Three Papers Exploring Substance Use in Sexual and Gender Minority Youth

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Abstract

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Disparities between the substance use rates of sexual or gender minority (SGM) youth and the rates of youth identifying as heterosexual (i.e., attracted to the opposite sex) and cisgender (i.e., gender identity corresponds to birth sex) have given rise to calls for 1) research to understand the specific risk and protective factors relating to substance use in SGM youth and 2) the development of corresponding intervention programming

In three papers, this dissertation explores predictors for substance use among SGM youth and describes methods of targeted recruitment for a prevention intervention program tailored to SGM youth. In the first paper, comparing the contributing factors of substance use between sexual minority and heterosexual youth revealed that although many predictors were associated with use in both groups, sadness, suicidal ideation, difficulty concentrating, and forced sexual encounters were the most consistent and substantial contributors to the explanation of the difference in use rates between groups. In the second paper, risk and protective factors identified from social learning theory and minority stress theory, including perceived stress, problem-solving skills, self-esteem, self-efficacy, substance refusal skills, and peer use of substance, were generally associated with past-month substance use. Peer use of substance and substance refusal skills, in particular, were consistently and robustly associated with substance use in the sample of SGM youth, and their intersection provides insight into themes to address in future intervention development. Issues of disclosure and parental permission have made recruiting representative

samples of SGM youth challenging, and the third paper offers insight into an inexpensive and time-efficient means of recruiting SGM youth for participation in such research. The specificity with which Facebook ads can be targeted to hard-to-reach populations makes it a preferred tool for researchers who seek to recruit SGM youth. Taken together, the three papers of this dissertation can serve as a guide for the development and execution of substance use prevention research that is tailored to the specific needs of SGM youth.

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Dedication

I dedicate this dissertation to the young people who participated in our study and to the memory of Dr. Nancy E. Kline and Dr. Steven P. Schinke.

Introduction

There are disquieting disparities between the substance use rates of youth who identify as a sexual or gender minority (SGM) and the rates of youth identifying as heterosexual (i.e., attracted to the opposite sex) and cisgender (i.e., gender identity corresponds to birth sex).[1-5] The Centers for Disease Control and Prevention estimate that lifetime and current substance use is higher among sexual minority youth (i.e., gay, lesbian, bisexual, queer, questioning, pansexual, or other non-heterosexual identities) than heterosexual youth: for example, for marijuana, 32.0% of gay, lesbian, or bisexual youth report current use, compared to 20.7% of heterosexual youth; and 52.9% of gay, lesbian, or bisexual youth report lifetime use, compared to 37.5% of heterosexual youth. This pattern is similar for alcohol (current: 40.5% sexual minority vs. 32.1% heterosexual; lifetime: 75.3% sexual minority vs. 62.5% heterosexual) and cigarettes (current: 19.2% sexual minority vs. 9.8% heterosexual; lifetime: 50.4% sexual minority vs. 30.5% heterosexual) and holds for lifetime measures of non-medical prescription drugs and steroids, hallucinogenic drugs, inhalants, cocaine, heroin, methamphetamines, and ecstasy.[4] (**Figures 1 and 2**)

These estimates are supported by a landmark meta-analysis of 18 studies, which found that sexual minority youth were 2.89 times more likely than their heterosexual peers to engage in substance use.[1,4,6] Studies of gender minority youth (i.e., transgender, non-binary, gender neutral, genderfluid, or genderqueer and those who are questioning their gender identity) also show they have higher lifetime and current use rates of across all substances, compared to cisgender youth.[7,8] In a report on the health of the SGMs in the United States, the National Academies of Medicine highlighted the negative long-term implications of these substance use disparities and called for 1) research to understand the specific risk and protective factors relating to substance use in SGM youth and 2) the development of corresponding intervention programming.[9] To that

end, in three papers, this dissertation explores predictors for substance use among SGM youth and describes methods of targeted recruitment for a prevention intervention program tailored to SGM youth.

Theoretical Framework

Minority Stress Theory (MST) has guided the construction of this dissertation. Minority stress, proposed by Meyer, differs from the stress experienced in everyday life in that is unique, chronic, and socially based.[10] The uniqueness is seen in its specificity to stigmatized populations over the non-stigmatized, as well as in its additive nature, whereby the minority experiences this specific stress in addition to the general stressors faced by the broader population. The chronicity of minority stress, meanwhile, refers to its well-established and consistent presence in social structures and cultural norms. Minority stress is socially based in that it is born out of, and reinforced by, socially defined structures, processes, and institutions. Minority Stress Theory was originally applied to mental health disparities and suggests that disparities between minority and non-minority groups result from the persistent stress minority groups face and not from inherent issues in the minority. For this dissertation, I build upon recent applications of MST to substance use disparities in SGM adults and extend this to SGM youth.

Internalized Stigma and Substance Use

In order to better understand MST in the context of SGM youth substance use though, it is first useful to explore the concept of internalized stigma. Defined broadly, the concept of stigma has been presented in the literature as the devaluing and marginalizing of an individual based on a perceived socially undesirable characteristic.[11-13] Typically demographic in nature, these characteristics can include race, ethnicity, religion, geography, socioeconomic status, sexual orientation, and gender identity, among others but also can extend to physical or cognitive

features and abilities, or any other characteristic in which an "us" and "them" situation arises and leads to loss of status or discriminatory practices.[11,12] Internalized stigma, meanwhile, is the inward acceptance of society's negative attitudes or perceptions by a member of the stigmatized class.[13,14]

Among those identifying as SGM, the literature refers to this internalized stigma by varying names, including internalized homo/trans-phobia, homo/trans-negativity, and heterosexism, as Szymanski and colleagues present in their historical overview of internalized stigma.[14] Although there are semantic nuances distinguishing these terms, the literature tends to use them interchangeably.[10,15-17] Internalized stigma arises upon inward acceptance of the homo/trans-phobic and heterosexist beliefs prevalent in society and consequent feelings of shame and disgust by one's sexual minority status.[10,14,16]

While the cause of internalized stigma is multi-factorial and impacted by both external and internal processes, theories on the development of SGM identity may prove useful in understanding the roots of internalized stigma: for example, Cass' six-step model (identity confusion, comparison, tolerance, acceptance, pride, and synthesis) suggests that internalized stigma may arise if the individual who recognizes his/her SGM identity is unable to tolerate and accept this identity.[18] Similarly, for sexual minorities, Minton and McDonald offer a three-stage process where homoerotic feelings are interpreted and acknowledged; normative assumptions about homosexuality are internalized; and norms are evaluated critically, leading to the achievement of a positive sexual minority identity.[19] Disruptions to the second and third phases may cause the individual to internally embrace negative normative assumptions.

Sexual and gender minorities may internalize the negative messages they receive from society, which can take the form of violence, rejection, harassment, and discrimination against

SGM, and develop psychological distress, which itself can manifest in different forms, including substance use. Hatzenbuehler explored the connection between internalized stigma and psychopathology in great depth in adults, addressing how stigma and minority stressors "get under the skin" to negatively impact health. He proposed a psychological mediation framework, whereby stress associated with internalized stigma leads to emotional dysregulation, interpersonal and social problems, and cognitive processes, which then manifest as psychopathology.[16] Hatzenbuehler provides examples from literature of how alcohol use can play a mediating role, as related to emotional regulation, interpersonal/social issues, and cognitive processing, in the relationship between sexual minority status and substance use disorders.[15,20,21] His later work extends to SGM youth, describing psychosocial and physiological mechanisms that may induce stigma and lead to impaired health, including vigilance, rumination, loneliness, and hypothalamic-pituitary-adrenal axis stress responses. He further proposes interventions that may be effective in targeting these mechanisms. [22] These interventions include structural alterations so to create environments in which fewer stressors exist (these can occur at the school or local level, or at the broader state and national policy level); inter-personal interventions to facilitate affirmative interactions between youth and their parents, peers, healthcare providers, and teachers; and individual-level interventions to improve coping relating to stigma.

Internalized Stigma and MST

Meyer's MST expands upon the notion of internalized stigma to address the broader social context in which such stigma both exists and interacts with other potential sources of distress in minorities.[10] Minority Stress Theory is built on psychological theory and stress literature and finds its roots in Lazarus and Folkman's distal—proximal construction of social

structure, a reference to the physical proximity in which experiences occur.[23] Stress, as Meyer notes, can take a number of meanings, although generally accepted understandings consider stress to be taxing events or conditions that may exceed an individual's endurance capacity, or pressure, strain, or tension on an individual's physical, mental, or emotional statuses. For Meyer and, later, others stressors faced by a minority may be distal in nature—that is, they originate outside of the subject and may involve victimization, discrimination (*de jure* and *de facto*), and/or harassment—or proximal, originating within the subject and including fear and/or expectation of rejection, identity concealment, and, as discussed above, internalized stigma.[14,24]

In general, MST addresses the impact of stress and coping on mental health. As Hatzenbuehler notes, in MST, stress acts as mediator between minority status and psychopathology.[16] More specifically, according to Meyer, the multi-phase model suggests that minority stress is found within general conditions and circumstances of an environment (e.g., socioeconomics), overlapped by an individual's own minority status (e.g., race or sexual minority status), with the overlap illustrating the intimate relationship between the two. From the environment and the personal, distal (i.e., outside the person) stressors are generated, but, as with the sources of the stress, these stressors may be interdependent as well. Further, additional stress may arise as individuals come to develop a specific identity related to the personal identification with their minority status, and Meyer suggests that this stress is more proximal (i.e., within the person) in nature than the stresses associated with environmental and generalized minority status-related stress. Meyer notes, however, that minority identity can also serve as a modifier, either positively or negatively, in the stress development process, dependent upon the prominence of the identity in one's definition of self and the potential for the identity to be a source of strength (e.g., when the identity creates chances for social support and/or community

affiliation). The stress processes, both distal and proximal, combine with the modifying responses to impact the mental health outcomes, positive or negative, of the minority individual. (**See Figure 3 for an illustrated model**.)

Using MST to Understand Substance Use Outcomes

Although Meyer's work focuses on specific mental health outcomes, including depression and anxiety disorders, suicidality, and other psychopathology, it has been extended in the literature to apply to alternative outcomes. For example, Denton and colleagues explored the relationship between minority stress and physical health: the authors found that in a sample of 564 sexual minority adults, experiences of distal stress (in this case, sexual orientation-based discrimination and prejudice) were associated with proximal stress (internalized homonegativity, expectations of rejection, and desire to conceal sexual orientation), with the combination resulting in high levels of physical symptom severity.[24] Another study applied the model to cardiometabolic risk in young adults, finding stressful life events acted as a moderator between sexual minority status and measures of cardiac health.[25]

Lehavot and Simoni, meanwhile, addressed the impact of minority stress on substance use in sexual minority adult women, finding that both distal stress (victimization) and proximal stress (internalized homophobia) have unique and significant impacts on substance use, whereby greater stress led to higher substance use.[26] In another study focusing on substance use outcomes among SGM young adults in Australia, although there were consistent positive associations between differing proximal stressors and psychological distress and suicidality, substance use outcomes varied: higher levels of perceived stigma yielded greater club-drug dependence, but there was a reported inverse relationship between internalized homophobia and club-drug dependence and between perceived stigma and problematic drinking.[27]

Among SGM youth, there is evidence emerging linking minority stress to higher rates of substance use, particularly as related to victimization, bullying, and violence: Bontempo and d'Augelli, for example, found positive links between in-school victimization and risky health behaviors, including substance use, among SGM teens.[28] Other studies on peer victimization and gay-related neighborhood violence have yielded similar results, and Paper 2 will highlight newer research on this associations.[29,30]

Findings from some earlier studies have questioned the association between minority stress and substance use, but limitations in the design of the studies require the results to be interpreted with caution. For example, two studies from the early 2000s found that stress associated with SGM status was not predictive of increased substance use or distress among teens, but the generalizability of the findings is limited in that the samples were small in size, 156 and 140 teens, respectively, and drawn from sexual minority youth affiliated with urban gay-related organizations.[31,32] Such recruitment implies both previous disclosure of sexual minority status and a certain level with comfort with the status so to be participating publicly in such an organization, which, as Floyd and Bakeman note, may not be typical of most sexual minority teens.[33] Similarly, Wright and Perry found that although minority stress was associated with poor mental health, there was no relationship between minority stress and substance use.[34] Again, though, this study was limited by its small sample size and its recruitment at a sexual minority-specific community center.

Of note, much of the early work exploring the relationship between MST and SGM youth substance use focused exclusively in sexual minority samples or included a small subset of gender minorities, but there has been an emergence of literature to describe this association among gender minority youth. For example, one of the first studies to focus specifically on

gender minority youth demonstrated that minority stress resulting from bullying and victimization was associated with higher substance use.[35] More recent work yielded similar results in a large sample of transgender and gender diverse youth and young adults and found that transgender women and non-binary youth who were assigned male sex at birth reported worse substance use outcomes than transgender men and non-binary youth who were assigned female sex at birth, but all groups experienced worse outcomes than their cis-gender sexual minority coutnerparts.[36]

Although the literature, particularly recent publications, has demonstrated the applicability of MST in understanding the complex and co-occurring forces that may be at the root of substance use in sexual minorities, MST is not without its limitations, including factors associated with exacerbating and controlling stress that are omitted from the model. Meyer calls attention to some of these: biology/genetics, personality and personal disposition, acute stress situations, and coping skills, among others. Further, as Hatzenbuehler and Meyer both acknowledge, the primary role of MST is to establish stress as a mediator in the relationship between minority status and psychopathology: the model does not consider mediating pathways between the stress itself and the mental health outcome.

A broader limitation relates not to the model itself, but rather to research attempting to understand the application of the model. For example, a meta-analysis by Goldbach and colleagues found a statistically significant moderate correlation between minority stress and substance use across 12 studies of sexual minority youth, but, as discussed in more detail in Paper 2, the authors caution that the studies included may not be accurately measuring components of minority stress among sexual minority youth.[37] This owes to measurement of minority stress across the studies: either sexuality-specific measures used in the studies had only

been validated in adults, or researchers used generic measures of a particular construct (for example, as noted by the authors, a measure would just ask youth about victimization and bullying at school but not determine if the victimization and bullying was directly related to the respondent's sexual minority status).

Further, other research highlights the inherent bias of self-reported, or subjective, measuring of stress, in that negative events, such as discrimination, are more likely to be recalled, and many recent studies, because of their design, cannot rule out reverse causality as related to discrimination and substance use.[38] Perception of stress may also be confounded by mental health issues, leading to a potentially biased association between the stress and substance use and, perhaps, a similar difficulty in establishing causality.

As related to SGM youth, MST may underplay the important relationship youth have with their peers. Peer context is of concern to adolescents, and the stress of not assimilating with peers is not specifically captured within MST.[33] Additionally, there is a growing body of evidence on the critical protective role positive familial disclosure reactions have on substance use in sexual minority, and although MST includes the minority identity development as a source of coping, these familial interactions may again be underplayed in MST when applied specifically to youth.[39-41] Ongoing efforts to apply MST more appropriately to SGM youth are promising; these are discussed in Paper 2.

Despite these limitations, MST provides a useful framework from which researchers and clinicians can come to understand the interdependent impact of distal and proximal stressors on substance use among sexual minorities. As such, the first two papers of this dissertation apply MST to gain insight into the impact of individual risk and protective factors on SGM youth substance use, which can, in turn, be used to develop targeted prevention interventions.[27,42-44]

Paper Descriptions

The first paper draws upon data from a large, nationally-sampled panel study, the Youth Risk Behavior Survey (YRBS), to compare the impact of determinants of substance use on differences in use rates between sexual minority and heterosexual youth. Blinder-Oaxaca decomposition, a method that quantifies the reduction in disparity that would result if group differences in determinants of substance use were equal, was applied to 2017 YRBS data to address the following primary aims:

1) To assess explained and unexplained variation in the different substance use rates between sexual minority and heterosexual youth;
2) To determine the specific marginal effects of each determinant to estimate its associated contribution to average difference in substance use rates between sexual minority and heterosexual youth.

Based on previous research, predictors were categorized as relating to youths' behavioral health, academic experience, or social setting, and three sequential logit models were created for lifetime use of alcohol, cigarette, marijuana, non-medical prescription drug, and a combined "other substances." Paper 1 has been prepared for submission to the *Journal of Adolescent Health*.

The second and third papers use data from a pilot study of a randomized controlled trial of an online substance abuse prevention program tailored to SGM youth. Under the guidance of Drs. Steven Schinke and Traci Schwinn, I oversaw the management of this study as part of the doctoral program research practicum requirement. Modeled after Dr. Schwinn's study of an online substance use prevention program for teenaged girls, the pilot study tested an interactive, animated intervention guided by social learning theory and minority stress theory.[10] The study

aimed to improve known mediators of substance use, including stress and self-esteem, and increase skills relating to coping, problem solving, and substance refusal. Intervention-arm youth engaged with the intervention weekly for three weeks. Participants were recruited via Facebook, and the entire study was conducted on the Internet. Youth were offered graduated incentives for the completion of baseline ($25), post-test ($35), and 3-month follow-up ($40) measures. The primary results from this study were published as a brief report in the *Journal of Adolescent Health*: at 3-month follow-up, youth in the intervention arm reported reduced stress; higher coping, problem solving, and drug refusal skills; and lower past-month use of other drugs, when compared to control-arm youth.[11] Papers 2 and 3 of this dissertation use responses from the baseline survey and do not discriminate between study arms.

Paper 2 addresses the following primary aims:

1) To assess past-month use of cigarettes, marijuana, alcohol, and non-medical prescription drugs;
2) To determine the association between risk and protective factors and past-month substance use.

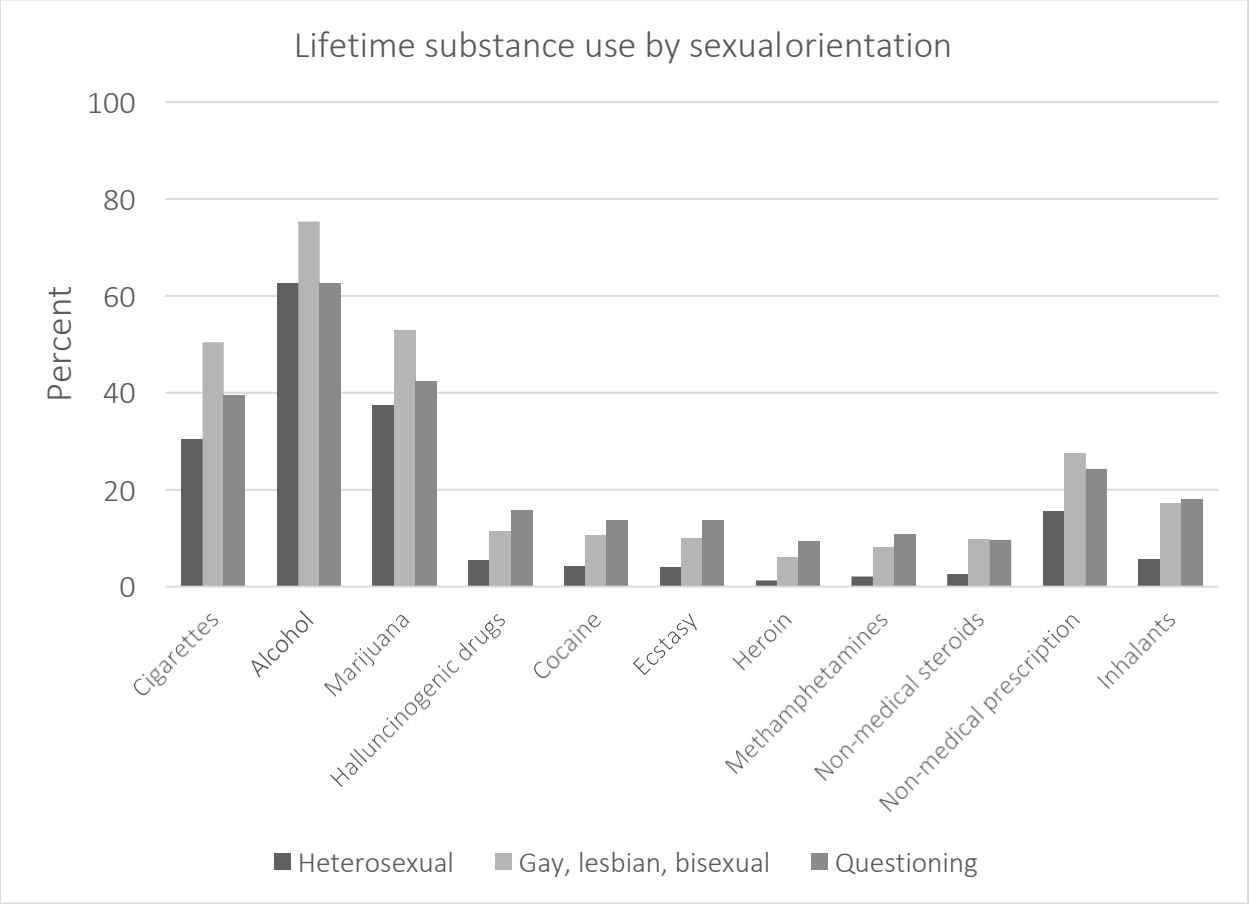
Paper 3 addresses the following primary aims:

1) To describe the process of developing and executing a Facebook ad campaign to recruit and enroll SGM youth in a clinical trial and explore analytics related to the campaign
2) To compare demographics and substance use rates from the Facebook-generated sample to national estimates

Paper 2 has been prepared for submission to *Addictive Behaviors*, and Paper 3 has been prepared for submission to *Substance Use and Misuse*.

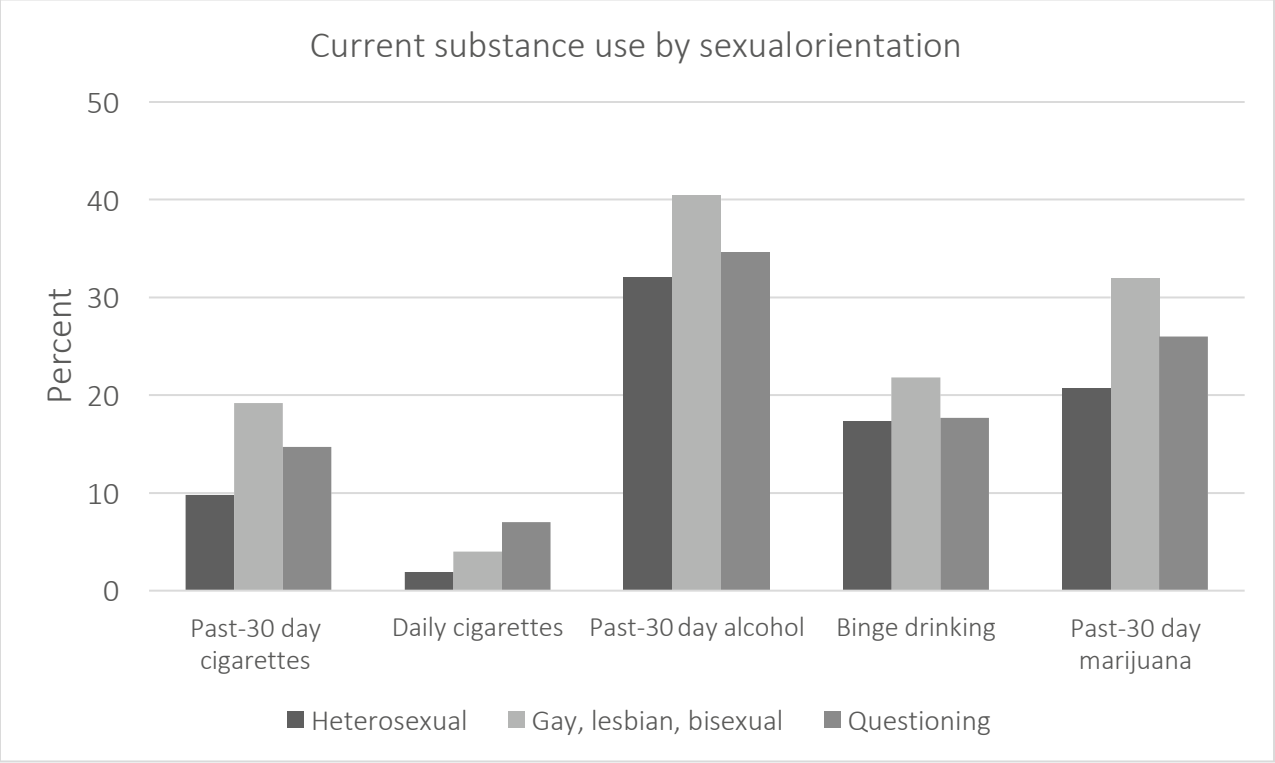
Collectively, these three papers aim to demonstrate the need for substance use prevention interventions tailored to the specific needs of SGM youth and provide an empirical base from which to develop such programming as well as offer insight into efficient methods for recruiting a representative sample of SGM youth for participation.

Figure 1. *Lifetime substance use by sexual orientation*



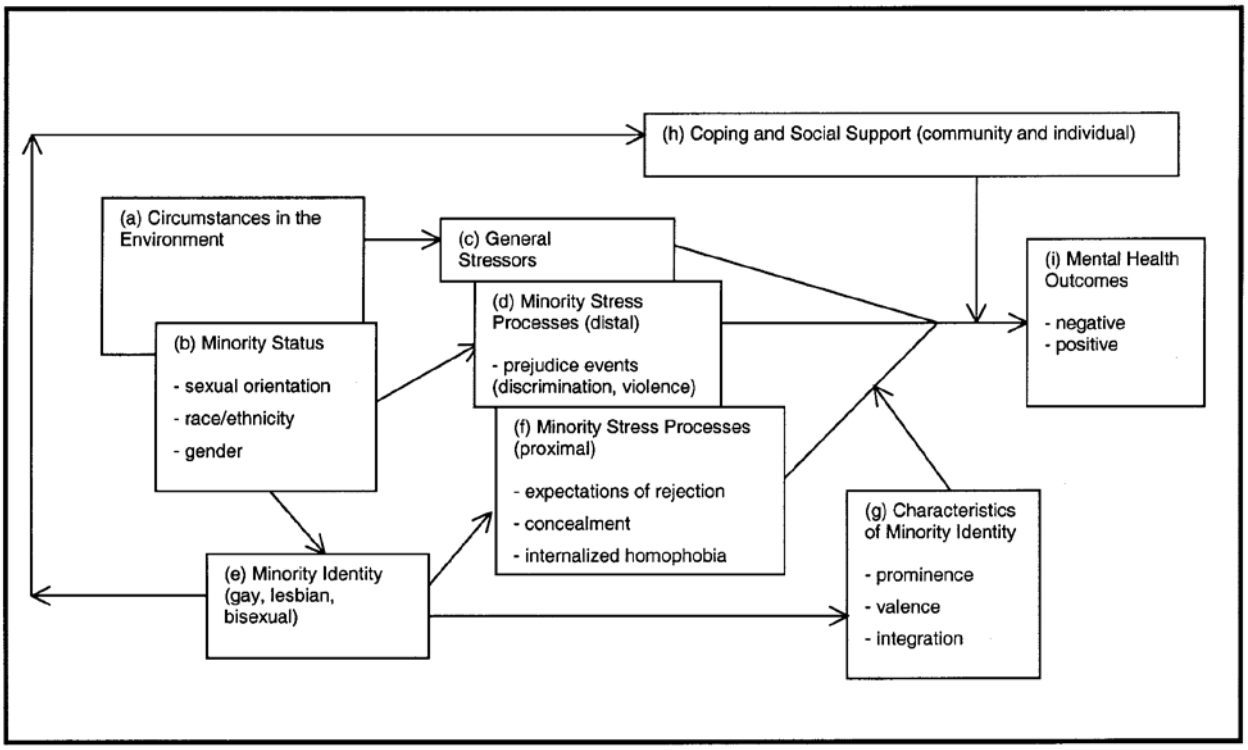
From: Kann, L., Olsen, E.O., McManus, T., Harris, W.A., Shanklin, S.L., Flint, K.H.,…, Zaza, S. (2016). Sexual identity, sex of sexual contacts, and health-risk behaviors among students in grades 9–12: United States and selected sites, 2015. Surveillance Summaries, 65(9), 1-202. Retrieved from http://www.cdc.gov/mmwr/volumes/65/ss/ss6509a1.htm

Figure 2. *Current substance use by sexual orientation*



From: Kann, L., Olsen, E.O., McManus, T., Harris, W.A., Shanklin, S.L., Flint, K.H.,…, Zaza, S. (2016). Sexual identity, sex of sexual contacts, and health-risk behaviors among students in grades 9–12: United States and selected sites, 2015. Surveillance Summaries, 65(9), 1-202. Retrieved from http://www.cdc.gov/mmwr/volumes/65/ss/ss6509a1.htm

Figure 3. *Model of Minority Stress Theory*



From: Meyer, I. H. (2003). Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. Psychological Bulletin, 129(5), 674-697. doi: 10.1037/0033-2909.129.5.674

Chapter 1: Decomposing substance use differences between sexual minority and heterosexual youth

Introduction

Sexual minority youth (SMY; youth identifying as gay, lesbian, bisexual, or unsure of their sexual orientation) have higher substance use rates than youth identifying as heterosexual.[4] These findings are seen across years, substance type, race and ethnicity, and study methodology,[5,6,45-47] and evidence has linked sexual minority substance use initiation in adolescence with persistent substance abuse throughout adulthood.[1,48] There are limited prevention interventions targeted at the SMY population, despite both policy calls at a national level for tailored programming and an emergence of evidence suggesting SMY would benefit from such interventions.[9,49-52] Understanding the determinants of substance use among SMY, and the extent to which these differ from heterosexual use determinants, can serve as starting point for developing tailored interventions.[53]

Meyer's minority stress theory offers a framework from which to disentangle the complex causal pathway leading to substance use in SMY.[10] Minority stress is specific to stigmatized populations over the non-stigmatized and is experienced in addition to the general stressors faced by the broader population. According to minority stress theory, stressors are experienced as either within (proximal) or outside (distal) the subject. *Proximal* stressors, those that originate in the subject, include rejection, identity concealment, internalized stigma), while *distal* stressors are those initiated outside of the victim's physical being and include victimization, discrimination, harassment, and negative disclosure reactions. The specific stress experienced by minorities is reinforced by well-established and consistent cultural norms and social structures, processes, and institutions, and it is from this stress that adverse outcomes arise

in the minority group. As related to SMY substance use, minority stress theory suggests that co-occurring proximal and distal stressors owing to sexual minority status may lead to substance use. A meta-analysis of 12 studies applied minority stress theory to substance use outcomes in SMY and found that victimization and negative disclosure reactions were among the strongest risk factors for substance use.[37]

Research focusing on SMY substance use, however, tends to compare rates of use to heterosexual youth, compare rates between sexual orientations (i.e., bisexual rates vs. gay/lesbian rates), or seeks to determine predictors of use in exclusively SMY samples.[53] Recent studies have identified frequent risk factors for substance use among SMY, including stressors that may be unique to SMY identified by minority stress theory (e.g., negative disclosure reactions, internalized stigma, victimization) and stressors that are seen in heterosexual youth as well (e.g., generalized stress, temperament, body image, peer use of substance, adverse mental health).[42,44,50,53] Identified protective factors in SMY include school- and family-connectedness and social learning-based skill development, which have also been found to be protective in heterosexual youth.[45,53,54] While this work is indeed useful in understanding what motivates SMY to engage in substance use, it does not offer a comparison of determinants of use between sexual minority and heterosexual youth, leaving much of the disparity in substance use rates between the two groups unexplained, subsequently hindering the development of tailored interventions.

Blinder-Oaxaca decomposition provides the analytic tools to better understand differences in rates of use by conducting a head-to-head comparison between two groups to quantify the reduction in disparity that would result if group differences in determinants of substance use were equal (e.g., measuring how the difference in smoking rates would decrease if

sexual minority and heterosexual youth reported the same scores on a measure of depression). Further, Blinder-Oaxaca "decomposes" group differences to determine how specific characteristics contribute marginally to overall effects (e.g., depression contributes 15% to the overall difference in smoking rates between sexual minority and heterosexual youth).[55]

Initially developed to determine unexplained differences in wages between groups, Blinder-Oaxaca decomposition has been used to quantify sources of group differences in health outcomes, including smoking, obesity, and vaccinations.[56-58] The technique combines counterfactual equations to determine characteristic effects (variation that can be "explained" by the factors included) and coefficient effects (variation that is "unexplained" by the factors included); that is, the contribution to the rate differential of individual predictors (explained) and the contribution of membership in the group (unexplained). For example, in a study of determinants of racial and gender disparities in youth obesity, Taber and colleagues sought to decompose the differences in obesity rates owing to known factors (e.g., dietary behaviors, school environment, home environment) and those owing to differences that can only be attributed to race or gender.[57] As applied to substance use outcomes, Blinder-Oaxaca decomposition is a novel approach in that offers a direct comparison of use rates between two groups and determines how these differences are constructed; this is in contrast to current analysis methods that simply compare rates between groups or calculate determinant impact within groups.

Herein, we use the Blinder-Oaxaca method to address the following aims: 1) to decompose the explained and unexplained variation in the different substance use rates between sexual minority and heterosexual youth; 2) to determine the marginal effect of each included determinant of use on the average difference in substance use rates between sexual minority and

heterosexual youth. To our knowledge, this analysis is the first use of the Blinder-Oaxaca method applied to substance use differences between sexual minority and heterosexual youth.

Methods

Data

This analysis uses data from the 2017 CDC Youth Risk Behavior Survey (YRBS). Administered during odd-numbered years, the YRBS is a panel study of US high school students. YRBS has been administered across US jurisdictions for over 20 years, using multi-stage cluster sampling. The survey consists of 89 questions and takes about 45 minutes to complete. The survey is anonymous, self-administered, completed on paper, and scanned electronically.[59] Data for this analysis were drawn from the national survey sample, with consideration for the CDC-provided specific guidance on the analysis of sexual minority data.[60]

Outcomes

The outcome variables were lifetime use of alcohol, marijuana, cigarettes, non-medical prescription drugs, and "other drugs" (any use of cocaine, inhalants, heroin, methamphetamines, ecstasy, or non-prescription steroids).

Demographics and sexual orientation

Demographic variables included age, gender, grade in school, and race/ethnicity. Sexual orientation was assessed with a survey question that asked respondents if they best describe themselves as "heterosexual (straight)," "gay or lesbian," "bisexual," or "not sure." To determine groups for comparison, sexual orientation responses of "gay or lesbian," "bisexual," and "unsure" were combined to form one group, sexual minority youth, and this group was compared to youth identifying as heterosexual. Responses that did not include sexual orientation were excluded.

Predictors

Based on previous studies using Blinder-Oaxaca decomposition, YRBS variables were characterized as relating to behavioral health, the academic setting, or the social environment.[57,61] This characterization has been used elsewhere in the literature as a means of categorizing YRBS-based factors that can influence youth substance use.[62]

Although YRBS includes a variety of questions for each of these categories, the variables selected for analysis here were based on their empirical relationship to youth substance use as seen in previous research[14,25] and the robustness of their association with substance use in our preliminary bivariate and multivariate analyses (results not shown).

Behavioral Health

Behavioral health variables included YRBS questions about perception of weight, daily television watching, difficulty concentrating, past-year feelings of sadness, and past-year suicidal ideation. Perception of weight served as a proxy for body image and was dichotomized as overweight/not overweight.[63,64] Based on YRBS coding guidelines, ordinal responses of television watching were categorized as less or more than three hours per day.[65,66] Past-year feelings of sadness, suicidal ideation, and difficulty concentrating were yes/no responses.

Academic

Academic variables included YRBS questions about average grades in school, threats at school, and bullying at school. Average grades in school, a proxy for school-connectedness, were based on letter grades and ranged from A-F; we dichotomized responses to As/Bs and Cs/Ds/Fs.[67] Experiencing threats and bullying at school were yes/no responses.

Social

Social variables were taken from YRBS questions relating to electronic bullying, physical fighting, sexual activity, and forced sexual activity. All social variables were yes/no responses.

Analysis

Data were weighted as suggested by YRBS.[59] Data were initially characterized using descriptive statistics; bivariate testing and multivariate logistic regression assessed the relationship between sexual minority status, substance use, and predictor variables.

As noted above, Blinder-Oaxaca decomposition assessed explained and unexplained variation in the different substance use rates between sexual minority and heterosexual youth. Blinder-Oaxaca decomposition was initially developed to assess group differences in continuous variable outcomes, but newer modeling has used the technique to assess absolute differences in the binary outcomes: as such, we created a binary yes/no dependent variable from the ordinal response choices offered by YRBS.

Three two-fold sequential logit models were built for each substance (alcohol, marijuana, cigarettes, non-medical prescription drugs, and other drugs): the first included behavioral health variables; the second added academic variables; and the final model added social variables.[57,61] Additionally, the specific marginal effects of each determinant were analyzed to estimate their associated contribution to average difference in use rates. Data were analyzed using Stata, version 13.

Results

In the 2017 survey, 14,108 of 14,765 respondents (95.5%) answered the sexual orientation question. Table 1 presents sample demographics: most (81.4%) respondents identified as heterosexual, with 2.4% identifying as gay/lesbian, 7.7% as bisexual, and 4.1% as questioning/unsure. There were slightly more (51.5%) female respondents than male in the

sample overall, but females comprised 71.6% of the SMY sample. Nearly three-quarters (73.8%) of respondents were 15, 16, or 17 years old.

In unadjusted chi-square testing and multivariate logistic regression, SMY had higher than expected proportions of use across all substances, when compared to straight youth (all p <.001). In unadjusted odds ratio calculations, SMY were more likely to feel sad/hopeless (95% CI: 3.31, 4.01), consider suicide (95% CI: 4.09, 5.02), be overweight (95% CI: 1.61, 1.96), have difficulty concentrating (95% CI: 3.06, 3.83), be bullied at school (95% CI: 1.81, 2.24) or bullied electronically (95% CI: 1.91, 2.40), be threatened at school (95% CO: 1.92, 2.63), be in physical fights (95% CI: 1.10, 1.40), be sexually active (95% CI: 1.22, 1.56), or have been forced to have sex (95% CI: 3.01, 3.96) than their heterosexual counterparts. The SMY respondents were less likely to receive mostly As/Bs in school (95% CI: 0.67, 0.85) than the heterosexual respondents. (Table 2)

Table 3 presents the adjusted rate differences and the "explained" portions as a percent of the difference for the Blinder-Oaxaca models for each substance, excluding alcohol (described below). Although three sequential models were created, for clarity, Table 3 shows only the final model. Also included in Table 3 is the percent of the explained difference contribution of each predictor group (behavioral health, academic, social). These percentages are the specific contribution to the difference in use that would be eliminated if sexual minority and heterosexual youth had the same responses for that predictor group.

For cigarette, marijuana, non-medical prescription drug, and other drug use, the adjusted differences in substance use between sexual minority and heterosexual youth were statistically significant, with sexual minority youth having higher rates compared to heterosexual youth. For cigarettes, the adjusted difference in log odds of use between sexual minority youth and

heterosexual youth was 9.2 (p<.001); for marijuana, 8.5 (p<.001); for non-medical prescription drugs, 9.0 (p<.001); and for other drugs, 7.9 (p<.001). The adjusted difference in log odds of alcohol use between sexual minority youth and heterosexual youth was 4.4, but this difference was not significant (p = .06)

For each substance analyzed, the behavioral health variable grouping contributed the most explanation to the substance use differences, on average about two-thirds (*M*: 64.9%) of the explanation. At the individual predictor level, past-year sadness, suicidal ideation, and difficulty concentrating offered the most contribution to explanations of the difference in use rates: on average, feeling sad or hopeless explained 24.4% of the difference in use, suicidal ideation explained 20.5%, and difficulty concentrating explained 16.9%. These percentages imply that, for example, 25.0% of the difference in use rates of marijuana and 32.9% of the difference in use rates of non-medical prescription drugs would be eliminated if SMY had the same reported feelings of sadness/hopelessness as heterosexual youth; or for difficulty concentrating, that 22.6% of the difference in other drug use would be eliminated. (Table 4)

The academic variables contributed the least explanation (*M*: 5.2%) and were impacted in all substances by a lack of contribution of the in-school bullying predictor for SMY. In-school bullying presented with a negative sign, suggesting it may contribute to higher use rates among heterosexual youth than SMY (i.e., heterosexual youth may be more impacted, in terms of substance use, by in-school bullying than SMY). These findings were significant for marijuana, whereby in-school bullying reduced the contribution to the difference in use rate by 13.0%. No other variable made significant contributions to the use difference across all substances, except grades and rates of cigarettes and other drugs.

Generally, social variables contributed about one-third (*M*: 30.0%) of the explanation of use rate differences, with less contribution to the non-medical prescription drug use difference (12.6%) than seen in the other substances. The contribution of the social category was driven by the "forced to have sex" predictor variable, which contributed, on average, 21.3% of the variation in use rates. The contribution of "forced to have sex" was highest for use of cigarettes (28.6%), marijuana (24.4%), and other drugs (22.4%). No other variable made a significant contribution to the difference in use rates across substances, except electronic bullying and use of marijuana (7.0%).

While the models were generally consistent for cigarettes, marijuana, non-medical prescription drugs, and other drugs, the alcohol use model behaved differently, whereby the adjusted difference in use was significantly smaller. As such, the sign on the unexplained portion of the difference was negative, suggesting that SMY may have lower alcohol use than heterosexual youth in the adjusted model. Because of this, meaningful analysis of the marginal impact of predictors on use rate differences could not be conducted, as the "explained" variation component of the model exceeded the actual difference.

Discussion

Across each substance except alcohol, the Blinder-Oaxaca models explained a significant portion of the difference in substance use between sexual minority and heterosexual youth. Variables assessing sadness, suicidal ideation, difficulty concentrating, and forced sexual encounters were the most consistent and substantial contributors to the explanation of the difference. These findings offer insight into the theoretical reduction in use differences that could be achieved if predictor-based disparities between sexual minority and heterosexual youth were eliminated.

Although each of the variables included in the Blinder-Oaxaca decomposition models had a significant and robust association with substance use in our preliminary analyses, most, aside from mental health-related variables, did not contribute significantly to differences in substance use rates between sexual minority and heterosexual youth. This suggests these variables (i.e., those that did not contribute to the difference) are equal contributors to substance use in both groups. In this sample, however, it is clear the profound impact mental health-related variables (sadness, suicidal ideation) have on substance use in SMY, and this presents an opportunity for the development of targeted prevention programming to address SMY mental health needs relative to their use of substances. Our previous work has shown that tailored SMY interventions have the potential to improve the social learning skills that can impact mental health, and this research should be expanded.[51] Targeting mental health may be particularly relevant to SMY, as there is evidence to suggest the psychological distress experienced by SMY may decrease as they age but that the distress experienced in adolescence, especially that resulting from bullying, has a lingering impact into young adulthood.[68]

The explained variation of the difference in use rates was statistically significant across all substances except alcohol and explained, on average, close to 80% of the difference in use rates. The difficulty of analyzing the sources of differences in use rates between sexual minority and heterosexual youth is illustrated in the unexplained variation. While the explained variation is useful in understanding how each variable contributes to the overall differences in use, it is in the unexplained variation that we see the difference that could be attributable to sexual minority status. Indeed, it is possible that the unexplained variation could be attributed, at least in part, to the minority stress experienced by the SMY in our sample, as suggested by minority stress theory. Further research in this area is warranted, and recent efforts to validate measures of

sexual minority stress in adolescents will be useful in describing this stress and determining how it mediates the relationship between minority status and substance use.[42,69]

Our findings provide an empirical base for the need for interventions targeting SMY specifically by highlighting the varying impact of predictors on use in both the SMY and heterosexual groups. Currently, there are few health-focused interventions targeting SMY, and many of the heteronormative scenarios and examples presented in existing non-tailored interventions may not have applicability or relevance to situations faced by SMY. One plausible reason for the lack of intervention research is the nature of the sample: although sexual minorities are often aware of their orientation or gender identity in childhood, they do not usually disclose their orientation until later in life, with the earliest disclosures around 15-16 years.[33] As such, this population can be difficult to reach, and targeted interventions and programming prior to the widespread use of the Internet would require adolescent participants to have both previously disclosed their sexual orientation and felt comfortable enough with their disclosure to participate in a targeted intervention study. At present, however, there are multiple online outlets for recruiting SMY and delivering interventions, including social media and smart phone-based applications, and research toward this end is promising.[51,70,71] From our findings, researchers should consider developing and testing interventions that focus on SMY's mental health and concentration difficulties, their coping with sexual violence, and the intersection of these concepts with the general and SMY-specific risk and protective factors seen previously in the literature.

Key limitations in this study relate to the YRBS dataset itself and a potential shortcoming of Blinder-Oaxaca modeling. While Blinder-Oaxaca decomposition calculates an "unexplained difference" in use rates that can be attributed to discrimination experienced by the minority

group (or, as suggested by MST, overall minority stress), we cannot determine what portion of this unexplained difference owes to that which may truly reflect minority stress and that which is simply reflective of variables not measured or included in the analysis. For example, the lack of assessment within YRBS of the influence of peers on substance use is problematic. Our earlier work, in both sexual minority and general youth samples, confirmed previous research findings that peer use of substance is a strong predictor of use.[64,72,73] Recent studies have found this to be particularly true in SMY and sexual minority young adults, as they may often rely on friends and social networks to provide support when facing rejection from their most intimate relationships, including their parents, siblings, family, and other trusted adults.[74,75] Yet, peer use is not currently captured in the YRBS, and we thus cannot gauge how it influences the differences between use rates between SMY and heterosexual youth. This is seen with other variables as well: romantic relationships have been shown to be predictive of substance use in both sexual minority and heterosexual youth, but this was not captured by the YRBS—nor were measurements of genetic risk for substance use or aspects of the home and neighborhood environments that have been associated with substance use.[76] As such, we are limited in our interpretation of the unexplained difference, and, in turn, our ability to truly estimate the difference the model defines as explained.

Another limitation in this analysis is the disproportionate number of females in the SMY group: future research is needed to examine the timing of sexual orientation disclosure in youth populations and how this may relate to substance use. Future work is also needed to explore the overall role gender plays in group difference decomposition, with potential stratification of models by gender. Gender identity minority status (i.e., transgender, non-binary, etc.) itself may contribute to substance use in SMY, particularly among youth who may not identify with the two

gender response options offered in the YRBS, and this issue warrants further investigation. These analyses must be conducted with consideration for potential intersecting minority identities, including race, ethnicity, disability, and socioeconomic status.[77]

Additionally, future research is needed to explore sources of differences in use among sub-groups of SMY (e.g., differences by gay, lesbian, bisexual, and questioning identity), as evidence suggests use varies by sexual orientation sub-group, with bisexual youth generally reporting higher rates of use than gay, lesbian, or questioning youth.[4,6,45,46] Intervention research may also benefit from conducting Blinder-Oaxaca decomposition to explore determinants of *non* use of substance, so to better differentiate the impact of potential protective factors.

Conclusion

Blinder-Oaxaca decomposition allows for a detailed understanding of the marginal impact of individual predictors on the disparity in substance use rates between sexual minority and heterosexual youth. The sources of this disparity can serve as a basis from which to develop targeted prevention interventions, but a key component of programming is acknowledging and addressing the "unexplained" factors experienced by SMY that impact substance use. In SMY, these may include the specific stressors identified by minority stress theory and other factors that have yet to be identified or measured in this population.

Table 1. *Sample demographics and substance use rates*

	% All	% Heterosexual	% Sexual Minority
Sexual Orientation			
Gay/lesbian	2.4		
Bisexual	7.7		
Questioning/not sure	4.1		
Straight	81.4		
Missing	4.4		
Grade in school			
9th	26.3	26.4	25.7
10th	25.4	25.1	27.0
11th	24.9	25.1	24.0
12th	23.3	23.4	22.8
Gender			
Female	51.5	48.1	71.6
Male	48.5	51.9	28.4
Age			
13 or younger	0.5	0.4	1.4
14	12.9	12.7	13.8
15	24.1	24.2	23.6
16	25.3	25.3	25.3
17	24.8	25.0	23.8
18 or older	12.4	12.4	12.2
Race/Ethnicity			
American Indian/Alaska Native	0.9	0.9	1.0
Asian	4.6	4.7	4.0
Black or African American	19.2	18.7	22.1
Native Hawaiian/Other Pacific Islander	0.8	0.8	0.7
White	43.2	43.5	41.4
Hispanic/Latino	10.8	11.2	8.8
Multiple--Hispanic	14.8	14.6	15.4
Multiple--Non-Hispanic	5.8	5.7	6.4
Substance Use			
Cigarette	28.0	26.7	36.0
Alcohol	60.5	59.2	68.0
Marijuana	36.2	34.9	44.0
Non-medical prescription drugs	14.2	12.5	23.8
Other drugs	11.3	9.7	20.4

Table 2. *Bivariate testing by sexual minority status, comparing SMY to heterosexual youth**

	Pearson χ^2	Odds ratio^	Odds ratio 95% CI
Behavioral health			
Felt sad or hopeless	746.7	3.64	3.31, 4.01
Considered suicide	944.1	4.53	4.09, 5.02
Overweight	136.5	1.78	1.61, 1.96
3 or more hours of TV +	1.9	1.08	0.97, 1.21
Difficulty concentrating	493.1	3.42	3.06, 3.83
Academic			
As/Bs in school	23.2	0.76	0.67, 0.85
Bullied at school	167.1	2.01	1.81, 2.24
Threatened at school	106.4	2.25	1.92, 2.63
Social			
Electronically bullied	176.3	2.14	1.91, 2.40
In a physical fight	13.1	1.24	1.10, 1.40
Sexually active	32.2	1.43	1.22, 1.56
Forced to have sex	349.2	3.45	3.01, 3.96
Substance Use			
Cigarette	59.3	1.54	1.38, 1.72
Alcohol	52.9	1.46	1.32, 1.62
Marijuana	60.8	1.47	1.33, 1.61
Non-medical prescription drugs	184.1	2.18	1.94, 2.44
Other drugs	204.4	2.39	2.11, 2.70

* All χ^2 have $df = 1$ and are statistically significant at $p < .001$, except as noted +, where $p > .05$.
^ Reference group is heterosexual.

Table 3. *Blinder-Oaxaca decomposition differences and explained portion by substance*

	Cigarette	Marijuana	Non-medical RX	Other drugs
Difference +	9.2*	8.5*	9.0*	7.9*
Percent explained	73.7*	96.7*	85.4*	87.1*
Behavioral health	51.8%	65.0%	76.9%	66.0%
Academic	7.5%	-1.4%	10.6%	3.9%
Social	40.7%	36.4%	12.6%	30.1%

+Difference in log odds of substance use between sexual minority and straight youth.
* $p < .001$

Table 4. *Individual marginal explanations of Blinder-Oaxaca decomposition differences in percent*

	Cigarette	Marijuana	Non-medical RX	Other drugs
Behavioral health				
Felt sad or hopeless	22.6*	25.0**	32.9***	16.9**
Considered suicide	8.6	19.4*	30.5***	23.4***
Overweight	4.1	2.0	-0.2	2.0
3 or more hours of TV	1.8	1.1	0.9	1.2
Difficulty concentrating	14.7*	17.4**	12.8**	22.6**
Academic				
As/Bs in school	9.4**	10.3	3.3	4.5*
Threatened at school	1.3	1.3	1.3	1.6
Bullied at school	-3.1	-13.0**	6.0	-2.2
Social				
Electronically bullied	5.5	7.0*	0.4	5.4
In a physical fight	0.7	0.0	0.1	0.2
Sexually active	5.9	4.9	2.3	2.1
Forced to have sex	28.6***	24.4***	9.8**	22.4***

*p<.05
**p<.01
***p<.001

Chapter 2: Risk and protective factors for substance use among a national sample of sexual and gender minority youth

1. Introduction

Substance use rates among sexual and gender minority (SGM) youth are higher than those of youth identifying as heterosexual (i.e., attracted to the opposite sex) and cisgender (i.e., those whose gender identity corresponds to their birth sex).[1-5] A meta-analysis by Marshal et al. found that sexual minority youth (i.e., gay, lesbian, bisexual, queer, questioning, pansexual, or other non-heterosexual identities) were more likely than their heterosexual peers to drink alcohol, smoke cigarettes or marijuana, and use illicit drugs, aligning with Centers for Disease Control and Prevention estimates that substance use is higher among sexual minority youth than straight youth, with an elevated risk among sexual minorities for polysubstance use.[1,4,6] Similarly, recent studies of middle and high school students have shown gender minority youth (i.e., transgender, non-binary, gender neutral, genderfluid, or genderqueer and those who are questioning their gender identity) have higher lifetime and current use rates of cigarettes, alcohol, marijuana, prescription painkillers, club drugs, and other illicit substances compared to cisgender youth.[7,8]

These findings are of concern given the well-documented negative outcomes associated with adolescent substance use, including engaging in delinquent behavior, perpetrating or being victimized by violence, developing chemical dependency or other related health issues, and increasing the likelihood of injury, accident, premature death, or suicide.[9,17,78] The Institute of Medicine (IOM; now called National Academy of Medicine) called attention to the growing problem of substance abuse among lesbian, gay, bisexual, transgender, and queer (LGBTQ)

youth, noting a need for research targeted at understanding risk and protective factors specific to LGBTQ adolescents.[9]

For all youth, including SGM youth, social learning theory offers insight into addressing the risk and protective factors associated with substance use.[79] Social learning theory proposes that human behavior is influenced by a continuous interaction of cognitive, behavioral, and environmental determinants, and humans learn by training themselves, through observation, modeling, and self-regulation, to respond to specific stimuli in their environment (Figure 1). Applied to substance use, the model suggests that developing and possessing the skills to reject the influences of peers and society can reduce youths' risk for use. Some skills identified in previous research include problem solving, goal setting, substance refusal, self-efficacy, and such coping techniques as positive reframing, active coping, and self-distraction.[64,80,81] These findings are supported by emerging evidence addressing risk and protective factors associated with substance use among SGM youth and young adults since the IOM report.[53] In one review across 37 studies focused on high school-aged sexual minority youth, peer use of substance and stress were consistent predictors of substance use, and the authors suggest providing youth the skills to manage their stress and resist peer influence could lead to lower use rates.[53]

Indeed, the typical stresses faced by adolescents can be amplified for sexual and gender minorities, as they endure additional stressors relating to their SGM status. These include the processes of realizing, and subsequently disclosing, their SGM status, and managing potential negative reaction to this disclosure. They may also face social stigmatization and be at higher risk for targeted physical and verbal acts of bigotry and bullying. Further, they may have to contend with their own potential internalized homophobia or stigma (i.e., feelings of low self-worth owing to their SGM identity).[16,18,82] It is in these stressors that the inadequacy of social

learning theory to explain SGM substance use is illuminated, requiring the application of more nuanced and relevant theory.

Minority stress theory (MST), first described by Meyer, refers to the additive, chronic, unique, and socially-based stress experienced by SGM youth.[10] It suggests that stress related to minority status, in this case sexual orientation, involves processes of experiencing prejudice, expecting rejection, hiding, concealing, internalizing, and coping/adapting. MST expands upon the notion of internalized stigma to address the broader social context in which such stigma both exists and interacts with other potential sources of distress in minorities. Drawn from psychological theory and stress literature, MST is rooted in Lazarus and Folkman's distal—proximal construction of social structure, referring to the physical space in which social experiences occur.[23] For Meyer, this application suggests stressors faced by a minority may be distal (originating outside of the subject) or proximal (originating within the subject). Distal stressors may involve victimization, discrimination (*de jure* and *de facto*), and/or harassment, and proximal stressors include fear and/or expectation of rejection, identity concealment, and, as discussed above, internalized stigma.[14,24] (Figure 2)

Although Meyer's work focuses on mental health, it has been extended to apply to other outcomes in adults, including substance use. One study addressed the impact of minority stress on substance use in sexual minority adult women, finding that both distal stress (victimization) and proximal stress (internalized homophobia) have specific and significant impacts on substance use, whereby greater stress led to higher substance use.[26] These findings are supported elsewhere in the literature in studies of alcohol abuse, binge drinking, marijuana use, illicit drug use, and tobacco addiction.[20,30,38,83-85]

Among SGM youth, there is evidence linking minority stress to higher rates of substance use, particularly as related to victimization, bullying, and violence. Bontempo and d'Augelli, for example, found positive associations between in-school victimization and risky health behaviors, including substance use,[28] as did early work related to bullying using national panel surveys.[86,87] These findings are supported by recent studies that use broad, diverse samples to show an association between sexual minority stress and substance use.[44,45,47,84,88,89] Similarly, in a study of gender minority youth specifically (one of the first, and only, studies to focus on gender minority youth), minority stress resulting from bullying was associated with higher substance use.[35]

Building from previous studies and reviews, this analysis uses a national sample of both sexual and gender minority high school-aged youth to 1) assess past-month use rates of cigarettes, marijuana, alcohol, and non-medical prescription drugs and 2) determine the association between risk and protective factors and past-month substance use. As part of a pilot study to test the feasibility of an interactive online substance use prevention intervention for SGM adolescents, the overall aim of this analysis is to provide an empirical basis for such targeted programming by refining our understanding of substance use among SGM youth by assessing risk and protective factors for use in relation to typical gold-standard programs.[51]

2. Materials and methods

2.1 Sample

Youth were eligible to enroll in the study if they were 15 or 16 years of age; identified as a sexual or gender minority; had exclusive use of a private computer with Internet access; and spoke English.

2.2 Recruitment and registration

Recruitment occurred over the Internet using targeted Facebook ads. Recruitment ads ran on the right column of the "Newsfeed" and "Profile" pages of registered Facebook users who were 15 or 16 years old and logging into the site from the U.S. The ads targeted youth whose interests, "likes," groups, or profile keywords are common among SGM youth (e.g., membership in Gay Straight Alliance; "liking" well-known LGBTQ celebrities; use of keywords such as "gay," "queer," "LGBT," etc.). Facebook estimated that approximately 800,000 youth meet these criteria and were exposed to the ads.

Once potential participants clicked on the ad, they were directed to a secure recruitment page where eligibility was determined; eligible respondents were directed to a study information page, which briefly explained the study's purpose, procedures, and requirements. The Columbia University Institutional Review Board granted a waiver of parental permission for this study to protect respondents from the risk of emotional or physical harm resulting from parental disclosure. Sharing participation or study information with a parent was left to the subject.

To participate, youth had to demonstrate understanding of human subjects' protection via an interactive online quiz. Respondents who successfully answered all quiz items were invited to enroll; they were randomized to either engage with a three-session intervention and complete a measurement survey at three timepoints (baseline, immediately post-program, three-month follow-up) or to just complete the measures at the same timepoints. Youth were paid $25 for completion of baseline measures.

2.3 Data collection and measures

Data were collected using Survey Monkey. Youth completed a 98-question survey that took approximately 20 minutes. Data for this analysis comes from baseline responses and does

not discriminate between study arms, as there were no significant differences in measured variables at this timepoint.

Respondents selected a gender identity among male, female, non-binary, genderqueer, gender neutral, genderfluid, and "not sure" or "something else." Respondents also reported if they identified as transgender and selected the specific gender with which they identified, if any. Sexual attractions were reported as being attracted to the same gender, a different gender, or both genders or being unsure of sexual attractions. Respondents self-reported their sexual orientation as gay, lesbian, bisexual, not sure/questioning, straight, or "something else." Demographic questions included age, race/ethnicity, average grades in school (a proxy for school connectedness), city type, and parent education (a proxy for household income).

2.3.1 Substance use

The substance use outcome variables were adapted from the Youth Risk Behavior Survey.[59] Respondents reported how many times in the past month they used cigarettes or marijuana (including synthetic marijuana); drank any alcohol; or engaged in non-medical use of prescription drugs.

2.3.2 Risk and protective factors

Risk and protective factors selected for analysis are those identified in the literature as noted above, and from our previous work, for their applicability to social learning theory or MST.[16,18,64,80,81,82] As literature has consistently suggested the importance of peer context and stress in substance use outcomes, we focused specific attention on skills relating to coping and resisting temptation. Due to a lack valid and reliable measures of minority stress and internalized homophobia/stigma in SGM youth, we used perceived stress, self-esteem, and self-efficacy as proxy measures.

Stress

Stress was measured using the Perceived Stress Scale.[90] Respondents rated 10 statements about thoughts and feelings during the past month relating to stress (e.g., "In the past month, how often have you felt that you were unable to control the important things in your life?"; "In the past month, how often have you felt things were going your way?"), on a five-point scale where 0 = "Never" and 4 = "Very often." Items were summed to form an index, with higher scores indicating greater stress ($\alpha = .87$; all measures of internal consistency were assessed using this sample).

Self-esteem

Although there are specific measures to assess internalized homophobia/stigma, they have not been validated in youth populations nor among transgender populations or those questioning their sexual or gender identity.[69,91,92] As a proxy, respondents completed the Rosenberg Self-Esteem Scale. Respondents ranked agreement on a scale of 1 = "Strongly disagree" to 4 = "Strongly agree" with 10 statements regarding their feelings of self-worth (e.g., "I am a valuable person"; "I often feel that I am a failure") Items were summed, with high scores indicating higher self-esteem.[93] ($\alpha = .90$).

Peer use of substance

Respondents ranked on a four-point scale (0 = "None," 3 = "All") how many of their peers regularly used each of the four substances being analyzed.

Self-efficacy

The short-form of the General Self-Efficacy Scale measured self-efficacy (i.e., belief in one's ability to succeed).[94] Respondents answered six questions (e.g., "It is easy for me to

accomplish my goals") on a scale of 1 = "Strongly agree" to 4 = "Strongly disagree," with lower summed scores indicating higher self-efficacy (α = .83).

Problem-solving skills

Five items from the Social Problem-Solving Inventory-Revised were used to measure problem-solving skills.[95] Respondents rated agreement with statements about solving problems and assessing consequences of action (e.g., "When I am trying to solve a problem, I keep in mind what my goal is") on a four-point scale of 1 = "Strongly agree" to 4 = "Strongly disagree," with lower summed scores indicating better problem-solving skills (α = .74).

Substance refusal skills

Substance refusal skills were assessed for cigarettes, marijuana, and alcohol. Respondents selected on a five-point of 1 = "Definitely would" to 5 = "Definitely would not" how likely they were to use a specific refusal strategy if offered a substance (e.g., "make excuse and leave"; "tell them no").[64] Five items were summed to form an index, with lower scores indicating better skills. Internal consistency ranged from .70-.82.

Coping

Coping was measured using items from the Brief COPE inventory.[96] Respondents assessed the frequency (1 = "Never," 4 = "All of the time") of using the following coping techniques when faced with difficult situations: self-distraction, active coping, seeking emotional support, positive reframing, and religion. Responses per coping technique were averaged, and higher scores indicated greater use of the technique. Internal consistency ranged from .67-.82.

3. Calculation

Data were initially characterized using descriptive statistics. Past-month use of cigarettes, alcohol, marijuana, and non-medical prescription drugs were dichotomized to yes/no. Risk and

protective factor scales were recoded as appropriate so that higher scores reflected positive outcomes. Chi-square and one-sided independent sample t-tests were used to assess bivariate associations between past-month use for each substance and risk and protective factors. We then used multivariate logistic regression to assess the robustness of significant associations in bivariate testing ($\alpha = .05$), controlling for grades in school, parent education, and race, factors that have been shown previously to influence substance use in youth.[64] Analyses were conducted using IBM SPSS Statistics 25.

4. Results

4.1 Sample

All respondents were 15 or 16 years old (mean = 16.1 years, *sd* = 0.6). Most (65%) were white, non-Hispanic; 44% lived in suburban locations, 30% urban, and 26% rural. Nearly one-half of the sample (49%) was in 10th grade, and the majority (77%) averaged As or Bs in school. One-half of the sample (52%) lived with their mother and father; 50% of the parents in the sample had a college degree. One-half of the sample (51%, *n* = 121) identified as female; 32% male, 11% genderqueer/genderfluid/gender neutral, 6% "not sure," and 0.4% "something else."

Ninety-six percent of the sample (*n* = 227) identified as a sexual minority: 39% gay/lesbian, 41% bisexual, 8% questioning/not sure, and 9% "something else." Respondents identifying as a gender minority (transgender, genderqueer, genderfluid, gender neutral, "not sure," or "something else") comprised 23% of the sample (*n* = 54). Sexual and gender minority statuses were not mutually exclusive: 21% of the sample (*n* = 49) identified as both a sexual and gender minority.

Among transgender respondents specifically (*n* = 18, 8%), 11 (61%) identified as male, 4 (22%) as female, and 3 (17%) as genderqueer/genderfluid/gender neutral. Sexual orientation and

sexual attractions among transgender respondents were 24% gay or lesbian (same gender), 47% bisexual (both genders), 24% straight (opposite gender), and 6% questioning/not sure (responses were the same for sexual orientation and sexual attractions). Complete sample demographics are seen in Table 1.

4.2 Substance use

Past-month substance use in the sample was as follows: 23% cigarettes, 24% marijuana, 37% alcohol, 17% non-medical prescription drugs; these rates are higher than those of a national sample of all high school-aged youth and comparable to sexual minority youth specifically.[4] Past-month use of cigarettes, marijuana, alcohol, and non-medical prescription drugs did not vary by gender, transgender identity, sexual orientation, or sexual attractions.

4.3 Risk and protective factors

4.3.1 Bivariate associations

Past-month cigarette, alcohol, and non-medical prescription drug use were associated with self-esteem, peer use of substance, self-efficacy, problem-solving skills, and refusal skills, in the expected direction (e.g., users had higher perceived stress; users had lower problem-solving skills). Past-month marijuana use was associated with perceived stress, peer use, problem-solving skills, and refusal skills, in the expected direction.

Use of active coping was associated with past-month cigarette, marijuana, alcohol, and non-medical prescription drug use. Positive reframing coping techniques were associated with past-month cigarette, marijuana, and non-medical prescription drug use. Coping techniques of self-distraction, emotional support, and religion were not associated with past-month substance use. (Table 2)

4.3.2 Multivariate associations

Controlling for race/ethnicity, grades in school, and parent education, higher stress was associated with past-month cigarette and non-medical prescription drug use, but not marijuana or alcohol use. Lower self-esteem and lower self-efficacy were associated with past-month cigarette, alcohol, and non-medical prescription drug use, but not marijuana use. Lower problem-solving skills were associated with past-month marijuana, alcohol, and non-medical prescription drug use, but not cigarette use. Respondents with lower active coping skills were more likely to use cigarettes, marijuana, and alcohol than those with higher active coping. Respondents who had lower positive reframing coping skills were more likely to currently use cigarettes, marijuana, and non-medical prescription drugs than those with higher active coping. (See table 2 for Wald χ^2 results).

Peer-use of substance showed significant association with all substances in multivariate analysis. Respondents whose peers used cigarettes were 22.9 times more likely to report past-month use than those whose peers did not smoke. Respondents whose peers used marijuana were 54.76 times more likely to report past-month use than those whose peers did not. Respondents whose peers drank alcohol were 2.36 times more likely to report past-month use than those whose peers did not drink. Respondents whose peers used non-medical prescription drugs were 7.75 times more likely to report past-month use than those who peers did not.

Lower substance refusal skills were associated with past-month cigarette, marijuana, and alcohol use in multivariate analysis (non-medical prescription drug refusal skills were not assessed). For cigarettes, a one-unit decrease in refusal skills yielded a 1.35 times increase in likelihood of smoking. For marijuana, a one-unit decrease in refusal skills yielded a 1.27 times increase in likelihood of smoking. For alcohol, a one-unit decrease in refusal skills yielded a 1.14 times increase in likelihood of drinking. (See table 3 for complete multivariate analysis results)

5. Discussion

This analysis explored past-month (i.e., current) substance use in a sample of 236 SGM youth who were recruited via Facebook. Roughly one-quarter of our sample reported past-month use of marijuana and cigarettes, and over one-third of the sample currently drank alcohol, with 17% reporting past-month non-medical prescription drug use. Risk and protective factors, including perceived stress, problem-solving skills, self-esteem, self-efficacy, substance refusal skills, and peer use of substance, were generally associated with substance use in our sample in both bivariate and multivariate testing. Our results support the need for prevention programming responsive to the risk and protective factors associated with social learning theory as well as those designed expressly to address the stressors identified by MST.

As both peer use of substance and substance refusal skills were consistently and robustly associated with substance use, their intersection may serve as a useful starting point in intervention development. Similarly, active and positive reframing coping techniques were predictive of substance use and may be meaningful in guiding intervention development. These protective factors should be combined with social learning-based skill development that is contextualized to the needs of SGM youth.

Consistent with previous research on risk and protective factors in other populations, the profile of marijuana use in our sample differed from that of other substances.[64] Stress, self-esteem, and self-efficacy were not associated with marijuana use in our sample, as they were with other substances, and these variations may have contributed to the wide confidence intervals seen in our multivariate analysis. As we have noted in our previous work, changing marijuana laws may have an impact on how youth view marijuana use, and future research is needed to better understand this phenomenon among SGM youth.[97]

In addition to the risk and protective factors derived from social learning theory, MST provided a framework that allowed us to understand substance use in terms of distal and proximal stressors, although our analysis would have benefitted from a better assessment of distal stressors. In recent years, MST has been used frequently to understand the associations between stressors and substance use in SGM youth: a meta-analysis by Goldbach and colleagues found a statistically significant correlation between minority stress and substance use across 12 studies.[43] The authors, however, caution that the studies included may not be accurately measuring components of sexual minority stress in youth, as either sexuality-specific measures used in the studies had only been validated in adults, or researchers used generic measures of a particular construct (for example, a measure would just ask youth about victimization and bullying at school but not determine if the victimization and bullying was directly related to the respondent's sexual minority status). Indeed, in this study, due to a lack of valid and reliable measures for this population, we did not measure minority stress and internalized homophobia/stigma explicitly, rather we used perceived stress, self-esteem, and self-efficacy as proxy measures. Future research should explore the relationships between general stress and minority stress and between self-esteem/self-efficacy and internalized homophobia/stigma. The 64-item Sexual Minority Adolescent Stress Inventory shows promise in this regard, although refinement may be necessary to develop a shorter tool so that respondents do not experience survey fatigue when completing it in combination with other measures.[69]

Another potential for future research is validating current tools for internalized stigma in younger populations and in gender minority-specific populations.[91,92] Although sexual and gender minorities in our sample did not vary in their substance use, incidental findings suggest gender minorities have lower self-esteem and higher perceived stress than non-gender minorities.

The literature, particularly recent publications, has demonstrated the applicability of MST in understanding the complex and co-occurring forces that may be at the root of substance use in sexual minorities, but MST is not without its limitations, including its omission of factors associated with exacerbating and controlling stress (e.g., biology/genetics, personality and personal disposition, acute stress situations, and coping skills, among others).[10] A broader limitation relates not to MST itself, but rather to research attempting to understand its application. As Keyes and colleagues have suggested, self-reported, or subjective, measuring of stress may be inherently biased, in that negative events, such as discrimination, are more likely to be recalled, and many studies cannot rule out reverse causality as related to discrimination and substance use.[38] In our sample, the cross-sectional nature of the analysis precludes causality analyses and may be susceptible to such biases. Despite these limitations, MST provides a useful framework from which researchers and clinicians can come to understand the interdependent impact of distal and proximal stressors on substance use, and future research should continue to explore this relationship and methods of combining MST with social learning theory to develop interventions specific to SGM youth.

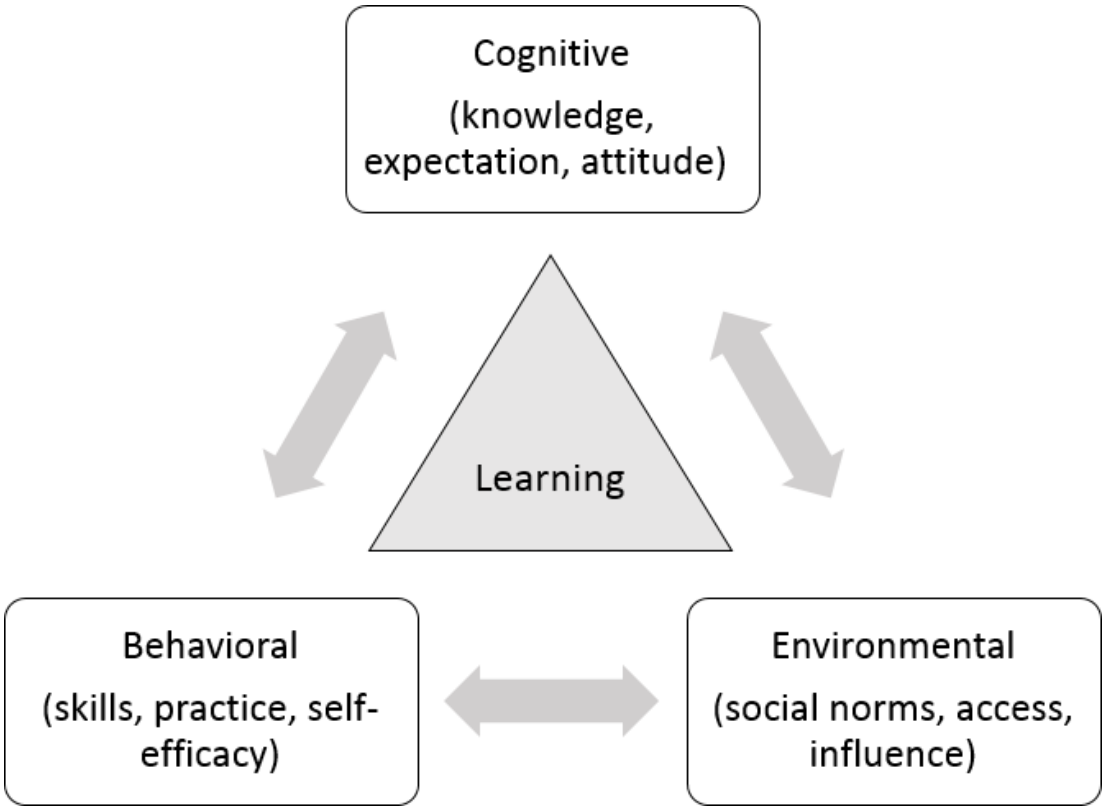
Another limitation of our study was the lack of assessment of the relationship between disclosure reactions (i.e., reactions by others to a youth's SGM disclosure) and substance use. As previous research has suggested that SGM youth who faced negative reactions were nearly universally more likely to report substance use, future research should build upon this using validated measures of disclosure reactions.[39,41,98,99] Further, the generalizability of our results is hindered by our recruitment techniques. Although Facebook boasts a vast user-base, our results can extend only to SGM youth who engage with the platform and opted to participate. Future

research should consider alternative sources of online recruitment (e.g., Instagram, YouTube, Snapchat) and other methods of reaching diverse samples.

6. Conclusion

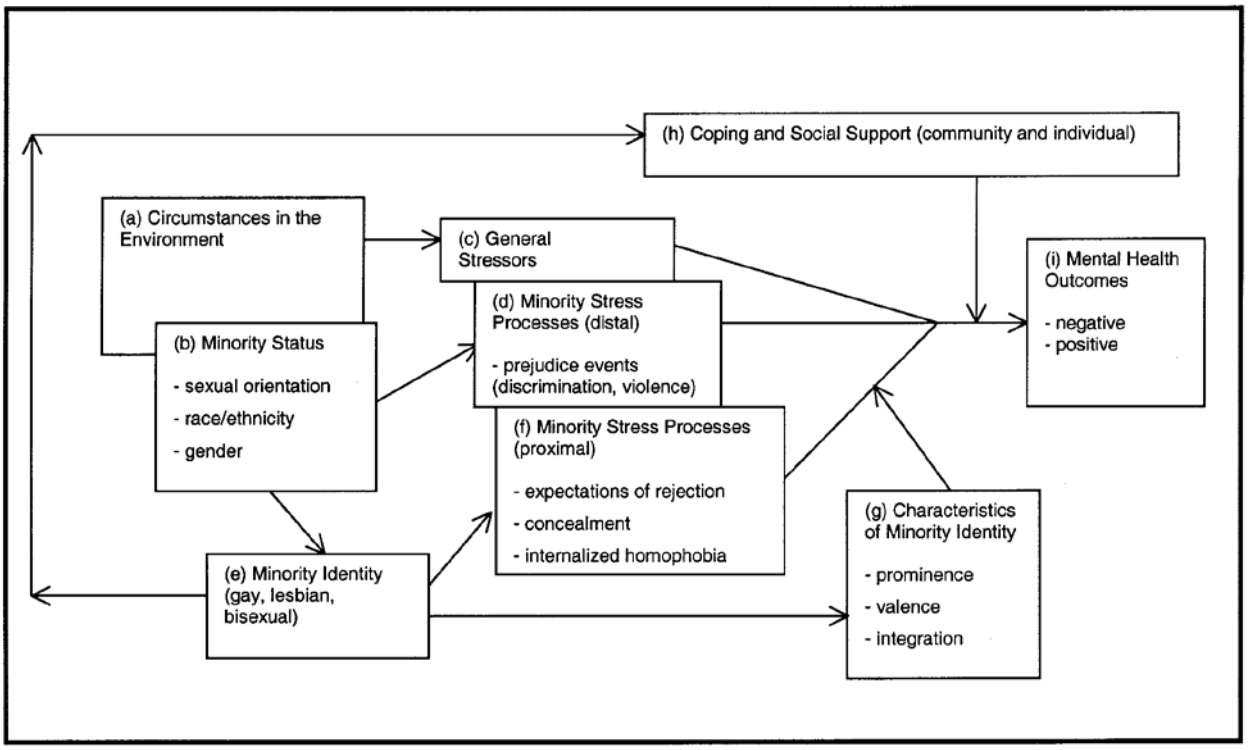
Given that SGM youth have consistently higher substance use rates than their heterosexual and cisgender counterparts, it is vital to develop preventative interventions that address the specific needs of this population and consider both the distal and proximal stressors they face. The risk and protective factors identified in this study can guide the development of such interventions, and because our sample included both sexual and gender minorities, the applicability can be extended to the often-understudied gender minority youth.

Figure 1. *Model of Social Learning Theory*



Adapted from Bandura, A. (1977). Social learning theory. Englewood Cliffs, NJ: Prentice Hall.

Figure 2. *Model of Minority Stress Theory*



From: Meyer, I. H. (2003). Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. Psychological Bulletin, 129(5), 674-697. doi: 10.1037/0033-2909.129.5.674

Table 1. *Sample Demographics*

	N	%
Grade in school		
8th/9th	48	21
10th	111	47
11th	68	29
12th	2	1
Missing/something else	*7*	*3*
White, Non-Hispanic	153	65
Transgender	18	8
Gender Identity		
Female	121	51
Male	75	32
Gender queer/fluid/neutral, non-binary	25	11
Not sure	14	6
Something else	1	0.4
Sexual Orientation		
Gay/lesbian	91	39
Bisexual	97	41
Questioning/not sure	18	8
Something else	21	9
Straight	9	4
Parent education		
No college degree	106	45
College degree or higher	105	45
Don't know	22	9
Missing	*3*	*1*
Grades in school		
Mostly A's	79	34
Mostly B's	94	40
Mostly C's/D's/F's	52	22
Missing	*11*	*5*
City Type		
Urban	70	30
Suburban	101	43
Rural	59	25
Missing	*6*	*3*
Peer Use		
Cigarettes	121	51
Marijuana	146	62
Alcohol	160	68
Prescription drugs	54	23

	Cigarettes		Marijuana		Alcohol		Prescription drugs	
	t/χ^2(df)	Wald χ^2	t/χ^2(df)	Wald χ^2	t/χ^2(df)	Wald χ^2	t/χ^2(df)	Wald χ^2
Stress	3.0(228)**	8.7**	2.1(228)*	3.0	2.0(228)*	3.2	4.3(228)***	14.7***
Peer-use^	53.3(1)***	25.0***	41.7(1)***	15.4***	11.6(1)**	6.5*	29.8(1)***	24.0***
Self-esteem	3.2(221)**	10.1**	2.0(221)	2.2	2.3(221)*	5.4*	4.0(221)***	12.9***
Self-efficacy	1.8(230)*	5.3*	1.8(230)	2.9	2.9(230)**	7.3**	2.5(230)**	9.1**
Problem-solving skills	1.8(231)*	3.2	2.5(231)*	7.2**	2.8(231)**	11.4**	2.8(231)**	3.9*
Refusal skills	7.7(230)***	27.8***	7.5(230)***	32.2***	4.7(232)***	14.2***	--	--
Coping								
Self-distraction	0.3(234)	0.3	1.4(234)	1.5	1.3(234)	4.0*	0.9(234)	0.7
Active	2.3(234)*	7.2**	2.5(234)*	6.4*	2.8(234)**	7.4**	1.7(234)*	3.8
Emotional support	0.2(234)	0.3	0.1(234)	0.001	0.7(231)	0.3	1.0(234)	0.3
Positive reframing	2.0(233)*	4.7*	2.7(233)**	5.8*	1.6(233)	2.8	2.3(233)*	4.7*
Religion	0.3(231)	0.001	0.5(231)	0.8	0.2(231)	0.1	0.8(231)	0.6

^: χ2 test used

*: $p < .05$

**: $p < .01$

***: $p < .001$

Table 3. *Adjusted odds ratio estimates of past-month substance use*

	Cigarettes			Marijuana			Alcohol			Prescription drugs		
	e^{β}	SE	95% CI	e^{β}	SE	95% CI	e^{β}	SE	95% CI	e^{β}	SE	95% CI
Stress	1.10	0.03	1.03, 1.16	1.05	0.03	0.99, 1.11	1.04	0.02	0.99, 1.09	1.16	0.04	1.08, 1.25
Peer-use	22.92	0.63	6.72, 78.18	54.76	1.02	7.41, 404.22	2.39	0.34	1.22, 4.59	7.75	0.42	3.42, 17.60
Self-esteem	0.90	0.04	0.84, 0.96	0.96	0.03	0.90, 1.01	0.94	0.03	0.89, 0.99	0.87	0.04	0.80, 0.94
Self-efficacy	1.13	0.05	1.02, 1.25	1.09	0.05	0.99, 1.20	1.13	0.05	1.03, 1.24	1.19	0.06	1.06, 1.33
Problem-solving skills	1.14	0.07	0.99, 1.31	1.21	0.07	1.05, 1.40	1.25	0.07	1.10, 1.42	1.17	0.08	1.00, 1.37
Refusal skills	1.35	0.06	1.21, 1.51	1.27	0.04	1.17, 1.37	1.14	0.04	1.07, 1.22	--		--
Coping												
Self-distraction	0.90	0.20	0.61, 1.33	0.79	0.19	0.54, 1.16	0.70	0.18	0.50, 0.99	1.21	0.23	0.77, 1.89
Active	0.49	0.26	0.29, 0.83	0.53	0.72	0.32, 0.86	0.56	0.21	0.37, 0.85	0.58	0.28	0.33, 1.00
Emotional support	0.89	0.21	0.58, 1.35	1.00	0.21	0.67, 1.49	1.11	0.18	0.78, 1.59	1.14	0.24	0.72, 1.80
Positive reframing	0.61	0.23	0.39, 0.96	0.58	0.23	0.37, 0.90	0.73	0.58	0.50, 1.05	0.57	0.26	0.34, 1.20
Religion	0.99	0.18	0.70, 1.41	0.85	0.19	0.59, 1.22	1.05	0.15	0.78, 1.41	0.85	0.21	0.56, 1.29

Chapter 3: Using Facebook to recruit sexual and gender minority youth in a substance use prevention clinical trial

Introduction

The Internet and social media offer the potential to recruit sexual and gender minority youth (SGMY; youth who identify as non-heterosexual or transgender, or whose gender differs from that assigned at birth) for health-related research and deliver interventions tailored to their specific needs. Research on SGMY is critical, as SGMY consistently experience poorer physical and mental health outcomes, including higher rates of substance initiation, use, and addiction, relative to heterosexual and cisgender youth.[4,7,8,100]

Recruiting SGMY is not without challenges. Issues include mistrust and skepticism of research, the timing of identity acceptance and disclosure, and discomfort in seeking parental permission for participation.[33,101-103] Although SGMY may know their sexual orientation or gender identity in childhood, disclosures of it typically occur later, with the earliest during adolesence.[33] Prior to the ubiquitous use of the Internet and social media, SGMY were required to disclose their status to a research team and a parent or guardian (in order to gain permission to participate) as well as feel enough comfort with their status and disclosure to openly participate in targeted research programs.[102] As such, SGMY who met these criteria were likely not representative of the larger SGMY population.[102,104] These challenges have resulted in a dearth of tailored, relevant intervention programming and left SGMY under-represented in most psychosocial and health-related research.[105]

Early work using the Internet and social media for research demonstrated efficacy in recruiting samples from similarly hard-to-reach and stigmatized populations, including illicit drugs users, men who have sex with men, sex workers, persons with rare diseases, and gay minority men.[106-109] These efforts have extended more recently to the use of Facebook

specifically to recruit sexual and gender minority young adults, offering promise for the recruitment of SGMY, as there is evidence to suggest SGMY use Facebook and other social media with more frequency than their non-SGMY peers.[70,71] SGMY have reported being drawn to Facebook and the sexual and gender minority social networking site TrevorSpace to seek a sense of community, access information and resources relevant to their experiences, explore their identities, and find relief from their feelings of stigmatization, depression, and isolation.[110-114]

In addition to their potential for finding hard-to-reach and stigmatized populations, the Internet and social media provide the opportunity to recruit and enroll study participants relatively inexpensively and quickly. In particular, Facebook and the Facebook-owned smartphone applications Instagram and Messenger allow for the conduct of targeted advertising campaigns to reach youth and young adults with a specificity not otherwise seen on the Internet. A recent systematic review of 35 health-related studies highlighted Facebook's utility as a recruitment tool, including its cost-and time-efficiency, diverse representation, and success at finding younger, hard-to-reach, or specifically targeted populations.[115] As is well known, Facebook's user base is vast: Facebook estimates some 1.5 billion users access the site daily, with 2.3 billion accessing it at least monthly.[23] About one-half of US youth aged 12-17 report using Facebook regularly, and Facebook's Instagram is used by 72% of US teens.[116] SGMY report high daily Facebook use and often, like other youth, log into the site multiple times per day.[117,118]

This paper explores the use of Facebook to recruit a historically hard-to-reach population, SGMY, into a pilot study of a tailored substance use prevention program. We describe a targeted advertising campaign to reach and enroll SGMY and compare the demographic characteristics and substance use behaviors of our recruited sample to a national sample of SGMY and

estimates from the US Census. Data collection occurred in the first quarter of 2014, when the use of Facebook for recruitment for clinical research was nascent, and, to our knowledge, there was no published intervention research to address substance use in SGMY.[51] Youth use of Facebook at data collection was comparable to current estimates, but our research took place prior to the controversaries surrounding Facebook data privacy that occurred in recent years.[116,119,120]

Methods and Materials

Sample

Eligible participants were 15- or 16-year-old youth who identified as a sexual or gender minority, spoke English, and had access to a private computer with Internet. Subjects were recruited as part of a pilot study of an animated, interactive online substance use prevention program.[51] The Columbia University IRB granted a waiver of parental permission for youth participating in this study so to not place youth at risk for harm.

Campaign and Recruitment Ads

Facebook charges for advertisements in two ways: "cost per click" (CPC) or "cost per impression." In the CPC model, campaigns are charged each time an ad is clicked; in the per-impression model, charges occur based on the number of users to which the ad is exposed. The per-impression model is useful for campaigns seeking to gain or expand brand recognition, but because we were interested in directing youth to enroll in our study, we selected the CPC model.

An ad set of six ads was created with one of four images: the program logo (the program name in bubble letters filled with a gradient rainbow), the program narrator (a gender-neutral young person with short, spiky hair), a stock image of a rainbow flag, and a stock image of an inverted rainbow triangle, the latter two of which are common identifying symbols of the sexual and gender minority community (Figure 1). The language of the ads spoke either to youth

directly (i.e., “Are you an LGBTQ teen?”) or indirectly (i.e., Do you know someone who is an LGBTQ teen?”), and both versions included information about earning money for taking surveys. The campaign targeted 15- and 16-year olds in the United States and included the following keywords: *bisexuality*; *gay lesbian and straight education network*; *genderqueer*; *LGBT community*; *gay-straight alliance*; *transgender*. All ads were approved by Facebook prior to running. Ads were programmed to run on weekdays in evening hours and on weekends (i.e., when potential participants were not in school). Per Facebook advertising practices, we were presented with a “bid” range for cost per click, which Facebook calculates as a reflection of the size of the target population, the frequency of the ad appearing, and the number of other advertisers targeting similar users at any given time. Based on our previous experience, we generally set our maximum bids (i.e., the maximum CPC we agree to pay per ad) in the upper 50% of the range or $0.02-$0.05 higher than the suggested range to ensure the ads were seen over with other advertisements targeting similar users.[121] Our initial budget for the campaign was $10,000, about quarter of the cost of our previous campaign that sought to enroll four times as many participants.

Youth who clicked on the Facebook ad were directed to an eligibility-screening webpage; eligible youth were then forwarded to a study information page, which described the goals and methods of the study. Interested youth who correctly answered all questions on a human subjects’ protection quiz were invited to enroll via email within one business day of completing the quiz. The human subjects’ protection quiz was composed of five questions that assessed the youth’s understanding of the risk and benefits of participating, the study goals and methods, the right to withdraw, and privacy protections within the study.

Participants were randomized to either an intervention (consisting of three 15-minute interactive online sessions, each a week apart) or control group, and all participants completed a 98-item survey at three timepoints (baseline, immediately post-program, three-month follow-up). The survey included reports of lifetime and current use of substances and measures of stress, self-esteem, self-efficacy, coping, peer use of substance, disclosures, and problem-solving and substance-refusal skills. Youth were paid in graduated incentives totaling $100 for completion of the measures ($25 baseline, $35 post-intervention, $40 three-month follow-up; intervention and control participants received equal incentives).

Analysis

To describe the campaign, we refer to Facebook's advertising metrics (complete details available at https://www.facebook.com/business/help). Unique clicks (uClicks) reports clicks per ad and removes the occurrence of repeat clicks by the same user. The unique click-through-rate (uCTR) refers to the number of unique clicks by the total campaign reach. As above, CPC is the cost of each ad click and is calculated as the total spent on the campaign by the number of ad clicks; this can also be calculated for individual ads by dividing the amount spent per ad by the clicks on that ad. Cost per action (CPA) is the cost of each desired action (i.e., study enrollment) and is calculated as the total spent on the campaign divided by the number of desired actions.

To determine the representativeness of our sample, we used *Z*-score and chi-square testing to compare proportions of substance use, grades in school, and sexual orientation between the Facebook-recruited sample and 15- and 16-year-old sexual minority respondents from the nationally representative Youth Risk Behavior Survey, a biennial survey administered by the US Centers for Disease Control and Prevention.[4] Differences in city type (urban, suburban, rural), race/ethnicity, and parental education were assessed with *Z*-scores, using

comparative data from the US Census Bureau.[122-124] Data were analyzed using IBM SPSS Statistics 25.

Results

Campaign Metrics

The Facebook ad campaign ran for 9 days; reached 159,227 unique users; had 4,121,924 total impressions and 2,487 uClicks; and yielded an average uCTR of 6.3%. Of the 2,487 uClicks, 748 youth were eligible for participation (30.1%), 575 expressed an interest in the study participation (23.1%), 365 successfully answered the enrollment quiz questions (14.7%), 236 completed baseline study measures (9.4%), and 211 completed all study measures (baseline, post-intervention, three-month follow-up; 8.4%). Attrition from enrollment to completing baseline measures (35.3%) did not vary by study arm, and from baseline from to study completion, we retained 89.4% of the sample. (Figure 2.)

The total spent on the campaign was $788.16, or $87.57 per day. The average CPC for the total campaign was $0.32 (range: $0.36-$0.40). The CPA of enrollment was $2.15; the CPA of baseline measure completion was $3.34; and the CPA of study completion was $3.74.

Ad Metrics

Because we reached our enrollment goals faster than we anticipated, we did not need to adjust our ad strategy, and there is minimal variation in the data for individual ads. Nonetheless, the ads with the lowest CPC and highest click-through rate (i.e., the more "successful" ads) were those that incorporated symbols of the sexual and gender minority community and/or indirect language (i.e., "Do you know someone who is an LGBTQ teen?"). The best performing ad, which featured the inverted rainbow triangle and indirect language, had a CPC of $0.26 and a

uCTR of 8.8%. The other ads, which had the rainbow symbols but used direct language, yielded CPCs averaging $0.30 and uCTR averaging 6.3%.

An ad featuring the narrator from the intervention was also one of our more successful ads, with a CPC of $0.28 and a uCTR of 7.2%. Ads featuring our program logo were the least successful: the ad with indirect language had a CPC of $0.37 and a uCTR of 4.9%, and the ad with direct language had a CPC of $0.40 and a uCTR of 4.3%.

Because our campaign ran for only a short time, we were unable to conduct meaningful analysis of ad performance by day of the week or time of day. Table 1 provides details for each ad, including reach and uClicks.

Sample Comparability

Of the 236 youth who completed baseline measures, 96.2% (n = 227) identified as a sexual minority and 22.8% (n = 54) identified as a gender minority, with 20.7% of the sample (n = 49) identifying as both.

Compared to national estimates from the US Census, our sample was similar with respect to racial and ethnic composition, although our sample had higher proportions of Native American respondents (4.2% in our sample vs. 1.2% nationally; $Z = 4.2$, $p < .001$). National estimates of urban residents, taken from the US Census' American Community Survey, were comparable to the proportion of urban participants in our sample (30.4% in our sample vs. 30.7% nationally; $Z = 0.007$, $p = .94$), but our sample had more rural participants than national estimates (25.7% in our sample vs. 14.4% nationally; $Z = 3.3$, $p < .001$ and fewer suburban participants (43.9% in our sample vs. 54.9% nationally; $Z = -2.5$, $p < .05$). Compared to national estimates, more parents of the youth in our sample had at least a Bachelor's degree (44.5% in our sample vs. 32.3% nationally; $Z = 4.0$, $p < .001$). Our sample was comparable to the YRBS sample for

average grades in school (χ^2 = 1.2, p = .55). Our sample included fewer questioning (5.9% in our sample vs. 29.3% nationally; Z = -7.3, p < .001) and more gay/lesbian youth (42.1% in our sample vs. 16.7% nationally; Z = 8.4, p < .001) than the YRBS sample. (See Table 2 for complete results.)

Rates of substance use in our sample were similar to the rates of use sexual minority youth in the YRBS sample, with the exception of smoking. Youth in our sample reported more current cigarette use than the national sample (χ^2 = 20.7, p < .001). Rates of past-month use of alcohol (χ^2 = 3.2, p = .08) and marijuana (χ^2 = 0.3, p = .87) and lifetime prevalence of non-medical prescription drugs (χ^2 = 2.6, p = .11), cocaine (χ^2 = 3.2, p = .07), ecstasy (χ^2 = 2.4, p = .13), and other drug use (χ^2 = 0.6, p = .45) were similar between the two groups. (Table 2.)

Discussion

Our results demonstrate the effectiveness of using Facebook for recruiting, enrolling, and retaining a largely representative sample of SGMY, a population that has traditionally been difficult to reach for research participation. The sample was representative in terms of substance use (alcohol, marijuana, non-medical prescription drugs, cocaine, ecstasy, and other drugs), and our sample had a similar racial/ethnic composition and academic achievement distribution to national estimates. Participants who were from rural locations, were Native American, who smoked in the past month, and whose parents had at least a Bachelor's degree were over-represented in our sample, and questioning youth and youth from suburban locations were under-represented in our sample. These variations have been found in other studies using Facebook for recruitment.[71,115,121]

Across 9 consecutive days, we were able to recruit N = 236 SGMY to complete baseline measures, at a total cost of $788.16, or $3.34 per respondent. These findings support recent

reviews that have demonstrated the superiority of Facebook-based recruitment over both traditional means of recruitment and recruitment using other Internet-based methods (e.g., Google Adwords.)[115,125] The ease and simplicity of our recruitment campaign was an unexpected surprise. Our recruitment results were less expensive and faster than a similar study in a sample of gay, bisexual, and queer adolescent men,[71] in which it took 52 non-consecutive days to recruit 302 participants at a cost of $12.54 per participant, as well as our previous experience in a substance use prevention trial for teenaged girls, in which it took 131 non-consecutive days to enroll 797 participants at a cost of $51.70 per girl.[121] (Both of these studies, however, had more stringent recruitment goals and enrollment procedures than our study.)

Although we recruited 365 SGMY initially, we experienced an attrition of 35.3% from enrollment to completion of baseline measures, with 236 youth completing baseline measures. As there was only one business day between completion of the human subjects' protection quiz and receiving enrollment confirmation and the baseline survey via email, time was not a factor. Attrition was similar between study arms, and we hypothesize that the ease of our enrollment process may have contributed to this attrition. Although youth were required to demonstrate an understanding of study procedures and human subjects' protection, they may not have realized the commitment involved in the study until receiving the baseline measures (a 98-question survey) and opted instead not to participate. Investigators using Facebook and social media for research recruitment should consider over-recruiting to ensure they are able to obtain the appropriate sample size as estimated by power calculations. Despite this initial attrition, 89.4% of the youth who completed baseline measures completed the entire study, which suggests that the youth who did go on to complete baseline measures after enrollment were highly engaged with the study.

Although we were able to recruit quickly and inexpensively, the use of Facebook for study recruitment is not without limitations. Scandals related to data privacy and discriminatory use of Facebook advertising have eroded public trust in the platform, and youth are less likely to use Facebook now than in the past, instead favoring YouTube, Snapchat, and other websites and applications.[116,119] Additionally, many SGMY report that Facebook and other social media serve as an additional avenue for the bullying and victimization they may be already enduring in their offline lives.[113] Despite this, Facebook's unique ability to target specific populations makes it a preferred recruitment tool.[119,126]

Implications of Recruiting SGMY

Our study benefitted from a parental waiver of permission, as the Columbia University IRB found the study did not exceed a minimal risk to participants. For many SGMY, obtaining parental permission is a hindrance to research participation, as disclosing their SGMY status to a parent may put them at risk for harm;[102] this may be particularly true for SGMY who also belong to a racial or ethnic minority.[127,128] As was the case in this study, IRBs can allow investigators to waive parental permission to participate, provided that youth are adequately able to express understanding of human subjects protection and privacy relative to the study and that the study presents no more than minimal risk to the participant. A recent qualitative analysis found that the majority of parents of SGMY in the sample did not believe parental permission should be required for minimal risk studies.[127]

Defining the concept of "minimal risk," however, presents difficulties for investigators and IRBs, particularly when conducting research on a potentially vulnerable population, and IRBs may be reluctant to waive parental permission of studies on topics that can be perceived as sensitive, including substance use, mental health, HIV status, and sexual health, all of which may

be salient to SGMY's overall health.[101,102,104,127] Research toward demonstrating the minimal risk imposed by studying these topics is emerging in sexual minority youth samples and should continue, extending to gender minority youth samples and to youth with multi-minority statuses, who, as noted, may face more challenges in obtaining parental permission for research. Investigators conducting research on SGMY should make efforts to minimize risks to participants, which may improve the likelihood for a waiver of parental permission and in turn improve the generalizability of data generated.

Future Research

In addition to recruitment, Facebook has shown promise in both intervention development and delivery for sexual and gender minority young adults.[129-131] These interventions have typically occurred via private Facebook groups or through Facebook Messenger, and although they have yielded positive outcomes as related to smoking cessation and health behavior improvement, some young adult participants have expressed concerns about sharing their health habits and substance use in a group setting, even one that is private.[132,133] Similar programming on Facebook will be valuable for substance use research, for although there are numerous youth substance use prevention interventions, they have not been tailored to a sexual and gender minority audience and may thus be irrelevant or inapplicable to SGMY and the unique issues they face relating to substance use.[6,49] Concerns raised by young adults about privacy in intervention delivery are especially relevant for SGMY and should be taken into consideration when researchers develop and test their interventions.

Limitations

This study is limited in its generalizability in that we can only draw conclusions based on youth who had access to Facebook and who were willing to click on our ads. Youth who had ad-

blocking software installed on their computers or mobile devices may not have been exposed to the ads. Because this study was conducted solely via the Internet, we were unable to confirm the identities and ages of our sample to ensure they were representing themselves accurately. We attempted to mitigate duplicate responses by monitoring internet protocol addresses, and that our sample demographics and substance use rates were consistent with national estimates is promising that youth in our sample were indeed who they said they were. Although our recruitment campaign was quick and inexpensive, we were only seeking to enroll 230 participants, and studies that require larger sample may not be as successful over a longer duration.

Further, because our enrollment procedures involved multiple steps on multiple webpages (i.e., clicking on the Facebook ad, learning about the study on our landing page, confirming eligibility via a webform, successfully completing a human subjects protection quiz, and enrolling via email), we were not able to track how individual ads performed in terms of enrollment actions. In the time since our study was conducted though, Facebook form technology has improved, and many of these steps could now be completed within Facebook and its family of applications, allowing for better analysis of CPA relative to individual ads.

Timing presents an additional limitation to our findings, as data collection occurred over five years ago and may not be representative of the current state of Facebook use for research purposes. As noted above, controversaries related to Facebook data privacy occurred after our data collection and may inhibit potential participant's current or future likelihood of engaging with ads for research purposes. Despite this there has been an emergence of literature published in the past two years that includes samples recruited through Facebook and other social media, suggesting these sources remain promising recruitment tools. A recent review called upon

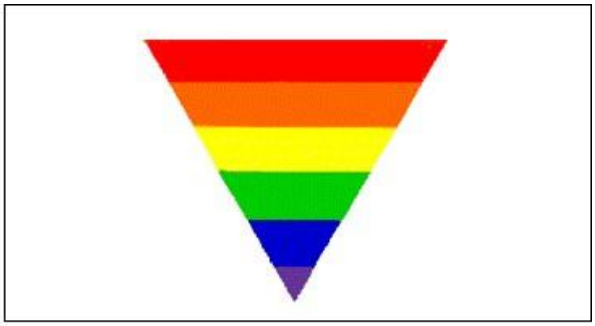
academic centers and IRBs to develop and publish guidelines relating to online recruitment and data collection, and it is incumbent upon researchers using Facebook and other social media to ensure data privacy is maintained and expressly communicated to potential participants and reiterated as requested to participants who choose to enroll.

Conclusion

This study confirms previous research demonstrating the cost and time benefits of using Facebook ads for research recruitment. Given the pronounced health disparities between SGMY and heterosexual and cisgender youth, there is a need for research conducted with representative samples of SGMY. The results from our study support the use of Facebook (and its associated properties) as an effective method for recruiting this traditionally difficult-to-reach population.

Figure 1. *Images used for Facebook ads*

1. Stock photo of rainbow flag



2. Stock photo of inverted rainbow triangle

3. Intervention program narrator

4. Intervention program logo

Figure 2. *Study participation tracking*

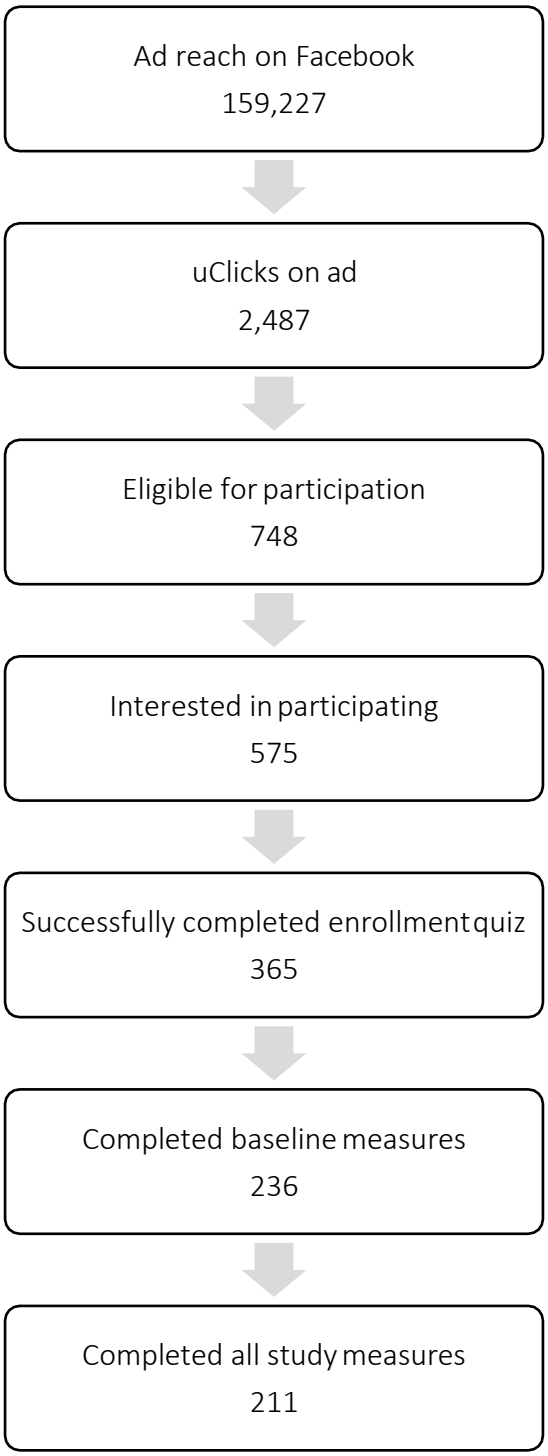


Table 1. *Facebook ad performance metrics*

Image	Text	Reach	Impressions	Amount Spent	uClicks	Cost per click	Click-through rate
Rainbow triangle	Do you know someone who is LGBTQ? Take surveys & have the chance to earn up to $100!	100,685	598,230	$137.13	527	$0.26	8.8%
Narrator sitting	Do you know someone who is LGBTQ? Take surveys & have the chance to earn up to $100!	80,333	426,144	$85.76	308	$0.28	7.2%
Rainbow flag	Are you an LGBTQ teen? Take online surveys and earn up to $100! Join free2b today!	76,196	321,788	$60.07	206	$0.29	6.4%
Rainbow triangle	Are you an LGBTQ teen? Take online surveys and earn up to $100! Join free2b today!	120,713	1,096,963	$211.03	684	$0.31	6.2%
Program logo	Do you know someone who is LGBTQ? Take surveys & have the chance to earn up to $100!	85,684	749,894	$136.16	364	$0.37	4.9%
Program logo	Are you an LGBTQ teen? Take online surveys and earn up to $100! Join free2b today!	82,236	928,905	$158.01	398	$0.40	4.3%

Table 2. *Comparison between Facebook-recruited sample and national population estimates (%)*

	Facebook sample	**National sample**	***Z*-score/χ^2**	***P*-value**
Hispanic Ethnicity [a]	13.9	17.4	-1.34	0.18
Race [a]				
White	72.8	77.4	-1.53	0.13
Black	10.1	13.2	-1.36	0.18
Asian	8.1	5.4	1.80	0.07
Pacific Islander	0.4	0.2	0.62	0.27
Native American	4.2	1.2	4.17	<.001
2 or more races	3.8	2.5	1.30	0.19
City type [b]				
Urban	30.4	30.7	-0.07	0.94
Rural	25.7	14.4	3.30	<.001
Suburban	43.9	54.9	-2.53	0.01
Bachelor's degree or higher [c]	44.5	32.3	4.01	<.001
Average grades[^,d]				
As	35.1	36.4	1.19	0.55
Bs	41.9	37.9		
Cs/Ds/Fs	23.1	25.6		
Attractions [d]				
Both sexes	50.9	54.0	0.53	0.59
Same sex	42.1	16.7	8.36	<.001
Not sure/questioning	5.9	29.3	-7.28	<.001
Substance use[^,d]				
Current cigarette	82.6	65.6	25.49	<.001
Current alcohol	36.9	30.8	3.15	0.08
Current marijuana	24.2	23.6	0.03	0.87
Lifetime non-medical RX	16.5	21.2	2.61	0.11
Lifetime cocaine	3.4	6.4	3.24	0.07
Lifetime ecstasy	4.7	7.5	2.36	0.13
Lifetime other drugs	19.5	17.4	0.57	0.45

^: χ^2 used. All else use *Z*-score comparisons

a: US Census Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States:
April 1, 2010 to July 1, 2014: 2017 Population Estimates. (*N* = 318,622,525)
b: US Census Comparing 2016 American Community Survey Data (*N* = 318,622,525)

c: Educational Attainment of the Population 18 Years and Over, by Age, Sex, Race, and Hispanic Origin: 2018. (N = 249,193,000)

d: From 2017 YRBS national questionnaire responses from 15-16 year olds who identify as gay, lesbian, bisexual, or questioning (N = 1017)

Conclusion

The three papers in this dissertation have illustrated disparities in substance use between heterosexual youth and sexual and gender minority (SGM) youth, with SGM youth reporting higher use rates across all substances. As noted, research to address these disparities is critical, and this dissertation sought to provide an empirical basis for the development of interventions that are meaningful and relevant to the issues faced by SGM youth.

Understanding the determinants of substance use among SGM youth, and the extent to which these differ from heterosexual use determinants, serves as starting point for developing such tailored interventions. This was demonstrated in the first paper, whereby comparing the contributing factors of substance use between sexual minority and heterosexual youth revealed that although many predictors were associated with use in both groups, sadness, suicidal ideation, difficulty concentrating, and forced sexual encounters were the most consistent and substantial contributors to the explanation of the difference in use rates between groups. In the second paper, risk and protective factors identified from social learning theory and minority stress theory, including perceived stress, problem-solving skills, self-esteem, self-efficacy, substance refusal skills, and peer use of substance, were generally associated with past-month substance use. Peer use of substance and substance refusal skills, in particular, were consistently and robustly associated with substance use in the sample of SGM youth, and their intersection provides insight into themes to address in future intervention development.

Active and positive reframing coping were also predictive of substance use in the sample in paper 2, and these techniques may have applicability toward managing the ill-effects of mental health issues and sexual violence seen in paper 1. Training in developing the skills associated

with these protective factors should be combined with other social learning-based skill development that is contextualized to the needs of SGM youth. Paper 3, meanwhile, offers insight into an inexpensive and time-efficient means of recruiting SGM youth for participation in such research. As noted, issues of disclosure and parental permission have made recruiting representative samples of SGM youth challenging. The specificity with which Facebook ads can be targeted to hard-to-reach populations makes it a preferred tool for researchers who seek to recruit SGM youth.

Taken together, the three papers of this dissertation can serve as a guide for the development and execution of substance use prevention research that is tailored to the specific needs of SGM youth.

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