects across studies that in and of themselves may have not had adequate sample sizes to formally test interactions [19].

Our final goal of this study was to conduct a systematic review of the methodology of each study to determine how many studies: (i) examined mediating mechanisms, which might explain how or why sexual orientation is associated with substance use; (ii) tested moderating variables that might identify who is at highest risk for substance use among the LGB youth population; (iii) used a matched comparison group design to help rule out alternative explanations for the effects; (iv) controlled for potential confounding variables; and (v) examined longitudinal effects.

METHOD

Reporting guidelines [20] developed and recommended by the Centers for Disease Control were followed closely for this study.

Selection of studies

There were two main inclusion criteria: (i) studies that reported a statistical test of the relationship between sexual orientation and some measure of adolescent substance use or abuse; and (ii) the mean age of the sample was 18 years or less, and the upper bound of the age range was not older than 21 years. We limited our studies to those who reported a mean age of 18 or younger in order to avoid college-based samples, due to the increased likelihood that LGB youth will have disclosed being gay or bisexual to their peers or family members for the first time in young adulthood [21], and because the majority of college students increase drug and alcohol use during college [22]. These developmental phenomena would probably bias the conclusions of this review regarding risk for substance use in pre-college LGB youth. Note that we used the term 'adolescence' throughout this paper because the vast majority of our studies (over 75%) fell within the age guidelines (ages 10–19 years) adopted by the United Nations World Youth Report [23]. Using these criteria, studies were identified for the analysis in four steps. First, a systematic search of two large, comprehensive databases (PsychInfo, MedLine) was conducted using various combinations of key terms including: 'alcohol', 'drug', 'gay', 'lesbian', 'bisexual', 'LGB', 'adolescent' and more. A total of 289 abstracts were identified using these search terms and were subsequently reviewed by authors Miles and Marshal to determine if they met criteria for the meta-analysis. Secondly, papers that appeared to meet criteria based on the review of abstracts in step 1 were retrieved and reviewed to confirm their eligibility ($n = 40$). Thirdly, all eligible studies were then read in detail and their citation lists were reviewed in order to identify any studies that may meet entrance criteria but were not identified by the database search. Using these methods a total of 20 studies were identified that met the inclusion criteria. Of these 20 studies, six of them used Youth Risk Behavior Survey (YRBS) sample data collected in Massachusetts and Vermont, and two of these did not contribute unique information above and beyond the other four [8,16,24,25], therefore we

excluded them from this review. In order to identify unpublished studies that met inclusion criteria, request letters were mailed to all the first authors of all eligible studies asking for their help in identifying published or unpublished studies that met our inclusion criteria. No additional studies were identified. The final sample of 18 studies [5-14,16,24-30] reported a total of 125 effect sizes representing tests of the relationship between sexual orientation and various substance use outcome measures.

Coding of studies

Two doctoral-level reviewers read all the studies and extracted the pertinent data from the published articles which fell into four categories: (i) the predictor variable (definition of sexual orientation); (ii) the outcome variables (substance use measures); (iii) other potential moderating variables (recruitment source; bisexuality status; gender); and (iv) the effect size data. The intraclass correlation across all coded variables was excellent (0.95). Disagreements and coding errors were resolved prior to estimating final results.

Definition of sexual orientation—Four coding categories were used, including measures of: (i) self-identification as gay or bisexual; (ii) same-sex romantic or sexual attraction; (iii) same-sex romantic or sexual behavior; and (iv) two or more of categories 1–3. Note that some studies [5] ask participants to describe themselves on a sexual-orientation continuum that included intermediate categories such as 'mostly heterosexual'. Only effect sizes for 'gay/lesbian' versus 'heterosexual' were used.

Substance use outcome variables—Substance use variables were coded based on the type of substance that was used (tobacco, alcohol, illicit drugs) and the time-frame in which it was used. Alcohol use variables were operationalized typically as a quantity and/or frequency measure, or a heavy alcohol use measure (e.g. binge drinking). Illicit drugs included marijuana, cocaine, crack, methamphetamine, ecstasy (and other 'club' drugs) and heroin. Some studies assessed whether or not certain classes of drugs were used, such as 'inhalants' or 'injection' drugs [10]. Some studies computed composite variables that indicated whether or not participants used any one or more of a list of illicit drugs [8]. All studies used variables that distinguished between current or recent use and life-time use. The majority of studies that reported measures of recent drug or alcohol use used a time-frame defined as the previous 30 days. A few studies reported recent use as occurring during the past year [14]. Only one study assessed and reported rates of substance use disorders (SUDs) operationalized as alcohol and drug abuse and measured using a comprehensive diagnostic interview [30].

Recruitment source—Participants across studies were recruited from several different sources that could be categorized broadly into school and 'high-risk' samples. One general population sample [5] consisted of the offspring of women participating in the Nurses Health Study [31] and did not fit well into either of these categories. School studies were typically large-scale, anonymous surveys of high-school students such as the YRBS [8,16,24,25] or the Add Health study survey [13]. High-risk samples ranged from those seeking mental health treatment or services [9] to homeless youth [10] to prison populations [11]. In addition to the type of sample that was used, we also coded whether or not samples were recruited from countries outside the United States.

Data analytical plan

The data analysis proceeded in four steps. First, mean effect size estimates for each study were calculated by averaging the effects across all drugs and subgroups. Secondly, an overall effect was estimated by combining weighted effects across all studies. Thirdly, methodological characteristics were tested as moderators of the overall effect. Fourthly, outcome variables were categorized based on the type of substance used and the time-frame of use, and the effects

of sexual orientation on different substance use variables were estimated. Sensitivity analyses were performed in order to identify potential outliers, publication biases and other threats to the statistical conclusion validity of the results [32]. A mixed-effects model was assumed which allowed for tests of heterogeneity and moderation but also allows for tests of random effects models once the variability accounted for by moderator variables has been removed [19]. Data management and analyses were conducted using software sponsored by the National Institutes of Health [33]. Effects herein are reported on a standardized mean difference scale often referred to as Cohen's d [34].

RESULTS

Overall effect size estimates

Weighted effect size estimates and methodological characteristics for each study are summarized in Table 1 and Fig. 1. There were a total of 18 studies and 125 effect size estimates. The largest effect size was omitted (one of four effects reported in [29]) because it was more than six times larger than the next largest effect and therefore was deemed an outlier. For the data and results presented in Table 1, the average effects across substance use outcomes within each study were calculated. Results show that the estimate for the overall weighted effect size for the relationship between sexual orientation and substance use is moderate in size and significantly different from zero ($Z = 35.31$, $P < 0.0001$).

Mean effect size for each study ranged from 0.14 [7] to 1.23 [29]. Individual effect sizes ranged from -0.63 [7] to 1.81 [6]. Over 30% of the individual effects (37 of 125) were smaller than 0.20, and almost an equal number (38 of 125) were larger than 0.80. The average number of substance use effect size estimates tested within each study was 4.76 and ranged from 1 [26] to 16 [7]. Sensitivity analyses showed that when the overall effect was re-calculated with each study removed, the re-estimated effect sizes ranged from 0.47 to 0.63. Regardless of which study was removed, the overall tests of significance remained significant (Ps < 0.0001). Begg & Mazumdar's rank correlation test ($P = 0.20$) and Egger's linear regression test ($P = 0.50$) suggested that there was no significant relationship between the standard errors and the effect sizes. Because there were only 18 studies in these analyses the tests were somewhat underpowered, therefore funnel plots were also examined. Results suggested that studies with small samples were not associated disproportionately with large effects. Rosenthal's fail-safe N-test suggests that 1790 missing studies with null effects would be needed (99 studies for every one included in this meta-analysis) in order to increase the overall P-value to above 0.05. Cochran's Q-test showed that the effects were significantly heterogeneous ($Q = 252.10$, d.f. = 14, $P < 0.0001$). As a result moderation analyses were conducted.

Moderation of overall effects

There were five moderators: (i) definition of sexual orientation; (ii) participant recruitment source; (iii) bisexual versus gay/lesbian orientation; (iv) gender of the participant; and (v) country of origin of the study (US-based studies versus non-US studies); χ^2 tests between the moderator variables suggested there were no confounds that may have threatened the interpretation of the results. Significance tests for subgroup analyses reported below assumed random effects models. The between groups heterogeneity Q- statistic showed that the definition of sexual orientation was a significant moderator ($Q = 164.7$, d.f. = 3, $P < 0.0001$). Analyses for this moderator were run with each of the four Vermont/Massachusetts YRBS studies [8,16,24,25] separately in order to avoid dependency between moderator subgroups. The pattern of results did not change substantially across the four sets of analyses. Average effect sizes for each level of the moderator showed that the strongest effects of sexual orientation on substance use outcomes (0.75, $P < 0.0001$) were found when self-identification was used to define sexual orientation. The effects within other categories were: 0.44 ($P < 0.01$)

for attraction, 0.29 [P = not significant (NS)] for behavior and 0.25 (P = NS) when combinations of two or more categories were used. Recruitment source was also a significant moderator (Q = 6.6, d.f. = 1, P < 0.01). For this analysis YRBS studies were averaged because the recruitment source was the same. School samples reported only slightly stronger effects 0.49 (n = 8, P < 0.0001) than did the high-risk samples 0.47 (n = 6, P < 0.01). Only one study used a general population-type sample [5] (children of nurses participating in a large-scale health study) which was excluded from the moderator analysis; however, it reported the largest effect size (0.87, P < 0.01). Gender of the participant was also a significant moderator (Q = 16.6, d.f. = 1, P < 0.0001). Results showed that the average effect of sexual orientation on substance use was higher for females 0.78 (n = 10, P < 0.0001) than it was for males 0.42 (n = 11, P < 0.01). There was a robust moderation effect of bisexuality status (Q = 154.3, d.f. = 1, P < 0.0001), such that the effects were strongest in youth who were considered bisexual 0.77 (n = 7, P < 0.0001) and not significant within subsamples of gay/lesbian youth who were not bisexual 0.10 (n = 6, p = NS). Finally, the average effect size for studies conducted outside the United States (0.92, n = 3, P < 0.0001) was significantly larger (Q = 156.4, d.f. = 1, P < 0.0001) than was the average effect of studies conducted within the United States (0.43, n = 12, P < 0.0001). However, this difference was driven largely by the study with the largest average within-study effect size [29] (across all studies in Table 1), and when removed from the analyses the test of moderation was not significant and the average non-US effect size estimate dropped to 0.56 (P < 0.05).

Association between sexual orientation and individual substances

The type of substance used could not be tested formally as a moderator due to the non-independence of the effects; however, average effects for each drug and time-line (recent versus life-time measures of use) were estimated and described in order to examine their possible influence on the effect size variability. Two broad conclusions may be drawn from an examination of the effects shown in Table 2. First, there was no clear pattern of effects associated with the assessment time-line employed by the studies. Secondly, the sizes of the average effects within each drug class seem to vary depending on the class of drug. Most notably, the largest average effect sizes were associated with hard drugs (cocaine, injection drugs) and the smallest were associated with drugs used more commonly by teenagers (heavy alcohol use, marijuana). Although some effects seemed to defy this trend (e.g. the large effects for cigarette use), this variability may account for some of the observed heterogeneity of effects in the overall model. Only one study tested the association between sexual orientation and adolescent substance use disorders [30], which reported an average effect size of 0.25.

DISCUSSION

Results of this meta-analysis indicate that LGB youth report significantly higher rates of substance use compared with heterosexual youth, and a meaningful proportion of the effects could be characterized as large, to very large, depending on the subgroup and the type of drug that was used. For example, the average Cohen's d for the relationship between sexual orientation and life-time cigarette use, injection drug use and a composite drug use variables were all greater than 0.80. Compared to suggested definitions of small (0.20), medium (0.50) and large (0.80) [34], effects of this magnitude are noteworthy. When the overall effect sizes were converted to odds ratios, the odds of substance use for LGB youth were 190% higher than for heterosexual youth and substantially higher within some subpopulations of LGB youth (e.g. 340% higher for bisexual youth, 400% higher for females). The relatively large effects found in this review suggest that the answer to the central question of this study, 'Are sexual minority youth at significantly higher risk for substance use and substance use problems than are heterosexual youth?', is a probable 'yes', but caution is warranted in drawing broad conclusions

about this risk due to the results of the moderator analyses and the methodological limitations discussed below.

One of these limitations is that none of the studies in this meta-analysis tested the mediating effects of variables that might explain the relationship between sexual orientation and substance use. The 'minority stress' model [17], provides some useful guidance regarding potential mediators for future research. For example, many LGB individuals experience hostility, discrimination and violence due to a largely homophobic culture. Thus, sexual minority status serves as a chronic stressor that may impair physical and psychological functioning, increasing one's susceptibility to illness and disease, and perhaps, substance use. There is some preliminary evidence to suggest that these mechanisms might be operating in LGB youth. For example, some important studies have found support for such mediators when examining mental health outcomes in LGB-only samples [35,36]. Furthermore, although they did not test mediating mechanisms, one study in this meta-analysis showed that the association between sexual orientation and substance use was stronger for LGB youth who had been victimized [8].

The majority of studies that were included in this review, however, did not have large enough LGB cell sizes to test moderation adequately; therefore in this study moderation was tested via meta-analysis procedures by combining studies with similar characteristics. These results showed that the association between sexual orientation and adolescent substance use was stronger in: (i) studies using 'self-identification' methods for assessing sexual orientation; (ii) girls; and (iii) youth endorsing bisexual identity, attraction or behavior. Furthermore, the effects seem to be stronger for harder drugs such as cocaine and injection drugs. While these results are an important first step in understanding the heterogeneity of the LGB youth population they are far from conclusive, and they raise as many questions as they answer. For example, what are the mechanisms that explain the moderating effects of self-identification methods and bisexuality status, and what do they mean for clinicians and researchers? Self-identified youth may be more confident in their identity, hence more likely to have disclosed being gay or bisexual to others than were youth identified through other measures of orientation. Thus self-identified youth may be more likely to experience victimization. On the other hand, bisexuality may be an indicator of transition in one's sexual identity among youth, and may be considered a normal but stressful component of an identity development process. Minority stress theory might predict that each is characterized by stressful personal or interpersonal processes, therefore stress might be a driving mechanism for both moderating effects. Future research guided by strong theory might help elucidate these and similar findings.

The results of this meta-analysis suggest that an extension or refinement of the minority stress model is needed that addresses the additional challenges introduced by the age and developmental stage of LGB youth. For the average heterosexual teenager, puberty can be characterized by turbulent changes in social, physical and emotional functioning that often are stressful and challenging and encompass large developmental tasks such as the development of sexual orientation and identity, the initiation of romantic and sexual relationships and sexual intimacy [37,38]. These normal stressors may be compounded exponentially for LGB teenagers by the additional stress of being gay. For most gay teenagers, developing a healthy gay identity may be difficult due to the social stigma of homosexuality and the ever-present fear of discrimination. Exacerbating this process is that coping skills and abilities in adolescents are often not fully developed [39,40], therefore they are often less able to use coping skills to protect themselves from stressors such as harassment compared to adults.

As a result, LGB youth who are victimized either explicitly (e.g. bullied by peers) or implicitly (e.g. antigay messages from religious institutes, popular media or political leaders) may have not yet developed adequate resources to cope. Compounding the problem for LGB youth is

that if they intend to stay hidden or covert as a way of protecting themselves their ability to request assistance and support from adults is hindered, and stress and distress may increase due to the anticipation and fear of violent or other negative reaction to disclosure by family and friends [41]. On the other hand, because many youth can disguise their minority status they have the option of staying hidden, which can give LGB youth control over how they are perceived by their family members, peers and society. Thus, developmental models of the minority stress paradigm that include these age specific challenges and phenomena are critical to promoting quality research that can identify age appropriate targets for prevention and intervention programs. Important to these developmental paradigms is the examination of individual, longitudinal trajectories of substance use over time in order to best examine risk and protective factors associated with escalations in use at the individual level. The results of this study showed that only one study tested longitudinal effects [7], and virtually no studies to date have estimated trajectories of substance use over time in LGB youth and compared them to heterosexual youth.

There are several clinical implications of these results for health-care providers. First, as recommended by most pediatric and adolescent medicine textbooks and articles about interviewing adolescents, all teenagers should be asked routinely at each annual visit about their sexual history, which should include assessment of sexual orientation and gender identity as well as substance use experiences [42,43]. Screening tools such as the CRAFFT can be used to determine problematic use and identify when a youth requires referral for further chemical dependency assessment and treatment [44]. Although we found only one study that examined SUD rate disparities in LGB adolescents [30], the large substance use disparities found in this study suggest that concern over chemical dependency in LGB youth is warranted. In settings where clinicians provide health care to youth who are already known to engage in high substance use/abuse behaviors such as residential treatment and detention facilities, teenagers should also be asked routinely about their sexual orientation and gender identity. In other community and out-patient settings clinicians should be prepared to refer patients to treatment programs that are sensitive to sexual orientation issues. In order to facilitate disclosure, clinicians must be trained and comfortable assessing varying sexual orientation and gender identity issues and should preface these discussions by reviewing the rules and limitations of patient-provider confidentiality. In the United States, institutes such as the Substance Abuse and Mental Health Services Administration (SAMHSA) have taken significant steps toward making such important health-care information available to providers [45,46].

A review of the prevention and intervention guidelines published by the American Medical Association [47,48], the National Institute on Drug Abuse [49], National Institute on Alcohol Abuse and Alcoholism [50] and the Institute of Medicine [51] found that none of these highly regarded institutes mention sexual orientation as a potential risk factor for substance use in adolescence, let alone provide information for researchers and health-care providers on how to prevent such problems. This is not surprising, given the nascent state of the literature. For example, it may difficult for professional organizations to recommend modifiable targets for prevention when there are virtually no studies that have examined mediators of the relationship between sexual orientation and adolescent substance use. Thus, given the robust effects found in this review, and the relatively small set of studies that have examined this topic to date, it is important to highlight the need for more LGB youth research. Important next steps should include identifying empirically supported mediators and moderators of risk, and examining individual trajectories of substance use and associated health risk behaviors over time. Furthermore, the importance of replicating and extending health disparities research in LGB populations internationally cannot be overstated. Our results show that in other large, relatively affluent countries such as Canada [29] and Australia [12], disparities in LGB youth substance use are equal to those in the United States. Young-adult studies in New Zealand [52] and Thailand [53] corroborate this trend. Researchers, clinicians and especially sexual minority

youth and their families will benefit from these efforts and future studies designed to identify and delineate risk and protective factors for LGB youth world-wide.

Acknowledgements

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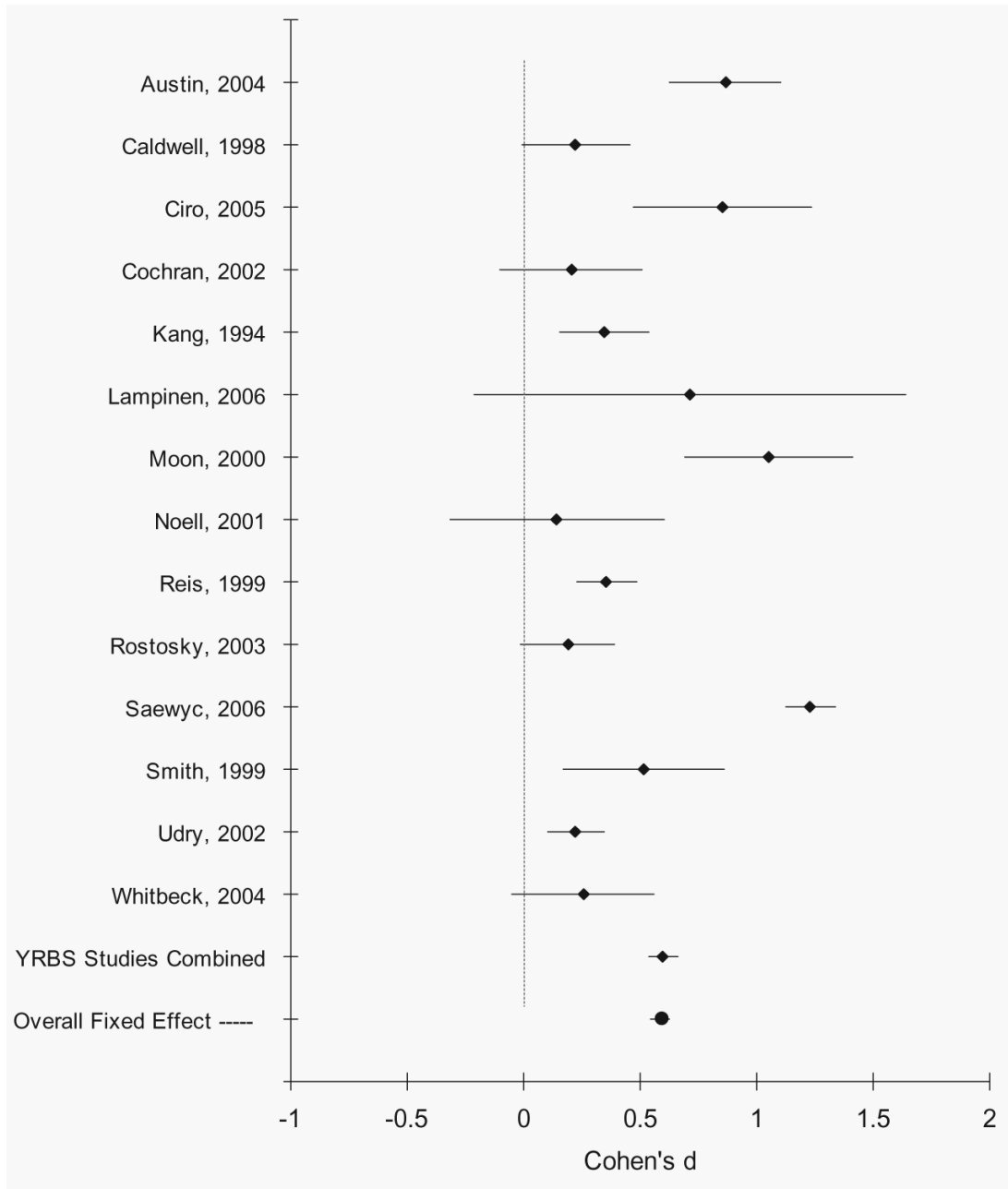
Figure 1.
Standardized mean differences (Cohen's d) and 95% confidence intervals for studies testing the association between sexual orientation and adolescent substance use

Table 1

Descriptive statistics and study characteristics for studies testing the association between sexual orientation and adolescent substance use.

Study	Gender	Sexual orientation group	Total n	% LGB	Odds ratio	Cohen's d	No. of effects	Recruitment site	Sexual orientation definition	Comments
1	C	L/G/B			4.06	0.77	4	Comm	Att	3
	M	G/B	3862	1.12	2.21	0.44	2			
	F	L/B	5537	1.06	6.96	1.07	2			
2	C	L/G/B			5.94	0.98	8	School	Beh, SI	1, 4
	M	G/B	4605	4.10	6.72	1.05	4			
	F	L/B	4583	2.75	4.89	0.88	4			
3	C	L/G/B	2641	4.20	1.50	0.22	1	School	Att	
4	C	L/G/B			4.70	0.85	11	High risk	SI	
	C	L/G	661	1.97	2.39	0.48	4			
	C	B	673	3.71	7.86	1.14	4			
	F	L/G/B	431	7.42	4.86	0.87	3			
5	C	L/G/B	168	50.00	1.44	0.20	12	High risk	Att, SI	2
6	C	L/G/B	1668	6.29	8.28	1.17	7	School	Beh	1
7	C	L/G/B	4159	2.50	4.96	0.88	11	School	SI	1
8	M	G/B	427	5.00	1.87	0.35	1	High risk	SI	
9	C	L/G/B	590	2.54	3.65	0.71	12	School	SI	
10	C	L/G/B			7.96	1.15	2	High risk	SI	
	M	G/B	124	26.61	2.46	0.50	1			
	F	L/B	217	16.13	26.47	1.81	1			
11	C	L/G/B			1.29	0.14	16	High Rrsk	Att, Beh, SI	5
	M	G/B	316	13.92	2.40	−0.16	8			
	F	L/B	216	44.91	0.75	0.48	8			
12	C	L/G/B	7477	4.43	1.91	0.36	1	School	Att, SI	
13a	C	L/G/B			1.63	0.27	6	School	Beh, SI	1
Robin 2002 [16], MA	C	L/G	4054	2.61	1.00	0.00	3			
	C	B	4070	3.00	2.35	0.47	3			
13b	C	L/G/B			1.80	0.36	6	School	Beh	1

Study labels: 1 Austin 2004 [5]; 2 Botempo 2002 [8]; 3 Caldwell 1998 [26]; 4 Ciro 2005 [9]; 5 Cochran 2002 [10]; 6 Faulkner 1998 [24]; 7 Garafalo 1998 [25]; 8 Kang 1994 [11]; 9 Lampinen 2006 [14]; 10 Moon 2000 [6]; 11 Noell 2001 [7]; 12 Reis 1999 [27]; 13a Robin 2002 [16], MA; 13b Robin 2002 [16], VT

Study	Gender	Sexual orientation group	Total n	% LGB	Odds ratio	Cohen's d	No. of effects	Recruitment site	Sexual orientation definition	Comments
	C	L/G	7209	4.66	1.24	0.12	3			
	C	B	7122	3.50	2.59	0.53	3			
14 Rostosky 2003 [28]	C	L/G/B	1725	5.74	1.41	0.19	2	School	Att	3
15 Saewyc 2006 [29]	C	L/G/B	125 895*		9.32	1.23	4	School	SI	3
	M	G	125 895*	0.70	2.25	0.45	1			
	M	B	126 245*	0.98	6.64	1.04	1			
	F	L	116 137*	0.40	12.83	1.41	1			
	F	B	119 994*	3.60	12.31	1.38	1			
16 Smith 1999 [12]	C	L/G/B			2.54	0.52	6	School	Att	
	M	G/B	1499	5.34	2.45	0.49	3			
	F	L/B	1888	6.94	2.63	0.53	3			
17 Udry 2002 [13]	C	L/G/B			1.50	0.22	12	School	Beh	
	M	G	6008	0.95	0.79	-0.13	3			
	M	B	6038	1.44	2.43	0.49	3			
	F	L	6291	1.59	0.83	-0.10	3			
	F	B	6314	1.95	2.36	0.47	3			
18 Whitbeck 2004 [30]	C	L/G/B			1.59	0.25	4	High risk	SI	6
	M	G/B	187	10.16	0.68	-0.21	2			
	F	L/B	241	18.26	2.34	0.47	2			
Total average effect sizes										
All studies					2.89	0.59				
Females					5.02	0.89				
Males					3.29	0.66				
Bisexual					4.42	0.82				
Gay/lesbian					1.10	0.06				

Study: First author and year of publication. MA = Massachusetts. VT = Vermont. Gender: M = male; F = female; C = combined (male and female); sexual orientation group: L = lesbian, G = gay (males), B = bisexual.

*
Total *n*: weighted sample sizes and effect size data provided by author (personal communication, 3 August 2006). Odds ratio/Cohen's d: weighted estimates of mean effect size across (non-independent) outcomes within each study. Sexual orientation definition: Att = attraction, Beh = behavior, SL = self-labeled. Sampling method: Comm = community. Sexual orientation definition: Att = attraction,

Beh = behavior, SI = self-identification. Comments: 1 = Vermont and/or Massachusetts YRBS sample. 2 = Matched comparison group design. 3 = Controlled for group differences in covariates. 4 = Tested mediation and/or moderation. 5 = Longitudinal/prospective design. 6 = Measured substance use disorder outcome variables.

Table 2

Association between sexual orientation and adolescent substance use stratified by type of substance use variable.

Substance	Recent use			Life-time use		
	Cohen's d	Odds ratio	n	Cohen's d	Odds ratio	n
Cigarettes	0.56	2.76	6	0.80	4.23	2
Alcohol	0.52	2.55	5	0.44	2.23	3
Heavy alcohol	0.16	1.34	5	—	—	—
Marijuana	0.23	1.56	6	0.52	2.58	3
Cocaine	0.72	3.27	5	0.62	3.09	4
Injection drug use	0.56	2.87	4	1.09	7.23	5
Composites	0.81	4.37	3	0.62	3.10	5

Composites = outcome variables operationalized as the use of any one or more of a list of illicit substances which typically excluded alcohol and tobacco.