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Utilizing Machine Learning and Technology-Based Intervention for Intimate Partner Violence
and HIV Prevention Among Young Sexual Minority Men

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of
Philosophy in Social Welfare

by

Chenglin Hong

2024

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ABSTRACT OF THE DISSERTATION

Utilizing Machine Learning and Technology-Based Intervention for Intimate Partner Violence and HIV Prevention Among Young Sexual Minority Men

by

Chenglin Hong

Doctor of Philosophy in Social Welfare

University of California, Los Angeles, 2024

Professor Ian W. Holloway, Chair

Young sexual minority men (SMM) experience higher rates of intimate partner violence (IPV) compared to their heterosexual counterparts, and these experiences were associated with adverse health and mental health outcomes including HIV, substance use, and psychological distress. However, little is known about the association between IPV victimization and HIV prevention services such as pre-exposure prophylaxis (PrEP). This dissertation aimed to describe the prevalence of IPV victimization, perpetration, and bi-directional violence among a sample of cisgender young SMM who use substances. It examined the associations between different types of IPV victimization and PrEP utilization, explores the mediating effects of PrEP stigma and alcohol, tobacco, and other drug use on the relationship between IPV and PrEP utilization, and

built and verified a machine learning model to predict self-reported IPV victimization using social media and mobile phone use data. The study found alarmingly high rates of IPV victimization, perpetration, and bi-directional violence among a sample of cisgender young SMM recruited from 2021 to 2023, particularly emotional IPV. The results indicated that experiencing emotional, monitoring, and controlling IPV victimization were associated with suboptimal PrEP utilization, such as lower likelihood of using PrEP for HIV prevention and suboptimal PrEP adherence. Additionally, the study found that PrEP stigma and nicotine use mediate the relationship between IPV victimization and PrEP use and adherence. Finally, social media data and mobile phone use activities can be used to predict self-reported IPV victimization through machine learning techniques when adequate data is available. These findings highlight the elevated vulnerabilities of cisgender young SMM to IPV and underscore the need to promote IPV screening and services across different settings. Future research is necessary to understand the longitudinal impact of IPV experiences on PrEP utilization and to explore the underlying mechanisms. There is potential to utilize machine learning, social media data, and mobile phone activities to identify young SMM who experience or are at risk of IPV, indicating opportunities for integrated eHealth and technology-based IPV services and interventions.

The dissertation of Chenglin Hong is approved.

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2024

DEDICATION

I dedicate this dissertation to my parents, grandparents, and all my family members for their
unconditional and unwavering love and support.

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2. **Hong, C., Mammadli, T., Lunchenkov, N., Garner, A., Howell, S., & Holloway, I. W.** (2024). Changes in alcohol, tobacco, cannabis, and other substance use and its association with mental health during the COVID-19 pandemic among sexual minority men in Eastern European and Central Asian countries. *Journal of Affective Disorders*. <https://doi.org/10.1016/j.jad.2024.05.089>
3. **Hong, C., Flinn, R.E., Miyashita, A., John, S.A., Garth, G., & Holloway, I.W.** (2023). Internalized homophobia and social well-being among Black sexual minority men with HIV: The mediating role of LGBT community connectedness and racial and sexual identity integration. *Psychology of Sexual Orientation and Gender Diversity*. <https://doi.org/10.1037/sgd0000679>
4. **Hong, C.** (2023). Mpox on *Reddit*: a thematic analysis of online posts on mpox on a social media platform among key populations. *Journal of Urban Health*. <http://doi.org/10.1007/s11524-023-00773-4>
5. **Hong, C., Hoskin, J., Berteau, L. K., Schamel, J. T., Wu, E. S. C., King, A. R., Randall, L. A., Holloway, I. W., & Frew, P. M.** (2023). Violence Victimization, Homelessness, and Severe Mental Illness Among People Who Use Opioids in Three U.S. Cities. *Journal of Interpersonal Violence*, 0(0). <https://doi.org/10.1177/08862605231179720>
6. **Hong, C., Ochoa, A. M., Wilson, B. D. M., Wu, E. S. C., Thomas, D., & Holloway, I. W.** (2023). The associations between HIV stigma and mental health symptoms, life satisfaction, and quality of life among Black sexual minority men with HIV. *Quality of Life Research*, 32(6), 1693–1702. <https://doi.org/10.1007/s11136-023-03342-z>
7. **Hong, C., Queiroz, A., & Hoskin, J.** (2023). The impact of the COVID-19 pandemic on mental health, associated factors and coping strategies in people living with HIV: A scoping review. *Journal of the International AIDS Society*, 26(3), e26060. <https://doi.org/10.1002/jia2.26060>
8. **Hong, C., & Graff, N. R., Guthrie, B., Micheni, M., Chirro, O., Wahome, E., van der Elst, E., Sanders, E. J., Simoni, J. M., & Graham, S. M.** (2023). The Effect of the Shikamana Peer-and-Provider Intervention on Depressive Symptoms, Alcohol Use, and Other Drug Use Among Gay, Bisexual, and Other Men Who Have Sex with Men in Kenya. *AIDS and Behavior*. <https://doi.org/10.1007/s10461-023-04027-x>
9. **Hong, C., Holloway, I.W., Graham, S.M., Simoni, J.M., Yu, F., Xue H., Zhang D., & Mi G.** (2023). Awareness of and willingness to use on-demand PrEP among men who have sex with men in China. *AIDS Patient Care and STDs*. <https://doi.org/10.1089/apc.2023.0004>

10. **Hong, C.**, Holloway, I.W., Bednarczyk, R., Javanbakht, M., Shoptaw, S., & Gorbach, P. (2023). High vaccine confidence is associated with COVID-19 vaccine uptake in diverse men who have sex with men. *LGBT Health*.
<https://doi.org/10.1089/lgbt.2022.0255>
11. **Hong, C.** (2023). The impact of the COVID-19 pandemic on mental health in social work students: A scoping review and call for research and action. *Social Work in Mental Health*. <https://doi.org/10.1080/15332985.2023.2196361>
12. **Hong, C.**, Abrams, L. S., & Holloway, I. W. (2022). Technology-Based Interventions to Promote the HIV Preexposure Prophylaxis (PrEP) Care Continuum: Protocol for a Systematic Review. *JMIR Research Protocols*, 11(3), e33045. <https://doi.org/10.2196/33045>
13. **Hong, C.**, Feinstein, B. A., Holloway, I. W., Yu, F*, Huang, W., Sullivan, P. S., Siegler, A. J., & Mi, G. (2022). Differences in Sexual Behaviors, HIV Testing, and Willingness to Use PrEP between Gay and Bisexual Men Who Have Sex with Men in China. *International Journal of Sexual Health*, 0(0), 1–8.
<https://doi.org/10.1080/19317611.2022.2053922>
14. **Hong, C.**, Yu, F., Xue, H., Zhang, D., & Mi, G. (2022). The impact of COVID-19 pandemic on mental health in gay, bisexual, and other men who have sex with men in China: Difference by HIV status. *Journal of Psychiatric Research*, 154, 198–202.
<https://doi.org/10.1016/j.jpsychires.2022.07.028>
15. **Hong, C.**, Huh, D., Schnall, R., Garofalo, R., Kuhns, L.M., Bruce, J., Batey, S., Radix, A., Belkind, U., Hidalgo, M.A., Hirshfield, S., & Pearson, C.R. (2022). Changes in high-risk sexual behavior, HIV and STI testing, and PrEP use during the COVID-19 pandemic in a longitudinal cohort of young men who have sex with men 13 to 18 years old in the United States. *AIDS and Behavior*. <https://doi.org/10.1007/s10461-022-03850-y>
16. **Hong, C.**, Stephenson, R., Santos, G.M., Garner, A., Howell, S., & Holloway, I.W. (2022). Intimate Partner Violence Victimization During the COVID-19 Pandemic Among a Global Online Sample of Sexual Minority Men. *Journal of Family Violence*. <https://doi.org/10.1007/s10896-022-00461-y>
17. **Hong, C.**, Yu, F., Xue, H., Zhang, D., & Mi G. (2022). HIV testing among gay, bisexual, and other men who have sex with men during the COVID-19 pandemic in China: Implications for promoting HIV self-testing among key populations. *AIDS Patient Care and STDs*. <http://doi.org/10.1089/apc.2022.0184>
18. **Hong, C.** (2022). Characterizing the impact of the COVID-19 pandemic on HIV PrEP care: a review and synthesis of the literature. *AIDS and Behavior*.
<https://doi.org/10.1007/s10461-022-03941-w>
19. **Hong, C.**, Puttkammer, N., Riabokon, S., Germanovich, M., Shost, A., Parrish, C., Shapoval, A., & Dumchev, K. (2021). Patient-Reported Treatment Satisfaction and Quality of Life Among People Living with HIV Following the Introduction of Dolutegravir-Based ART Regimens in Ukraine. *AIDS and Behavior*, 26(4), 1056–1073.
<https://doi.org/10.1007/s10461-021-03461-z>
20. **Hong, C.**, Horvath, K. J., Stephenson, R., Nelson, K. M., Petroll, A. E., Walsh, J. L., & John, S. A. (2021). PrEP Use and Persistence Among Young Sexual Minority Men 17–24 Years Old During the COVID-19 Pandemic. *AIDS and Behavior*, 26(3), 631–638.
<https://doi.org/10.1007/s10461-021-03423-5>

CHAPTER 1: INTRODUCTION

Background of the problem

The emergence of research on intimate partner violence (IPV) among cisgender sexual minority men (SMM) including gay, bisexual, and other men who have sex with men has demonstrated that IPV occurs in male-male partnerships at rates similar to or higher than in opposite-sex partnerships. Research suggests that nearly one in three SMM reported experiencing IPV in multiple forms during their lifetime, including physical violence, emotional violence, sexual violence, and other monitoring and controlling behaviors (Liu et al., 2021; Stephenson & Finneran, 2013). These experiences can profoundly impact SMM's health, including physical injuries, psychological distress, substance use and abuse, increased risk of HIV and other sexually transmitted infections (STIs), or life-threatening behaviors such as suicidal ideation and attempts (Buller et al., 2014). Receiving timely help related to IPV has been shown to reduce negative post-traumatic outcomes and increase well-being among individuals who experience IPV (Folger & Wright, 2013; Robinson et al., 2021).

Existing literature has primarily focused on exploring IPV *victimization* among SMM, leaving a significant gap in understanding the co-occurrence of IPV victimization and perpetration, especially among SMM subgroups experiencing high vulnerabilities, such as young individuals and those who use substances. Meanwhile, not only do SMM experience higher rates of IPV, but this group remains disproportionately affected by the HIV epidemic, especially among young individuals (Centers for Disease Control and Prevention, 2020). Pre-exposure prophylaxis (PrEP) is a novel biomedical HIV prevention intervention that reduces the risk of HIV transmission among at risk populations when taken as prescribed (Baeten et al., 2012; Grant et al., 2010; Heffron et al., 2014). However, limited extant research has sought to understand the

pathways between IPV victimization and HIV prevention service utilization such as PrEP uptake and adherence, and the potential underlying mechanisms linking IPV experience and PrEP utilization among this population. Previous research suggested that alcohol, tobacco, and other drug (ATOD) use was associated with higher risk of IPV and suboptimal PrEP utilization (Gebru et al., 2022; Shuper et al., 2020; Wu et al., 2015). These disparities may exacerbate the negative impact of IPV, influence the patterns of PrEP uptake and adherence, and hinder the effectiveness of PrEP for HIV prevention.

In the past decade, technology-based interventions (TBIs) including eHealth and mHealth have been widely used in health promotion and disease prevention to facilitate large-scale information dissemination and cost-effective service delivery. Examples of these TBIs include web-based modules for health education, mobile apps for locating health services, and interactive digital gamification to promote users' health behaviors, such as medication adherence and HIV testing (Maloney et al., 2020; Muessig et al., 2015). But these approaches have not been fully utilized in preventing IPV or delivering IPV services, especially among SMM (Anderson et al., 2021). One of the potential barriers to receiving IPV services may be concerns about privacy and confidentiality, which might lead to under-reported IPV experiences among SMM. To reach key populations to deliver IPV services and prevention, it is critical to understand the feasibility of identifying IPV through novel strategies beyond self-reported experiences and determine preferences for and acceptability of delivering IPV prevention and resources via technology. Recently, researchers started to use subjective data such as social media and mobile phone use activities to predict health behaviors and health outcomes. Such approach may overcome traditional barriers in identifying SMM who experience IPV and deliver services more efficiently.

Purpose of the study

This proposed study aims to describe the prevalence of IPV victimization, perpetration, and bi-directional violence among a sample of cisgender young sexual minority men, examine the associations between experiencing IPV victimization and PrEP utilization including PrEP uptake and adherence. By using mediation analyses, this research also seeks to explore the direct and indirect impact of IPV victimization on PrEP uptake and persistence among cisgender young SMM and whether PrEP stigma and alcohol, tobacco, and other drug (ATOD) use mediate this association. Given prior analysis using robust social media data collection and machine learning to predict substance and HIV risks among SMM, this study also aims to build and verify a machine learning algorithm to predict self-reported IPV victimization using social media and mobile phone use data from an on-going NIH-funded study (uTECH; PI: Holloway; NIH DP2 1DP2DA049296-01).

Specific aims and hypothesis

1. Describe the prevalence of IPV victimization, perpetration, and bi-directional violence among a sample of cisgender young SMM.

Hypothesis: young SMM will report high rates of IPV victimization, perpetration, and bi-directional violence, which will be equal to or higher than the observed rates among SMM in general in the literature. These IPV outcomes will also differ by sociodemographic characteristics such as sexual orientation.

2. Assess the associations between IPV victimization, PrEP stigma, ATOD use, and PrEP utilization among cisgender young SMM using previously validated scales, explore the

mediating effect of PrEP stigma and AOTD use on the relationship between IPV victimization and PrEP uptake and adherence.

Hypothesis: IPV victimization will be negatively correlated with PrEP uptake and adherence among young SMM. PrEP stigma and ATOD use will partially or fully mediate the association between IPV victimization and PrEP uptake and adherence.

3. Build and verify a machine learning model to determine the extent to which social media and mobile phone data can be used to predict self-reported IPV victimization.

Hypothesis: Social media and mobile phone data will predict IPV experiences among young SMM with high accuracy, verified through self-reported IPV victimization using the IPV-GBM scale.

CHAPTER 2: LITERATURE REVIEW

This chapter is intended to demonstrate the public health relevance of intimate partner violence (IPV) among sexual minority men (SMM). This chapter first provides an introduction to IPV among SMM, including the prevalence of IPV among SMM, factors associated with IPV among SMM, and the associations between IPV and health outcomes, including both physical health and mental well-being. The following section focuses on the connections and impact of IPV on HIV pre-exposure prophylaxis (PrEP) among SMM. The next section focuses on the development and utilization of eHealth/mHealth, or technology-based interventions for health promotion and disease prevention in the literature, with a focus on HIV prevention and care. The final section presents emerging literature on using data science approaches such as building machine learning models to predict health outcomes and behaviors, especially by using social media and mobile phone activities.

Intimate partner violence (IPV) is a pervasive public health issue that could result in a range of adverse health outcomes and behaviors. It refers to the abuse or aggression that occurs in a romantic relationship (Breiding et al., 2015). The World Health Organization defines IPV as “any behaviors within an intimate relationship that causes physical, psychological or sexual harm”, which mainly include physical assault, psychological abuse and other aggressive behaviors.” (World Health Organization, 2012). Despite the fact that IPV is most often discussed in the context of heterosexual relationships historically with female victims and male perpetrators, there has been a growth in research illustrating that SMM experience IPV at substantially higher rates than heterosexual men, and rates that are comparable to those among heterosexual women (Finneran & Stephenson, 2013, 2014a; Rollè et al., 2018). The following section will outline recent research focused on IPV prevalence among SMM, identify

demographic and social-behavioral risk factors for IPV, associations between IPV experience and health behaviors and outcomes.

Prevalence of intimate partner violence among sexual minority men

Recent research suggests that sexual minority men experience IPV at rates that are substantially higher than their heterosexual counterparts, and in some studies, rates of IPV experienced among gay, bisexual, and other sexual minority men (SMM) are comparable or even higher than those among heterosexual women (Balsam et al., 2011; Pantalone et al., 2012; Stephenson, Hall, et al., 2013). An early systematic review of 28 empirical studies in the United States suggested that the prevalence of IPV in male couples ranged from 29.7% to 78.0% across all recall periods (Finneran & Stephenson, 2013). A meta-analysis published in 2014 concluded that the pooled prevalence of IPV victimization among SMM was 41.24% (95% confidence interval (CI) : 32.38-50.11%) (Buller et al., 2014). More recently, an updated systematic review and meta-analysis was published to synthesize the estimates of IPV victimization and perpetration among SMM in literature published in the past three decades around the globe (Liu et al., 2021). The pooled estimate of IPV victimization among SMM across all recall periods was 33.0% (95% CI: 28.0-39.0%). This review also revealed that pooled prevalence of IPV perpetration was 29% (95% CI: 17.0%-40.0%). Furthermore, the most prevalent form of IPV was emotional violence, which was 33.0% for emotional victimization and 41.0% for emotional perpetration, followed by physical violence and sexual violence (Liu et al., 2021). In addition, other forms of IPV were also documented in recent studies – Davis et al. (2016) found 29.6% and 20.1% of SMM in New York City reported experiencing monitoring and controlling violence from their regular partners (Davis et al., 2016). Among a more diverse sample of gay and bisexual men in Atlanta, researchers also observed high rates of physical/sexual IPV,

monitoring, controlling, and emotional IPV (Stephenson & Finneran, 2017b). These studies also suggest that IPV victimization and perpetration often co-exist among SMM, indicating the need for bidirectional investigation (Stephenson, Hall, et al., 2013).

Factors associated with IPV among SMM

A combination of demographic, interpersonal, community, and societal factors contribute to the risk of experiencing IPV among SMM necessitating a socioecological framework to understand risk and protective factors (Centers for Disease Control and Prevention, 2015, 2019). First, demographic factors including age, education and income level, race and ethnicity, substance use and mental distress, as well as HIV status contribute to one's risk of experiencing IPV. Studies have demonstrated that young SMM experience higher rates of IPV (Edwards et al., 2015; Greenwood et al., 2002; Kubicek et al., 2015a; Stults, Javdani, Greenbaum, Kapadia, et al., 2015). A recent study among a global online sample of SMM found that men aged 18-24 years old were more likely to report having experienced IPV in the past six months compared to those who were 35 years old and above (Hong, Stephenson, et al., 2022). Research also suggests that experiences of IPV are associated with lower levels of education (Greenwood et al., 2002; Wall et al., 2014). There is evidence that racial and ethnic minority SMM were more likely to report having experienced IPV compared to their white counterparts (De Santis et al., 2014; Finneran & Stephenson, 2013; Gonzalez-Guarda et al., 2010). For example, Pantalone et al. (2011) found that non-white SMM in their study reported past-year partner abuse at almost twice the rate of white participants (51.7% vs. 28.7%, $p=0.02$) (Pantalone et al., 2012). In a global online sample of SMM, those who identified as a member of an ethnic minority group reported significantly higher rates of IPV compared to majority groups (Hong, Stephenson, et al., 2022).

Other individual factors associated with IPV among SMM are substance use and histories of abuse (Centers for Disease Control and Prevention, 2015). Indeed, substance use was correlated with IPV in several early studies on IPV among SMM (Houston & McKirnan, 2007; Klitzman et al., 2000; Koblin et al., 2006; Relf, 2001). More recently, researchers have explored the association between specific type(s) of IPV and substance use. For instance, Duncan et al. (2018) found that SMM who experienced physical IPV and sexual IPV victimization were more likely to report elevated substance abuse in the preceding month compared to SMM who did not experienced these types of IPV (Duncan et al., 2018). Another study examining IPV and substance use risk among young SMM in New York City also found that IPV was associated with increased odds of alcohol use, marijuana use, stimulant use, and other substance use (Stults, Javdani, Greenbaum, Kapadia, et al., 2015). These associations may also suggest a plausible mediating effect of ATOD use on the relationship between IPV and sexual risk behaviors and health outcomes, which will be discussed in the following section (Stephenson & Finneran, 2017b).

Relational factors also contribute to a greater risk of IPV among SMM. While some recent studies investigating IPV among SMM explicitly recruited partnered individuals (e.g., having a main partner, boyfriend, or lover), it is important to note that IPV may occur regardless of relationship status. Relational factors include relationship conflicts such as jealousy, tension, separation, and passive aggressiveness. Bell and Naugle (2008) argued that motivating factors are particularly relevant within the context of IPV; anger, fear, and jealousy can all proximally precede IPV perpetration (Bell & Naugle, 2008). Other studies also suggest that family relationship patterns and peer interactions can also increase one's risk of IPV (Centers for Disease Control and Prevention, 2015). Within male couples, Finneran and Stephenson (2017)

argued that disagreements around sexual positioning, one or both partners not having disclosed their sexual orientation, and sexual satisfaction can also contribute to violent behaviors (Stephenson & Finneran, 2017a). In a qualitative study, Goldenberg and colleagues (2016) found that dyadic inequalities such as differences in income, education, and “outness” –the degree to which one discloses their sexual orientation and/or gender identity to others – could trigger IPV among SMM (Goldenberg et al., 2016). In addition, researchers found associations between IPV and the number of sexual partners, relationship status, and sexual agreements among SMM. One study among SMM couples suggested that an increased number of outside sexual partners was associated with increased odds of IPV victimization; however, this was only significant among those with nonmonogamous sexual agreements (Walsh et al., 2021). In another study, Hong et al. (2022) found that SMM who reported being in more than one relationship or being separated but living together were more likely to say that they experienced IPV and experienced more severe or frequent IPV relative to those who were single or in a married or registered relationship (Hong, Stephenson, et al., 2022).

Another group of factors associated with experiencing IPV is the settings where social relationships occur and the environments in which SMM interact with diverse communities. These settings include workplaces, neighborhoods, and the larger LGBT community (both in-person and virtually) where SMM seek and/or avoid connections. An analysis of 403 SMM with main partners illustrated the association between social network factors and the reporting of IPV among SMM in Atlanta (Stephenson, Sato, et al., 2013). In this study, SMM having social networks that contain more gay friends reported significantly lower rates of IPV experiences, whereas having social networks that contain more closeted or gay friends was associated with increased risk of both IPV victimization and perpetration (Stephenson, Sato, et al., 2013).

Another study also provided strong evidence in support of the associations between IPV and minority stress, including discrimination, homophobia, and racism (Finneran & Stephenson, 2014b). The authors argued that SMM with closeted partners and friends may also have limited access to larger LGBT communities and therefore lower social support and access to LGBT specific services. These studies highlighted the powerful role of a friendly, open, and accepting community and environment in providing multidimensional social support for SMM relationships, which may serve as protective factors for experiencing IPV among SMM.

Finally, societal factors including structural vulnerabilities and social policies and norms can create an environment where IPV behaviors are encouraged. The Centers for Disease Control and Prevention suggested that these factors include the cultural forms that support violence as a way to address conflict (Centers for Disease Control and Prevention, 2015). This also includes economic policies that could create and maintain financial and social inequalities between social classes in society. Numerous studies have found that structural vulnerabilities, including unemployment, living in poverty, and financial stresses were positively associated with both IPV victimization and perpetration (Capaldi et al., 2012; Tankard & Iyengar, 2018). These effects were especially pronounced during the recent COVID-19 pandemic, when SMM were particularly vulnerable to the significant negative social and economic impacts caused by the pandemic (Santos et al., 2021, 2022). In fact, several studies investigating the impact of the COVID-19 pandemic among SMM all had similar findings; that is, experienced structural vulnerabilities during the pandemic were associated with experiences of IPV among this population. A study conducted in the early phase of the COVID-19 pandemic found that experiencing IPV victimization and perpetration was associated with having skipped meals during the pandemic, as well as increased substance use and alcohol intake during the lockdown

among SMM in the United States (Stephenson et al., 2021). Similarly, Hong et al. (2022) found that SMM who reported cutting meals since the beginning of the pandemic were more likely to report experiencing more severe or frequent IPV relative to those did not cut meals (Hong, Stephenson, et al., 2022). In the same study, the authors also found that SMM who reported having an income reduction of more than 20% and cutting meals since the crisis started were more likely to say their IPV experiences were more severe or frequent relative to not experiencing IPV (relative risk ratio=1.60, 95% confidence interval (CI): 1.21-2.10) (Hong, Stephenson, et al., 2022).

Associations between IPV and health behaviors and outcomes among SMM

A wealth of evidence in the literature has suggested that experiences of IPV, both victimization and perpetration, are associated with adverse physical and mental health outcomes among SMM. For example, a systematic review and meta-analysis published in 2014 suggested that experiencing IPV victimization was associated with reporting depressive symptoms, being HIV positive, and engaging in unprotected anal sex (Buller et al., 2014). Despite the methodological limitations in included studies, this article was the first and only review that provided a coherent understanding of the associations between IPV and health behaviors and outcomes among SMM. Since then, numerous studies across different settings continue to add to the evidence by suggesting associations between IPV and diverse health outcomes among SMM.

The first study demonstrating the association between IPV and sexual risk behaviors, including unprotected anal sex, can be traced to 2000. In this study, Nieves-Rosa and colleagues found that among Latin American SMM living in the New York metropolitan area, more than half (51%) reported having experienced domestic violence in their relationships and experiencing physical and sexual abuse was strongly correlated with having condomless anal sex

(CAS) (Nieves-Rosa et al., 2000). Following these results, Kalichman et al. (2001) found that SMM who experienced sexual coercion were more likely to report CAS and more likely to report having CAS with two or more partners in the preceding six months, compared to SMM without a history of sexual coercion (Kalichman et al., 2001). These early findings directed the research on investigating the association between IPV and sexual risk behaviors in the past two decades and researchers continue to confirm this association through empirical studies. In the same meta-analysis, Buller et al. (2014) pooled the estimates for CAS in eight studies with a total of 4,447 SMM and found that exposure to IPV significantly increased the odds of engaging in CAS (Buller et al., 2014). A study of 1,575 internet recruited SMM across the United States documented that men who perpetrated physical violence had twice the odds of engaging in CAS compared to those who did not report violence perpetration (Finneran & Stephenson, 2014b). A study of 750 SMM in Atlanta showed that CAS was significantly associated with specific forms of IPV; that is, SMM who reported experiencing recent physical/sexual IPV, or monitoring IPV had higher odds of reporting CAS in the past six months (Stephenson & Finneran, 2017b). The co-occurrence of IPV and CAS, may contribute to the high rates of HIV and other sexually transmitted infections (STIs) among SMM.

To date, SMM are still disproportionately impacted by the HIV epidemic globally. In the United States, nearly 70% of new HIV diagnoses in 2020 were among SMM who reported male-to-male sexual contact (Centers for Disease Control and Prevention, 2020). Evidence in the literature has a long history documenting the association between IPV and HIV infection. In Buller's meta-analysis, experiencing IPV was significantly associated with HIV positive status (Buller et al., 2014). In a study of 7,844 SMM who attended the Gay Men's Health and Wellness Clinic for HIV and STI testing in Washington, D.C., self-reported IPV was significantly

associated with HIV (OR:1.67, 95% CI: 1.14-2.45). A recently published article also found that in a prospective cohort of SMM, experiencing IPV increased the risk of HIV seroconversion (Wang et al., 2018). Similarly, studies have shown that experiencing IPV also increases the risk of STIs other than HIV. For example, a study conducted among 817 SMM in the Chicago area showed that SMM who experienced partner abuse reported elevated odds of STIs (adjusted OR=1.40, 95%CI: 1.04-1.76), adjusting for sociodemographic and behavioral characteristics.

Another associated health outcome of IPV frequently reported among studies in SMM was mental health and psychological distress, including depression, anxiety, and suicide attempts and thoughts (Buller et al., 2014; Kazan et al., 2016). In the early review, Buller et al. only identified three published studies investigating the associations between IPV and mental health outcomes; these studies demonstrated a pooled odds ratio of 1.52, suggesting SMM who experience IPV were more likely to report screening for depressive symptoms (Buller et al., 2014). In recent years, additional studies have specifically examined the association between IPV and psychological distress as well as other negative mental health outcomes. Davis and colleagues (2022) found that SMM who experienced any form of lifetime IPV had roughly twice the odds of experiencing anxiety (Davis et al., 2020). In this same study, SMM who reported experiencing recent emotional IPV had over 7 times the odds of experiencing anxiety. In a study of 578 SMM from 15 cities in China, researchers found that IPV victimization was statistically significantly positively correlated with depression ($r=0.206$, $p<0.01$), and this association was fully mediated by higher homosexual self-stigma and lower self-efficacy (Peng et al., 2020). In the same sample, another study showed that psychological violence perpetration was associated with poor general mental health outcomes and significant depressive symptoms (Wei, Hou, et al., 2020). In this study, the authors also found that both physical and sexual victimization were

positively associated with suicidality. A study among Black/African American young SMM and transwomen found that a history of IPV was significantly associated with lifetime suicidal thoughts (Wilton et al., 2018).

IPV and HIV pre-exposure prophylaxis

Pre-exposure prophylaxis (PrEP) is a novel biomedical HIV prevention intervention for people without HIV who are at risk of being exposed to HIV through sex or injection drug use. When taken as prescribed, PrEP is highly effective for the prevention of HIV and can reduce the risk of getting HIV from sex by up to 99% (Centers for Disease Control and Prevention, 2022). Multiple clinical trials have demonstrated the efficacy and safety of PrEP in preventing HIV among at-risk populations, including SMM (Baeten et al., 2012; Choopanya et al., 2013; Grant et al., 2010; Heffron et al., 2014). In November 2010, the results of the iPrEx trial were published showing that oral emtricitabine/tenofovir disoproxil fumarate (FTC/TDF) was safe and effective for preventing the acquisition of HIV infection among SMM and transwomen (Grant et al., 2010). In 2012, the U.S. Food and Drug Administration approved FTC/TDF for use as PrEP and later in 2014, the Centers for Disease Control and Prevention also published clinical practice guidelines for PrEP use (Centers for Disease Control and Prevention & Service, 2018). The same year, the World Health Organization (WHO) also recommended PrEP for HIV prevention for SMM and issued considerations for PrEP implementations at a large scale (World Health Organization, 2015). Recent real-world studies in Australia and Scotland also demonstrated the population-level long-term efficacy of daily oral PrEP in maintaining and reducing the overall HIV incidence among adherent SMM (Estcourt et al., 2021; Grulich et al., 2021). To date, two different pills are approved for PrEP use – Truvada and Descovy, and there is growing research and evidence suggesting new methods for administering PrEP for prevention, such as event-

driven (or on-demand PrEP) and long-acting injectable (LAI) PrEP. Individuals now have the ability to choose different PrEP modalities based on their preferences and frequency of potential exposure (Beymer et al., 2019; Hall et al., 2016). Despite the high effectiveness in preventing HIV, PrEP uptake remains low among SMM in the U.S., especially among subgroups at substantial high risks, including racial and ethnic minorities and young SMM (Finlayson et al., 2019; Kanny et al., 2019). Numerous studies have found that SMM experience multilevel barriers to PrEP uptake, adherence, and persistence, including cost, concerns about side effects, medical mistrust, experienced and internalized homophobia, and stigma (Ayala et al., 2013; Edeza et al., 2021; Golub et al., 2013; Hubach et al., 2017; Pinto et al., 2018).

However, the role of IPV as a factor associated with PrEP uptake and persistence among cisgender SMM is understudied in the literature and knowledge about this association is very limited as most of the existing studies on the intersection of IPV and PrEP are among women (Braksmajer et al., 2019; O'Malley et al., 2020; Roberts et al., 2016; T. Willie et al., 2017; T. C. Willie et al., 2018). The first study investigating the intersection between IPV and PrEP was published in 2018 among a sample from a U.S. national cohort of SMM with main partners. In this study, however, instead of investigating an individual's willingness to use PrEP, John and colleagues explored the association between IPV victimization and one's willingness to try to convince their partner to initiate PrEP and their perceived importance of partner PrEP use (John et al., 2018). They found that men who experienced IPV victimization were more likely to report higher partner PrEP importance and had higher partner persuasion to use PrEP compared to those who had not experienced IPV victimization (John et al., 2018). John argued that IPV might interact in distinct ways with indicators of PrEP-related social control compared to other HIV prevention methods, and such experiences could diminish one's perception of shared control and

leave survivors with the belief that sexual health is primarily an individual-level concern (John et al., 2018). The PROUD study was a multi-center, pragmatic open label randomized control trial evaluating the benefit of PrEP as a part of an HIV risk reduction package among SMM in the United Kingdom (Miltz et al., 2019). In this study, the researchers found that SMM who were seeking/taking PrEP may experience high rates of IPV and it was likely linked to depression. But the study did not evaluate the association between IPV and any PrEP-related outcomes such as PrEP adherence (Miltz et al., 2019). Similarly, a study in Brazil assessing syndemics among participants enrolled in a PrEP demonstration study also found that IPV was among the syndemic conditions among SMM but did not evaluate the impact of IPV on their PrEP related outcomes (De Boni et al., 2018).

The first study sought to understand the relationship between IPV and PrEP utilization in the U.S. was conducted by Braksmajer et al, who analyzed data from a nationwide online sample of 863 SMM via a cross-sectional survey (Braksmajer et al., 2020). The “PrEP-AWARE” project utilized a validated IPV scale – the IPV-GBM scale (Stephenson & Finneran, 2013), to assess the effects of different types of IPV on PrEP use. The results showed a high prevalence of recent (prior 6 months) IPV among the study sample, and SMM who experienced emotional IPV, monitoring IPV, and forced sex were less likely to use PrEP than SMM who did not report these forms of IPV, while SMM who reported experiencing controlling behaviors by their partner were more likely to use PrEP. They did not find any statistically significant associations between physical IPV and PrEP use (Braksmajer et al., 2020). Another study conducted exclusively among Black SMM in several cities including Baltimore, Maryland and Jackson, Mississippi found that 40% of the Black SMM experienced some form of IPV in their lifetime and physical IPV was inversely associated with current PrEP uptake (adjusted prevalence ratio: 0.35, 95% CI:

0.13-0.90) (Wirtz et al., 2022). Similar to John's article in 2018, Kahle et al. (2020) examined perceived partner support of PrEP use among 659 SMM in the U.S. and found that although a high percentage of SMM perceived their partners to be supportive of their PrEP, those who reported their partner would NOT support them to use PrEP were more likely to report experiencing IPV (adjusted OR: 1.19, 95%CI: 1.05-1.36). A study in China also showed that sexual IPV perpetration was negatively associated with the overall willingness to use PrEP in both unadjusted and adjusted models (Guo et al., 2022). A recent study also further explored the relationships between different forms of IPV and preferences for PrEP modes of delivery. Among a sample of 694 sexually active SMM, Stephenson et al. (2022) found that SMM who reported experiencing physical IPV preferred pill-based PrEP, whereas men experiencing monitoring IPV preferred LAI PrEP. While men who experienced emotional IPV prefer not to use pill-based PrEP, experiencing sexual and controlling IPV was not sufficiently associated with any PrEP modality preferences (Stephenson et al., 2022). In Guo's study, experiencing different forms of IPV was associated with willingness to use different modes of PrEP delivery as well: that is, any forms of IPV perpetration was negatively associated with the willingness to use daily oral PrEP (AOR: 0.65, 95%CI: 0.43-0.94) while experiencing emotional, controlling, and monitoring IPV victimization were inversely associated with willingness to use LAI PrEP (Guo et al., 2022). However, to date, no study has examined the underlying mechanisms between the experiences of IPV and PrEP utilization among sexual minority men.

Technology-based intervention for health promotion and disease prevention

In the past decade, electronic health and mobile health technologies, collectively referred to as technology-based interventions (TBIs) have grown exponentially in health care and health promotion (Pagliari et al., 2005). These interventions include but are not limited to analyzing

patient's electronic health records for disease management, disseminating health information on popular social media platforms, monitoring sleep duration and blood pressure through wearable devices, and using internet-based chatrooms for remote counseling (Iribarren et al., 2021). These TBIs have several key features that provide them with advantages over traditional health promotion interventions, including the ability to reach a broader range of communities and individuals across diverse contexts in a short timeframe, provide consistent services over long physical distances, and potential cost-effectiveness if it was well-designed. Such approaches have been widely used in HIV prevention and care among SMM globally. More recently, researchers started to explore the potential of analyzing the data on social media and health records to predict health behaviors and outcomes among vulnerable populations for just-in-time feedback and services, such as using data science and machine learning approaches. This next section will first provide an overview of the literature related to TBIs for HIV prevention and care among SMM, followed by a presentation of applying TBIs for IPV prevention and the rationale for utilizing a machine learning approach to predict IPV risks in light of existing literature.

TBIs for HIV prevention and care among SMM

Novel technology developments create an existing opportunity for health promotion along the HIV care continuum (Simoni et al., 2015). These strategies provide opportunities to reach and engage key populations such as SMM across the HIV testing, treatment, care and medication adherence cascade (Muessig et al., 2015). An early review of recent smartphone, internet, and Web 2.0 interventions to promote HIV care and prevention interventions found that there was an overall trend of using new tools including social networking sites, provision of real-time assessment and feedback, gamification and virtual reality functions to provide consistent

delivery of interventions and to be potentially low cost once developed and tested (Muessig et al., 2015). A more recent review of electronic and other new media technology interventions for HIV care and prevention provided an overview and collection of TBIs in the published literature as well as unpublished interventions that were still in development from 2014 to 2018 (Maloney et al., 2020). In this review, Maloney and colleagues found a robust collection of TBIs that targeted various points of the HIV care and prevention continua, especially for young SMM. For example, the myDEx project was a study of online delivered HIV/STI prevention intervention for young SMM to develop skills in dating and relationship building while reducing their risks for HIV/STI through personalized content (Bauermeister et al., 2017). Similarly, MyPEEPS tested the efficacy of a mobile-delivered HIV prevention intervention among a national longitudinal cohort of 13-18 years old SMM (Kuhns et al., 2020). The mobile intervention consists of 21 online psychoeducational and skill-building modules, which young SMM completed over a 3-months period and their results suggested that the intervention reduced short-term sexual risk behaviors significantly (Schnall et al., 2022). Many more examples can be found in Maloney's review, suggesting the increase and popularity of using TBIs and the online platform to deliver HIV prevention interventions among SMM. Indeed, these technology- or internet-based interventions and services could provide accurate and updated information on where one can get tested for HIV, schedule remote doctor and nurse appointments, order laboratory tests, and offer educational materials in attractive visual and video formats to promote behavior changes. Another strength of these interventions is that they can be changed and updated rapidly (Maloney et al., 2020).

However, this review also identified critical gaps in the literature; that is, published literature has a strong emphasis on education and behavior change over linkage to HIV care,

retention in care, and adherence. However, they did not find any intervention to support PrEP adherence and persistence among SMM or any PrEP users. Despite the several studies published on promoting PrEP uptake and adherence after the review was conducted such as the UPrEPU, PrEPSteps, and AMPrEP projects (Chai et al., 2021; Strong et al., 2020; van den Elshout et al., 2021), the effectiveness of each intervention was still unknown. In addition, a majority of these interventions were not theory-based or evidence-based, and very few had integrated user experiences and perspectives into the design and development of the services. Therefore, the acceptability, appropriateness, and feasibility of these interventions in real-world settings are unknown.

TBI for IPV prevention

Technology-based health interventions and promotions are increasingly used in health programming and illness management including cardiovascular disease, diabetes, medication adherence, and HIV prevention and care (Bonoto et al., 2017; Iribarren et al., 2021; Linn et al., 2011). In the past few years, some evidence-based interventions have been adapted and utilized for IPV prevention as well (Anderson et al., 2021). Existing TBIs to reduce IPV include novel strategies and delivery methods adapted from other evidence-based interventions for online and internet service delivery, including mobile app-based features for IPV screening and risk assessments, educational information dissemination to prevent primary and secondary injuries of individuals at high risk of victimization, and using email-embedded software for victim-therapist text communications (Anderson et al., 2019). Emerging literature also suggests that compared to traditional human-delivered IPV services in health care settings, computerized self-paced IPV prevention interventions have been found more effective in identifying and addressing IPV among individuals who experience violence (Nelson et al., 2012).

For example, the SURE (Strength for U in Relation Empowerment) tested a randomized controlled trial of a computer-based brief intervention for perinatal women seeking mental health treatment (Zlotnick et al., 2019). The intervention used theory-driven approaches consistent with motivational interviewing (MI) principles, with a computerized intervention delivered on a tablet for a 6-month postpartum. The intervention aimed to promote participants' readiness to utilize IPV resources, such as using IPV hotlines, remaining in mental health counseling and services, and openly talking to health care providers and nurses about IPV experiences and resources. The results of the study showed that among the study participants, the degree of IPV decreased significantly from baseline to the 4-month follow-up in the intervention group, and there was a significant reduction in emotional abuse for SURE participants relative to participants in the control arm (Zlotnick et al., 2019).

Another study that reported promising results using technology-based intervention for reducing IPV victimization was conducted by Gilbert and colleagues in New York City (Gilbert et al., 2016). The study had 3 different arms, (1) the computerized women on the road to health (computerized WORTH), (2) traditional IPV and HIV prevention materials but not delivered by computer (traditional WORTH), and (3) a wellness promotion control group. The computerized WORTH intervention contained 4 group sessions intervention with interactive computerized games, video demonstrations, and visual tools for participants to engage independently. The intervention lasted for a year and the primary study outcomes were physical, sexual, and injurious IPV victimization in the previous 6 months among the study participants. The final results of the study showed that the computerized WORTH participants reported a significantly lower risk of physical IPV victimization, severe injurious IPV, and severe sexual victimization at 12-months follow-up compared with individuals in the control arm. In addition, the researchers

did not find a significant difference between the traditional WORTH arm and the control arm, suggesting the efficacy of the computerized intervention delivery (Gilbert et al., 2016). Similar study in the literature include using internet-delivered cognitive behavior therapy incorporating emotional regulation and conflict resolution techniques on IPV (Hesser et al., 2017), web-based safety decision aid for individuals to reduce IPV exposures (Koziol-McLain et al., 2018), and use tablet/device-based IPV assessment tools emergency rooms and clinics for IPV screening (Choo et al., 2016), all of which emphasized the importance of service delivery modalities for IPV prevention and highlighted the advantages and potential feasibility of utilizing TBIs and the internet to facilitate this process.

However, despite the potential feasibility of prevention of IPV and delivering IPV services, these web-based and technology-based interventions are not fully used in preventing IPV among other at-risk populations including SMM. In fact, a recent systematic review published in 2021 identified 31 studies of 28 unique web-based and mHealth IPV prevention interventions in the past three decades, none of these interventions was designed for SMM (Anderson et al., 2021). Given the advantage of TBIs for IPV prevention and services among women and the high acceptability of receiving internet- or mobile app-based interventions for health promotion among SMM, there is a pressing need to design, test, implement, and evaluate such TBIs to prevent violent behaviors among and provide IPV-related services among SMM who experience or at high-risk of IPV victimization.

There are several potential benefits of utilizing TBIs for IPV prevention among SMM, especially in reducing barriers to help-seeking. Liang et al. (2005) suggest that there are three non-linear stages of IPV help-seeking: problem recognition and definition, decision to seek help, and selecting support. Previous research found that many men who experienced IPV did not

realize or acknowledge the fact that the behaviors they were experiencing were violent or abusive (Freeland et al., 2018; Merrill & Wolfe, 2000; Ollen et al., 2017), which indicates the low awareness and limited understanding of this problem. TBIs can be a platform for SMM to receive educational information and knowledge through day-to-day life, given that many SMM are active users of many popular social networking mobile apps and websites. This could also potentially increase the confidence in recognizing this problem, given that many suggested another barrier to IPV help-seeking is the challenge to masculinity. Many SMM hesitate to seek help even when experiencing severe physical and sexual abuse by the partners because of the fear of disclosure to formal helpers such as their providers and mental health counselors, or don't know where to find help (Calton et al., 2016; Huntley et al., 2019). Many suggested their concerns about privacy and confidentiality (Huntley et al., 2019). Mobile apps and social media platforms have the potential to provide immediate and confidential access to health and community IPV resources and increase privacy and anonymity. IPV victims and survivors are often isolated by their partners (Capaldi et al., 2012), and have limited social support and friendships, but the increasing access to the Internet provides an avenue to search for information and report the experiences of abuse (Anderson et al., 2019). Lastly, many existing interventions for IPV prevention and services rely on a one-size-fits-all approach in community and healthcare settings, which limits the adaptability to a broader population and individuals with specific needs or who face particular barriers (Messing et al., 2015). Programs and interventions on technology- and internet-based platforms can be easily changed and adapted to meet culturally specific needs and requests based on user's preferences.

Data science and machine learning approach to predict IPV

A major gap in the literature and challenge in practice for IPV services among cisgender SMM is to identify who are experiencing IPV or at substantial risk of IPV. This is due to both the underreported rates of experiencing IPV and the methodology applied in screening for IPV. As presented previously, SMM in general were hesitant to report their experiences of IPV due to various reasons such as low awareness, fear of disclosure, and fear of being judged. Therefore, it is very likely that the actual prevalence of IPV, in both victimization and perpetration was higher than the existing reports. In fact, epidemiological reports suggested that IPV is much more likely to be underreported among men compared to women (Black et al., 2014; Carmo et al., 2011; Dicola & Spaar, 2016). Besides, most of the quantitative studies in the literature collected IPV data through self-reported survey and questionnaire, which was subject to social desirability bias and recall bias (Burge et al., 2014). In addition, measurements of IPV among SMM were found inconsistent in a recent systematic review, with studies using a variety of invalidated scales assessing IPV across different recall periods (Liu et al., 2021). Therefore, it is critical to developing new strategies to identify SMM who experience IPV through new advanced methodology and deliver prevention and care services accordingly.

In recent years, there has been a growing trend and recognition of using data science, especially machine learning and data mining approaches to understand health behaviors and predict health outcomes. For example, researchers use health care industrial data to predict and detect cardiovascular disease using various combinations of data mining techniques and mining algorithms (Learning, 2017). Another study in South Carolina applied machine learning methods to electronic health record data to identify important predictors of increased comorbidity burden among people living with HIV and found a promising high accuracy (Yang et al., 2021). Other

examples include applying artificial intelligence (AI) and machine learning in diagnosing tuberculosis (Meraj et al., 2019) and facilitating orthopedic surgery (Maffulli et al., 2020). The advantages of these approaches include flexibility and scalability compared to traditional statistical methods, and the ability to analyze diverse data types including demographic data, laboratory findings, free text messages, and imaging data (Ngiam & Khor, 2019). Numerous studies have demonstrated that machine learning methods perform better with higher accuracy and fewer input data structure restrictions than traditional logistic regressions (Crown, 2015; Doupe et al., 2019). Once the models are developed and verified, they can be easily adapted to other health outcomes predictions with high efficiency and cost-effectiveness (Ngiam & Khor, 2019).

There are several studies published using these approaches to predict health outcomes and behaviors exclusively among cisgender SMM. For example, researchers constructed prediction machine learning models to predict SMM at high risk of HIV acquisition and identified potential PrEP candidates using the electric health record in North California (Marcus et al., 2019). Another study also showed their machine learning approaches had high accuracy in predicting HIV and STIs including syphilis, gonorrhea, and chlamydia among Australia SMM, and consistently outperformed multivariable logistic regression models (Bao et al., 2021). Jing and colleagues (2021) also built and trained four machine learning models (logistic regression, support vector machine, decision tree, and random forest) to identify key influencers to engage in secondary HIV self-testing kits distribution (Jing et al., 2021). A more recent study sought to leverage social media activities and machine learning for HIV and substance use risk among SMM also found that offline HIV, amphetamine, and methamphetamine use were correctly identified using only social media data, with machine learning models obtaining F1 scores of

82.6%, 85.9%, and 85.3%, respectively, and these results were further verified through biological testing (Ovalle et al., 2021). This study was unique because the researchers utilized social media posts and activities through social networking apps and websites provided by the study participants with no additional costs. Population-based investigations and analyses, as well as in-person interventions are costly, both in time and resources (Pagoto et al., 2016). Using existing social media data for analyses and social media platforms for service delivery can not only reduce the cost, but also provide important data for just-in-time adaptive interventions (Platteau et al., 2020).

Social media activities, such as posts and discussions on Twitter, Reddit, Facebook, and dating apps, provide textual narratives at a personal level details but among a population level coverage that is larger than normal surveys (Homan et al., 2020). These activities are communication tools for individuals to express their attitudes and beliefs, seek information and options, and interact with each other to initiate offline social networks (Al-Garadi et al., 2022). Recently, researchers started to analyze these massive and subjective data to predict human behaviors and health outcomes, such as alcohol, tobacco, and other substance use, mental distress, and other disease outbreaks (Chancellor et al., 2019; Marczinski et al., 2016; Saha et al., 2022; Schmidt, 2012). However, knowledge on applying machine learning approaches or utilizing social media data and activities to predict the risk and experiences of IPV is limited in the literature. For instance, Petering et al. (2018) built several supervised machine learning algorithms to construct an IPV perpetration tool to identify individuals who were at high risk of IPV perpetration among young individuals who were homeless (Petering et al., 2018). Another study using a machine learning approach to predict IPV risks was conducted by Dehingia and colleagues (2022). In this study, the researchers use two machine learning models (L-1 and L-2

regularized logistic regression models) to identify IPV risks among women among more than 6000 variables in the nationally-representative health survey conducted in 2015–16 (Dehingia et al., 2022). The results suggested that several themes were associated with help-seeking behaviors, including the husband’s controlling behavior, the husband’s alcohol consumption history, and experience of injury from violence.

More recently, Al-Garadi and colleagues (2022) published a first-of-its-kind study using natural language processing and machine learning to identify IPV-related posts on Twitter automatically (Al-Garadi et al., 2022). The study team first downloaded tweets containing a list of IPV-related keywords using Twitter’s application programming interface, and then manually coded each tweet into IPV-reported and non-IPV reported posts by four annotators. They then investigated several different approaches and evaluated the performance of these models to identify IPV-related tweets based on the annotated results. These models include traditional machine learning algorithms (decision tree (DT), support vector machine (SVM), neural networks (NN)), and more advanced algorithms such as deep learning-based algorithms such as bi-directional long short-term memory (BiLSTM), and two transformer-based models: Bidirectional Encoder Representations from Transformers (BERT) and Robustly Optimized BERT (RoBERTa). In the results, the RoBERTa produced the best performance compared to other models, such as 95% accuracy, and F_1 scores of 0.76 and 0.97 for classifying IPV-related tweets and non IPV-related tweets, respectively. These findings suggested that the models built can accurately identify IPV related-tweets at a high accuracy level, which is almost comparable to human annotators based on their practice (Al-Garadi et al., 2022). These systems have the potential to be employed for collecting and analyzing IPV experiences and risks using publicly available social media data at a population level. This could be a particularly promising method

and system to predict IPV experiences and risks among SMM, given that SMM prefer to seek informal help and resources such as sharing the experiences with their friends, and many prefer not to mention and discuss IPV with their providers directly. Therefore, the machine learning approach and natural language processing algorithms can be potentially effective in detecting IPV experiences in social media and dating apps among SMM. Given the high prevalence of IPV and limited knowledge in this field, there is a pressing need to build, test, and verify these machine learning models and algorithms in social media platforms and social networking sites to predict IPV-related risks and deliver IPV services accordingly.

CHAPTER 3: THEORETICAL FRAMEWORK

This section outlines the theoretical and conceptual frameworks to understand the vulnerability to intimate partner violence (IPV) among young SMM and to guide various aspects of the current study, including how experiencing IPV can exacerbate HIV risk and create barriers to prevention services like pre-exposure prophylaxis (PrEP).

First, I review the conceptual model by Kubicek (2018), which highlights the intersectionality of age, sexual identity, and gender that relate to IPV among young SMM and how these factors combine to impact victimization and perpetration of IPV among young SMM. The Minority Stress Theory, which places particular importance on the roles of both internal and external minority stressors on individual health behaviors and outcomes, provides a theoretically grounded rationale for the identification of multilevel risk factors of IPV among SMM. The Syndemic theory, which suggests considering multiple interrelated systems that contribute to heightened vulnerability when examining health disparities, will be used to understand the multilevel vulnerabilities, both socio-behavioral and psychological factors that contribute to high levels of IPV and the way it impacts risk for HIV infection among SMM. The following chapter provides a brief overview of each theory and an explanation of how each theory will be applied to research questions and the specific hypothesis.

Understanding intimate partner violence among young SMM requires consideration of intersectionality of age, sexual identity, and gender and how these unique factors work together create a unique spectrum of vulnerabilities. In a previous review article, Kubicek synthesized the literature on research investigating IPV among young SMM and proposed a conceptual model to highlighted the factors that could contribute to the elevated risk of IPV among young SMM (Kubicek, 2018). Kubicek applied an intersectional approach, considering the convergence of

various forms of oppression, and argued that the experiences of being a young non-heterosexual man must be understood holistically rather than individually. In this model, Kubicek argued that people oftentimes experience various types of privilege and subordination based on their class, race, gender and sexuality, and young SMM reside within three major domains, including (1) being in the developmental period of emerging adulthood, during which some of the highest risk and violent behaviors occur, (2) identifying as a sexual minority and often experiencing social discrimination and health disparities related to mental health, substance use, and HIV and other STIs, and (3) gender identity, which may involve conforming to or rejecting traditional notions of masculinity and facing unique pressures and stigmas related to both their gender expression and sexual orientation (Kubicek, 2018).

Kubicek's model proposes that the intersection of age, sexual orientation, and gender, along with factors like discrimination, homophobia, relationship status, and legal frameworks around marriage, as well as societal attitudes towards violence among men, collectively shape the dating and sexual norms within relationships among young men who have sex with men (YMSM). (Kubicek, 2018). Their model highlights several factors that cannot be overlooked for HIV prevention among young SMM. First, socio-cultural inequality and discrimination (such as inequalities in gay rights) continues to shape young SMM's relationships and SMM may have been conditioned to defend themselves because of these social views (Díaz et al., 2004; Diaz & Ayala, 2001). The lack of positive role models for healthy and fulfilling intimate relationships among young SMM often leads them to emulate relationship dynamics observed in their parents, friends, and other adults, which may not always be the "healthiest images" (Kubicek, 2018). In addition, the socially constructed ideals of manhood, coupled with the social learning process of attaining such ideals and conforming to gender roles, influences how young SMM choose to

adopt assertive and sometimes aggressive behaviors in pursuit of power and status. Finally, consistent with previous reviews of the literature (Buller et al., 2014; Finneran & Stephenson, 2013), Kubicek also underscore the associations between experiencing IPV and adverse health and mental health outcomes among young SMM (Kubicek, 2018), and highlighted the opportunity for integrated IPV interventions that address other health disparities such as HIV and substance use.

Next, the Minority Stress Theory is a theoretical framework that examines the effect of individual, social, and contextual factors on health outcomes among the minority populations (Meyer, 2003). Meyer proposed this framework in a study describing stress as derived from minority status and exploring its impact on mental health among a community sample of gay men in New York City (Meyer, 1995). In this study, Meyer conceptualized minority stressors among gay men as internalized homophobia, stigma, and experiences of discrimination and violence based on their sexual orientation:

“Minority stressors were conceptualized as: internalized homophobia, which related to gay men’s direction of societal negative attitudes toward the self; stigma, which related to expectations of rejection and discrimination; and actual experiences of discrimination and violence.” (Meyer, 1995).

In this model, minority status and identity, for example, sexual and gender minority status experienced by sexual and gender minority individuals create a context for distal and proximal experiences of these minority stresses. In this regard, these minority stressors, in combination with the general stressors, could lead to adverse health outcomes such as psychological distress (Lytle et al., 2014; Meyer, 2003). This process, however, can be influenced by the degree to which minoritized individuals process individual and community resources and support, such as

self-coping skills and LGBTQ community connectedness, where these individual strengths and interpersonal supports could neutralize the negative effects of the minority stressors and create positive self-esteem and resilience.

Numerous studies have used the Minority Stress Theory to explain the high levels of psychological distress and high prevalence of mental illnesses such as depression and anxiety symptoms among SMM across the globe (English et al., 2018; Fingerhut et al., 2010; Fulginiti et al., 2021; Pachankis, 2014; Ramirez & Paz Galupo, 2019; Schwartz et al., 2016, 2016; Zheng et al., 2020). A recent systematic review of studies summarizing the evidence in the literature found that higher levels of minority stressors were associated with lower self-acceptance, and these minority statuses were associated with poorer mental health outcomes (Camp et al., 2020). A meta-analysis also illustrated the strong correlation between minority stressors and adverse mental health and well-being among LGBT youth (Dürrbaum & Sattler, 2020). In addition, robust evidence in the literature also suggested that higher levels of minority stressors were associated with poorer biological health outcomes. For example, a systematic review of literature on the relationship between minority stressors and physical health outcomes found that there was evidence that experiences of minority stress were associated with a variety of physical health outcomes including HIV-related laboratory outcomes, treatment side effects, and AIDS-related mortality, changes in cardiovascular function, cortisol, and cancer incidence and treatment side effects (Flentje et al., 2020).

In the past few years, studies have used the Minority Stress Theory to explain minority stressors, such as perceived and experienced stigma and homophobia, and their associations with experiencing IPV or the increased risk of IPV among SMM. For example, in a study among 1,575 gay, bisexual, and other sexual minority men in the U.S., Finneran and Stephenson (2014)

conceptualized minority stressors as homophobic discrimination and internalized homophobia and found that SMM who reported experiencing more internalized homophobia and more homophobic-based discrimination were more likely to report having experienced IPV (Finneran & Stephenson, 2014b). In another study led by the two, they also found significant associations between IPV perpetration and minority stressors among 750 SMM living in Atlanta, with most types of IPV perpetration were linked to higher levels of internalized homophobia (Stephenson & Finneran, 2017a). This analysis also revealed the positive associations between experienced racism and IPV victimization & perpetration among their study participants. In addition, other general minority stressors including low educational attainment and being HIV positive also contributed to higher rates of reported IPV (Stephenson & Finneran, 2017a).

In order to understand the risk of intimate partner violence and its impact on health behaviors and health outcomes among SMM, a holistic perspective is needed, especially when multiple vulnerabilities and conditions co-exist simultaneously. Therefore, the Syndemic Theory was employed in the present study. The Syndemic Theory suggests that co-occurring psychological, social, and structural health conditions such as substance use, mental health problems, poverty, history of incarceration, and other vulnerabilities are mutually reinforcing and could further exacerbate the risk of adverse health behaviors and outcomes, such as HIV/AIDS (Singer et al., 2017). The term *Syndemic*, merged by the two words, *synergy* and *epidemic*, was first proposed by an American medical anthropologist, Merrill Singer in the 1990s (Singer, 1994). It was first described by Singer to explain how the HIV epidemic influenced the inter-city residents of Harford, Connecticut, in the U.S.:

“Syndemics are defined as the aggregation of two or more diseases or other health conditions in a population in which there is some level of deleterious biological or behavioral

interface that exacerbates the negative health effects of any or all of the diseases involved”

(Singer, 2009; Singer et al., 2017).

Singer suggested that the local (Harford, Connecticut) HIV epidemic could not be understood in isolation. Instead, it had to be examined in a holistic view with the local epidemics of substance use and violence (Singer, 1994). He proposed the “SAVA” syndemic (substance abuse, violence, HIV/AIDS) to explain how these health behaviors and outcomes were mutually intertwined and mutually reinforcing of one another. This is, to some extent, similar to Meyer’s Minority Stress Theory that when individuals belong to multiple minority groups (e.g., sexual and gender minority, racial and ethnic minority, being HIV positive, etc.), the negative consequences of belonging to these groups from external stressors are additive. Collectively with general stressors such as poverty, and low educational attainment, these co-existing stressors may lead to adverse health outcomes (Meyer, 2003).

In the past decade, the syndemic framework has been widely used by researchers in various disciplines such as medicine, psychology, sociology to understand health disparities (Choi et al., 2020; Mendenhall et al., 2022; Peters et al., 2020, 2020; Slagboom et al., 2021). In clinical medicine, researchers have used the Syndemic theory to examine how populations with multiple social and structural vulnerabilities in the U.S. are more likely to be impacted by the COVID-19 pandemic (BCompH, 2021; Gravlee, 2020; Islam et al., 2021; Poteat et al., 2020); When examining mental health disparities, the Syndemic Theory has been used to explain the disproportionately high rates of depression, anxiety, stress, and suicidality among communities and individuals with social and economic vulnerabilities (Mezzina et al., 2022; Shim & Starks, 2021; Weaver & Kaiser, 2020).

Similarly, the evidence of these syndemics and their impact on HIV-related outcomes among sexual minority men in the U.S. have also been well established in the literature (Godley & Adimora, 2020; Holloway et al., 2021; Parsons et al., 2012, 2015, 2017; Walters et al., 2020). In a review using the syndemic framework in HIV research among African Americans, Godley and Adimora (2020) found valuable insights into links between HIV-related outcomes, mental health, experiences of violence, and substance use, and found that the syndemic framework not only explains synergistic individual-level risk factors for these outcomes, but it also examines the interactions with economic, political, and social systems that influence those factors and thereby shape the HIV epidemic among African Americans (Godley & Adimora, 2020). In a national sample of SMM, Parsons et al. (2017) found that over 60% of men reported at least one syndemic condition including depression, childhood sexual abuse, polydrug use, sexual compulsivity, and the number of syndemics were significantly higher among nonurban SMM, and increased number of syndemic conditions were associated with increased HIV transmission risk behaviors (Parsons et al., 2017). Holloway and colleagues (2021) found that Black SMM living with HIV experience multiple structural syndemics including poverty, criminal justice involvement, depression, and alcohol misuse, and each point increase in structural syndemic indicators was associated with 1.63 times greater likelihood of having missed a dose of antiretroviral therapy medications (Holloway et al., 2021). Taken together, these studies confirm that syndemic conditions interact synergistically and sometimes occur in clusters and the co-existence of these conditions contributes to an excess burden of disease or negative health outcomes in a population.

The existing literature demonstrates the utility of the Syndemic Theory in understanding the risk of IPV and its interactions with HIV/AIDS, substance use, and mental health problems

among cisgender female and heterosexual women (Cordoba et al., 2021, 2021; González-Guarda et al., 2011; Illangasekare et al., 2013; Jiwatram-Negrón et al., 2018; Laurenzi et al., 2020; Sharps et al., 2021; Sileo et al., 2022; Stoicescu et al., 2019); however, the Syndemic Theory has rarely been applied to understand the experiences of IPV and its impact on health outcomes, and particularly on how these interactions place great barriers to IPV help seeking among SMM.

In conclusion, these two theoretical frameworks, the Minority Stress Theory and the Syndemic Theory were employed in the present study to help explain the experiences of IPV among SMM and how syndemic conditions may place great barriers to HIV prevention service utilization. While the present study did not test either of the theory, this research is meant to inform future IPV prevention and service intervention efforts with SMM. Social Work researchers and practitioners seeking to understand the experiences of IPV must consider the unique barriers one might come across when SMM seek help, and design, test, implement and evaluate novel IPV prevention interventions and services that could reduce and avoid the structural barriers.

CHAPTER 4: RESEARCH METHODS

Study design and recruitment

Data for the present study were derived from the Phase 2 of the study entitled “uTECH: Machine Learning for HIV Prevention Among Substance Using GBMSM” (hereafter: uTECH, Principal Investigator: Holloway). The uTECH study is a National Institute on Drug Abuse (NIDA) funded study of utilizing a novel Machine Learning approach to promote HIV prevention and harm reduction service utilization among substance using young sexual and gender minorities who have sex with men and use substances in the U.S. (Holloway et al., 2024). The intervention aims to reduce HIV transmission by improving access to biomedical and behavioral risk reduction strategies, including pre-exposure prophylaxis (PrEP) for HIV prevention and medication assisted treatment (MAT) for substance use harm reduction, using smartphone technology. Eligibility criteria for the Phase 2 study included (1) being age 18 – 29 by study enrollment, (2) having used substances (such as marijuana, poppers, methamphetamines, heroin, cocaine ecstasy, etc.), (3) having had sex while using substances in the past 3 months, (4) being HIV negative or of unknown HIV status, (5) using a social networking site or app for substance use and sexual partner seeking in the past 3 months, (6) living in the U.S., and (7) being able to provide informed consent. For the current study, only individuals who reported as cisgender gay or bisexual men were included.

The uTECH study Phase 2 utilized both online and offline community outreach recruitment strategies to enroll participants between 10/2021 and 05/2023. Advertisements were posted on a list of social networking websites and dating/hook-up apps including Facebook, Instagram, Grindr, etc. Research staff also distributed flyers with study information at community events and organizations. Potential participants were instructed to scan the QR code

or click the link on the website to access the study screening page with a brief study introduction and screening questions. The screener collected data related to the study eligibility criteria; screening data were only accessible to study staff. Eligible participants were directed to a web page to establish informed consent with information about study design, enrollment, procedures, and compensation. Study staff reached out to eligible participants to schedule enrollment and onboarding appointments. Participants completed a baseline survey with a trained interventionist during the onboarding appointment. Eligible participants in the uTECH Phase 2 study received up to \$350 in web-based cash payment (i.e., PayPal Holdings Inc, Venmo LLC, and Cash App by Square Inc) or e-gift cards. All information and identification were removed, and only study-related information is stored in Qualtrics. A complete description of the uTECH study protocol was presented elsewhere (Holloway et al., 2024).

Data Collection and Procedure

All study data were collected through Qualtrics-based surveys and social media activities and data mining including keystrokes and geolocation information. The following section outlined different types of data that were collected for the present study and the procedures for working with these data to address research hypotheses. During onboarding, study participants were instructed to complete a comprehensive baseline survey with an interventionist. A trained research staff member reviewed the survey with the participants, which takes approximately 30 minutes to complete. The survey asked about participant's sociodemographic information including age, education level, income level, relationship status, etc., health behaviors including sexual behaviors and substance use histories, and sexual health service utilization such as histories of HIV testing, STI testing and diagnoses, PrEP and PEP uptake and adherence, and experiences of IPV and PrEP stigma using previously validated scales. The survey instruments

were in English, and some interventionists, who were bilingual and can speak fluent Spanish if the participants preferred to communicate in Spanish.

A variety of social media activities and data were collected through social networking platforms and dating/hook-up apps among the participants. Specifically, participants using Android system smartphones were asked to download and install an app called “eWellness” on their phone, which remains active and collect data for 12 months during the study period. The “eWellness” app was created and utilized in previous studies (Ovalle et al., 2021). The app collects information including keystrokes (letters and numbers typed into the phone’s keyboard), the name of the app used when typing in an app, the name of the website when the user is typing, and the geolocation (i.e., GPS) when these activities are recorded. Videos, voice, accelerometer, contacts, screen time tracking, and other personal private information were not collected. After installing the eWellness app, participants were instructed to keep it running in the background to continuously collect their keyboard and location data for the duration of the study. Along with capturing keyboard data when participants typed, the app also recorded which application they were using or, if they were browsing, which website they were on. The app sent these collected data to a secure server every half an hour when internet connection was enabled.

Measures

Intimate partner violence. Experiences of IPV among the study participants were measured using the IPV-GBM scale. The IPV-GBM scale was developed and adapted by Stephenson from the Conflict Tactics scale to measure IPV victimization and perpetration more accurately among GBMSM (Stephenson & Finneran, 2013). The IPV-GBM assessed five unique domains of IPV: (1) physical and sexual IPV (e.g., “[partner] punched, hit, or slapped you?,” “[partner] raped you?”), (2) emotional IPV (e.g., “[partner] told you to ‘act straight’ around

certain people?,” “[partner] called you fat or ugly?”), (3) controlling IPV (e.g., “[partner] prevented you from seeing your family?,” “[partner] prevented you from seeing your friends?”), (4) monitoring IPV (e.g., “[partner] demanded access to your email?,” “[partner] read your text messages without your knowledge?”), and (5) HIV-related IPV (e.g., “[partner] lied to you about his HIV status,” “[partner]intentionally transmit HIV to you?”). The scale was asked in two parts: whether the participants have experienced any of these acts from a male partner in the past 12 months and the frequency (victimization), and whether participants have enacted any of these acts toward a male partner in the past 12 months and frequency (perpetration). The scale has been used widely to measure IPV prevalence among SMM in recent years and studies have showed high internal consistency (Liu et al., 2021; Peng et al., 2020; Stephenson et al., 2021; Walsh et al., 2021; Wei, Cao, et al., 2020; Wei et al., 2021).

PrEP uptake and adherence. Participants were asked about their history of engagement along the PrEP care continuum. First, participants were asked if they had heard of PrEP with the following question: “*Have you ever heard of PrEP (pre-exposure prophylaxis)? This is an HIV prevention method in which people who don’t have HIV take HIV medicine daily to reduce their risk of getting HIV if they are exposed to the virus. Drug names for PrEP include Descovy and Truvada*” (Yes/No/Refuse to answer). Participants were asked, “*Have you ever in your lifetime taken PrEP?*”. Among those who said they had ever taken PrEP in their lifetime, the following question was presented, “*Have you taken any HIV prevention medication in the last 6 months*” (Yes/No/Don’t know/Refuse to answer, coded as Yes=1; the others=0). Next, participants were asked if they are currently using a prescription for PrEP (Yes/No/Don’t know/Refuse to answer, coded as Yes=1; the others=0). To assess PrEP adherence, we asked the participants, “*In the last 7 days, rate your ability to take ALL of your PrEP medications*”. Response options include very

poor, poor, fair, good, very good, excellent, and refuse to answer. This variable was dichotomized into (excellent=1; the others=0)

PrEP stigma. We used the HIV PrEP Stigma Scale (HPSS) to assess the perceived stigma regarding HIV PrEP among the participants. The 12-item Likert scale was developed by Siegler et al. (Siegler et al., 2020) and assessed three predominant domains: (1) shame regarding PrEP use (e.g., “*I would feel ashamed to take PrEP pills in front of others*”), (2) character judgments of people using PrEP (e.g., “*People experience negative judgment because they take PrEP*”), (3) perceived social support for taking PrEP (e.g., “*My friends would be supportive of me taking PrEP*”). Items with an opposite direction were reverse scored, and a total score was calculated, where higher values correspond to higher levels of stigma.

Alcohol, tobacco, and other drug use. A wide array of ATOD use data were asked in the uTECH study Phase 2. First, participants were asked about their alcohol consumption history and frequency in the past 6 months using the Alcohol Use Disorders Identification Test (AUDIT-C) (Bush et al., 1998). A total score of the AUDIT-C was calculated and alcohol use disorder was classified as suggested in previous studies (Bush et al., 1998). Participants were asked about their nicotine use and other drug use in the last six months (Yes/No/Refuse to answer). These outcomes were coded as dummy variables (yes=1; the others=0). A complete list of ATOD use variables included in the current study was presented in the Results section.

Sociodemographic and behavioral characteristics. Participants were asked to report their age by the time of the study enrollment, the highest level of education, sexual orientation (gay or bisexual). Participants were also asked to report their racial background and ethnicity. The survey also asked the participants to report the number of sexual partners in the past six months

(coded to >10 or ≤10) and if they had engaged in condomless anal sex with a male sexual partner (yes/no) and if they had attended a sex party (yes/no).

Data analysis

A series of quantitative analyses were conducted to examine the robustness and associations of the study measures among the study sample. First, descriptive statistics were calculated to present the characteristics of the study participants, the prevalence of IPV victimization, perpetration, and bi-directional violence, the rate of PrEP uptake and excellent PrEP adherence, the levels of PrEP stigma, as well as other health behaviors and outcomes such as the prevalence of ATOD. To explore the associations between IPV victimization and PrEP uptake/adherence, bivariable and multivariable logistic regressions were conducted presenting the odds ratios (ORs) and adjusted ORs (AORs), adjusting for study covariates that were associated with both IPV and PrEP outcomes that were suggested in the literature. Next, two separate mediating analyses were conducted to explore the possible mechanisms through which IPV victimization might indirectly exert its effect on PrEP uptake. The first model tested the mediation of the relationship between IPV victimization and current PrEP uptake/adherence through ATODS use, and second model tested the mediating role of PrEP stigma underlying the relationship between IPV and PrEP uptake/adherence. All analyses were conducted using STATA and RStudio, providing estimates of path coefficients (β) and bootstrapped 95% confidence intervals (95% CI) for indirect effects. Potential confounding variables which were significantly associated with PrEP uptake in the logistic model were adjusted.

To build and test the machine learning models to predict IPV victimization among young SMM in this study, each participant was code as one of the two categories based on the self-reported IPV victimization according to the IPV-GBM scale: IPV-reported (1) and non-IPV-

reported (0). Each unique study identifier (study ID) was associated with a dataset that contains this participant's social media activities and mobile phone use data. Data were cleaned to maximize consistency and accuracy by removing unwanted words, such as non-English characters and additional symbols. Personally identifiable information such as addresses, phone numbers, and usernames will be tokenized (Ovalle et al., 2021). Next step included data preprocessing such as preprocess keyboard data, application use data, and geo-location data. After preprocessing the datasets, various features from each of the data sources were extracted to be utilized in the machine learning algorithms including text data collected from social media, data apps, and messaging apps and websites, words and phrases associated with IPV experiences and their levels related to IPV experiences (e.g., highly related, moderately related), location data containing participant's mobility. Other feature extractions also include the Bidirectional Encoder Representations from Transformers (BERT) language model (Devlin et al., 2018), and Linguistic Inquiry and Word Count (LIWC) (Pennebaker et al., 2001), and OpenAI embeddings on the text and risky messages text. Table 1 presents a list of features extracted to apply the machine learning techniques and rationales.

All these features were combined, and feature selection was performed using the Fisher score method before model training. Based on these feature extractions, we trained logistic regression model (Cox, 1958), a Gradient Boosting Classifier (J. H. Friedman, 2001), and a Support Vector Classifier with a linear kernel (Ghosh et al., 2019) using Scikit-learn (Pedregosa et al., 2011). These models were selected to represent both linear and more complex non-linear models. To identify which data types would be the most useful for the prediction tasks, we trained separate models for individual data categories like location data, app usage, and risky word use and assessed combinations of these features, aiming to provide a comprehensive view

of participants' activities. We used leave-one-out cross-validation to evaluate the models, given the relatively small number of participants. The primary metric for assessing the model's prediction accuracy and classifier's performance was the F_1 -score for the IPV-report (1). As suggested in previous studies, an F_1 score of 0.7 or higher suggests acceptable/good model performance and prediction accuracy (Ovalle et al., 2021). The machine learning model building and training, and feature extraction and model performances conducted by a graduate student under the supervision of the uTECH co-investigator (Co-I: Sarrafzadeh) in the Department of Computer Science at UCLA.

Table 1. List of data and features extracted in machine learning techniques and rationales

1. Social networking apps data
2. All mobile phone apps
3. Geo-location data
4. Risky words
- A list of keywords and phrases that were related to experiences of violence, abuse, and aggressions that were adapted from previous studies (Al-Garadi et al., 2022), such as “ <i>attack, beat, bruises, kick, grab</i> ”, etc.
5. Risky word categories
- All the keywords and phrases were categorized into high, moderate, and low risks
6. Bidirectional Encoder Representations from Transformers (BERT)
7. Linguistic Inquiry and Word Count (LIWC)
8. OpenAI Embeddings
- When a text message was provided to OpenAI API, it converts the text into a vector embedding that captures the underlying notion or meaning behind the text. This feature was applied to all text messages.
9. OpenAI on risk messages and words
- Similar to the feature above, but was only applied to risk messages and words identified

Ethical consideration

The current study utilized data from the UTECH study (PI: Holloway; NIH DP2 1DP2DA049296-01) and all study procedures and protocols were reviewed and approved by the South Campus Institutional Review Board at the University of California Los Angeles (UCLA; IRB#21-001157).

CHAPTER 5: RESULTS

Characteristics of Study Participants

The average age of the 277 young SMM included in the current study was 24.8 years (standard deviation: 3.1), over half (58.1%) were 24 years old or younger. Over sixty (60.3%) reported having a college or higher degree. The sample was racially and ethnically diverse: 59.9% of the study participants were identified as white, and 6.1% and 13.3% were identified as Black/African American and Asian, respectively. Over a quarter (28.4%) were identified as Latino/Hispanic. Most of young SMM identified as gay (86.6%) and 13.4% were identified as bisexual. A vast majority of the study participants (84.8%) had engaged in condomless anal sex in the past six months: 65.3% reported having insertive condomless anal sex (e.g., put their penis in their partner's butt without a condom) and 71.5% reported having receptive condomless anal sex (e.g., put their partner's penis in their butt without a condom). One fifth of the study participants (20.4%) reported having more than 10 male sexual partners in the last six months.

The prevalence of alcohol, tobacco, and other drug (ATOD) use was also showed in Table 2. Based on the Alcohol Use Disorders identification Test (AUDIT-C), 65.7% of the study participants were screened positive for alcohol use disorders. Nearly half (44.4%) of the young SMM reported having nicotine and tobacco products such as cigarettes and e-cigarettes in the last six months. A large percentage of the participants (72.9%) used marijuana and 9.4% reported having used methamphetamine.

Lastly, nearly all study participants had heard of HIV pre-exposure prophylaxis (PrEP) and 69.7% reported having a history of using PrEP for HIV prevention. Over half (56.7%) were currently using PrEP and among those, 45.2% reported excellent PrEP adherence in the last seven days.

Table 2. characteristics of young sexual minority men (n=277)

	N (%)
Age (range 18-30)	24.8 (3.1)
Race	
White	166 (59.9%)
Black/African American	17 (6.1%)
Asian	36 (13.3%)
Mixed race	22 (7.9%)
Other	36 (13.0%)
Ethnicity	
Latino/Hispanic	81 (28.4%)
Non-Latino/Hispanic	196 (71.6%)
Education	
College and above	167 (60.3%)
Below college	110 (39.7%)
Sexual orientation	
Gay	240 (86.6%)
Bisexual	37 (13.4%)
Had condomless anal sex	235 (84.8%)
Had condomless insertive anal sex	181 (65.3%)
Had condomless receptive anal sex	198 (71.5%)
Having more than 10 sexual partners	84 (20.4%)
ATOD use	

Nicotine	123 (44.4%)
Alcohol use disorder	182 (65.7%)
Marijuana	202 (72.9%)
Methamphetamine	26 (9.4%)
Ever used PrEP in lifetime	193 (69.7%)
Used PrEP in the past 6 months	171 (61.7%)
Current PrEP uptake	157 (56.7%)
Excellent PrEP adherence	71 (45.2%) *

**among those who were using PrEP currently*

Prevalence of IPV Victimization, Perpetration, and Bi-directional Violence

The prevalence of IPV victimization, perpetration, and bi-directional violence among cisgender young sexual and gender minorities who have sex with men and use substances in this study was presented in Table 3. Lifetime prevalence of IPV victimization, perpetration, and bi-directional was alarmingly high: 69.7% of the study participants reported experiencing IPV victimization in their lifetime; nearly half (47.7%) reported having perpetrated IPV in their lifetime, and 44.4% had experienced lifetime bi-directional violence (both victimization and perpetration). The most common types of IPV victimization was emotional and physical/sexual IPV, of which 52.3% and 45.5% reported having experienced these types of IPV, followed by monitoring (32.5%) and controlling (23.1%) victimization. In addition, 20.6% of the participants experienced HIV-related victimization. In the meantime, the most common reported form of IPV perpetration was emotional IPV (26.0%), followed by physical/sexual and monitoring IPV perpetration (24.5% and 23.1%, respectively).

Similarly, the rates of IPV victimization, perpetration, and bi-directional violence in the last year were also high: over half (65.0%) reported experiencing IPV victimization, while 43.3% reported perpetrating IPV, and 39.4% experienced bi-directional IPV. In terms of specific types of IPV victimization, physical/sexual victimization was the most prevalent, reported by one in three individuals (45.5%), followed by emotional IPV victimization (39.4%) and monitoring victimization (23.5%). In the meantime, 16.2% and 24.5% reported perpetrating monitoring and physical/sexual IPV to their partners in the past year. Lastly, 22.7% reported bi-directional physical/sexual IPV in the past year and 11.9% reported bi-directional emotional IPV.

Given the high prevalence of lifetime IPV victimization, perpetration, and bi-directional violence among the study participants, we also examined the frequency of different forms of IPV

victimization, perpetration, and bi-directional violence. Specifically, we classified those who reported experiencing IPV twice or more as frequent IPV. As shown in Table 2, nearly forty percent (39.0%) had experienced frequent IPV victimization in the past year, with emotional IPV victimization (30.0%) being the most prevalent type, followed by frequent physical/sexual IPV (10.5%) and monitoring IPV (12.3%) victimization. Meanwhile, over a quarter (26.7%) had perpetrated IPV frequently, with emotional IPV (15.5%) perpetration being the most prevalent type, followed by monitoring behaviors (10.5%). Lastly, 18.8% reported frequent bi-directional violence, with physical/sexual IPV (7.6%) and emotional IPV (7.6%) among the most reported types of bi-directional violence.

Among the study participants, lower educational attainment (having a highest degree below college vs. having a college degree or higher) was associated with higher odds of experiencing IPV victimization, especially for monitoring violence in the past year and frequent monitoring IPV ($p < 0.01$ for both). Individuals who reported being bisexual were more likely to report experiencing frequent monitoring, controlling, and emotional IPV in the past year ($p < 0.05$ for all) compared to gay. Differences in experiencing IPV victimization were also observed across racial and ethnic groups: for example, individuals identified as mixed race reported constantly high rates of various forms of IPV victimization compared to other racial groups; Black and African American were more likely to report experiencing physical/sexual IPV compared to those who were white, while those who were white were more likely to report experiencing emotional IPV ($p < 0.05$ for all). Lastly, young SMM who identified as Latino/Hispanic also reported higher odds of experiencing monitoring IPV in the past year and frequent physical IPV in the past year compared to non-Latino/Hispanic individuals ($p < 0.01$ for both).

Table 3. prevalence of intimate partner violence among young sexual minority men:
victimization, perpetration, and bidirectional violence (n=277)

	Victimization	Perpetration	Bi-directional
Lifetime			
Any type of IPV	193 (69.7%)	132 (47.7%)	123 (44.4%)
Physical/sexual	126 (45.5%)	68 (24.5%)	63 (22.7%)
Monitoring ever	90 (32.5%)	64 (23.1%)	46 (16.6%)
Controlling ever	64 (23.1%)	35 (12.6%)	22 (7.9%)
Emotional ever	145 (52.3%)	72 (26.0%)	55 (19.9%)
HIV-related ever	57 (20.6%)	-	-
Last year	Victimization	Perpetration	Bi-directional
Any type of IPV	180 (65.0%)	120 (43.3%)	109 (39.4%)
Physical/sexual last year	126 (45.5%)	68 (24.5%)	63 (22.7%)
Monitoring last year	65 (23.5%)	45 (16.2%)	29 (10.5%)
Controlling last year	64 (23.1%)	35 (12.6%)	22 (7.9%)
Emotional last year	109 (39.4%)	52 (18.8%)	33 (11.9%)
HIV-related last year	32 (11.5%)	-	-
		-	-
Last year frequent (2 times or more)	Victimization	Perpetration	Bi-directional
Any type of IPV	108 (39.0%)	74 (26.7%)	52 (18.8%)
Physical/sexual last year	29 (10.5%)	24 (8.7%)	21 (7.6%)
Monitoring last year	34 (12.3%)	29 (10.5%)	16 (5.8%)

Controlling last year	23 (8.3%)	22 (7.9%)	9 (3.2%)
Emotional last year	83 (30.0%)	43 (15.5%)	21 (7.6%)
HIV-related last year	11 (4.0%)	-	-

The Associations Between IPV Victimization and PrEP Utilization

To examine the relationship between IPV victimization and PrEP utilization, we first conducted a series of bivariable logistic regressions to assess the associations between each type of IPV victimization and current PrEP use across different time points. As shown in Table 4, experiencing controlling behaviors in their lifetime was negatively associated with current PrEP use (odds ratio (OR)=0.75, 95% confidence interval (CI): 0.42-0.91), meaning that individuals who have experienced lifetime controlling IPV were 0.75 times as likely to currently use PrEP for HIV prevention. Similarly, those who experienced controlling IPV in the last year were less likely to currently use PrEP (OR=0.57, 95% CI: 0.38, 0.92). When examining frequent IPV experiences, cisgender young SMM who experienced frequent physical/sexual IPV in the last year were also less likely to currently use PrEP (OR=0.43, 95% CI: 0.19-0.92). After adjusting for sociodemographic characteristics and ATOD use in the multivariable model, those who experienced frequent physical/sexual IPV in the last year were still significantly less likely to currently use PrEP (adjust OR (AOR)=0.41, 95%CI: 0.18-0.93). However, the association between experiencing controlling IPV in the last year and current PrEP use was no longer statistically significant (AOR=0.61, 95%CI: 0.45-1.04).

Next, similar approaches were used to measure the relationships between IPV victimization and PrEP adherence (Table 5). First, experiencing emotional IPV in lifetime was associated with suboptimal PrEP adherence: that is, those who reported experiencing lifetime emotional IPV was 54% less likely to have excellent PrEP adherence (OR=0.46, 95%CI: 0.22, 0.94). When it comes to experiencing IPV victimization in the last year, cisgender young SMM who experienced monitoring IPV victimization were significantly less likely to have excellent PrEP adherence (OR=0.44, 95%CI: 0.20,0.98). Similarly, those who reported experiencing

frequent monitoring and controlling IPV in the past year were less likely to have excellent PrEP adherence (OR=0.31, 95%CI: 0.11-0.85; OR=0.21, 95%CI: 0.05-0.79, respectively).

In multivariable models controlling for sociodemographic factors and ATOD use, lifetime emotional IPV was still significantly associated with excellent PrEP adherence (AOR=0.45, 95%CI: 0.21-0.94) while the association with monitoring IPV was no longer statistically significant. However, the associations between experiencing frequent monitoring IPV and controlling IPV were still significantly associated with PrEP adherence (AOR=0.29, 95%CI: 0.10, 0.84; AOR=0.23, 95%CI: 0.05, 0.83).

Table 4. bivariable and multivariable logistic regressions predicting current PrEP use

	Current PrEP use	
	OR [95%CI]	AOR [95%CI] *
Lifetime		
Any type of IPV	1.04 [0.82, 1.96]	
Physical/sexual	0.87 [0.54, 1.40]	
Monitoring ever	1.07 [0.64, 1.78]	
Controlling ever	0.75 [0.42, 0.91]	0.71 [0.56, 1.12]
Emotional ever	0.82 [0.51, 1.33]	
HIV-related ever	1.40 [0.78, 2.59]	
Last year		
Any type of IPV	1.21 [0.74, 1.99]	
Physical/sexual last year	0.87 [0.54, 1.40]	
Monitoring last year	0.86 [0.49, 1.51]	
Controlling last year	0.57 [0.38, 0.92]	0.61 [0.45, 1.04]
Emotional last year	1.07 [0.66, 1.76]	
HIV-related last year	1.23 [0.87, 1.45]	
Last year frequent (2 times or more)		
Any type of IPV	0.64 [0.39, 1.00]	
Physical/sexual last year	0.43 [0.19, 0.92]	0.41 [0.18, 0.93]
Monitoring last year	0.84 [0.41, 1.74]	

Controlling last year	0.55 [0.23, 1.32]	
Emotional last year	0.70 [0.42, 1.18]	
HIV-related last year	0.91 [0.27, 3.24]	

OR = odds ratio; AOR = adjusted odds ratio

** multivariable model adjusted for sociodemographic and ATOD use.*

Bold texts indicate statistically significant

Table 5. bivariable and multivariable logistic regressions predicting excellent PrEP adherence

	Excellent PrEP adherence	
	OR [95%CI]	AOR [95%CI]
Lifetime		
Any type of IPV	0.55 [0.23, 1.23]	
Physical/sexual	0.81 [0.40, 1.67]	
Monitoring ever	0.56 [0.27, 1.17]	
Controlling ever	0.76 [0.33, 1.82]	
Emotional ever	0.46 [0.22, 0.94]	0.45 [0.21, 0.94]
HIV-related ever	1.69 [0.71, 4.50]	
Last year		
Any type of IPV	0.54 [0.23, 1.18]	
Physical/sexual last year	0.81 [0.40, 1.67]	
Monitoring last year	0.44 [0.20, 0.98]	0.48 [0.21, 1.10]
Controlling last year	0.76 [0.33, 1.82]	
Emotional last year	0.58 [0.28, 1.18]	
HIV-related last year	1.73 [0.90, 3.22]	
Last year frequent (2 times or more)		
Any type of IPV	0.60 [0.29, 1.26]	
Physical/sexual last year	1.70 [0.42, 11.45]	
Monitoring last year	0.31 [0.11, 0.85]	0.29 [0.10, 0.84]

Controlling last year	0.21 [0.05, 0.79]	0.23 [0.05, 0.83]
Emotional last year	0.64 [0.30, 1.41]	
HIV-related last year	1.86 [0.28, 6.27]	

OR = odds ratio; AOR = adjusted odds ratio

**multivariable model adjusted for sociodemographic and ATOD use.*

Bold texts indicate statistically significant

HIV PrEP Stigma

HIV PrEP stigma was measured using the 12-item HIV PrEP Stigma Scale (HPSS). We calculate the mean score, and the score was coded such that high values indicate high levels of PrEP stigma. The Cronbach Alpha of the HPSS among the study participants was 0.79 and the overall mean of the 12 items was 2.21 (standard deviation=0.58) on a 5-point scale, equating to a value closer to disagree (2). Note that item 7-12 was coded reversely when calculating the mean score.

Table 6 shows the percent distribution of participants' responses to Likert scale items. Although only a small percentage of participants' responses were classified as stigmatizing for most of the items, a few items stood out with notably high levels of stigmatizing responses. For example, 23.5% agree and 4.3% strongly agree that "*People experience negative judgment because they take PrEP*". Similarly, over thirty percent strongly agreed (4.7%) or agreed (29.2%) that "*Someone taking PrEP would be seen by others as slutty*", while 33.9% were being neutral. In the meantime, 6.9% disagreed or strongly disagree with the statement "*People taking PrEP receive praise for being responsible*". In addition, over one fifth disagreed or strongly disagreed that "*My family would be supportive of me taking PrEP*" (13.7% and 8.7%, respectively). Conversely, a significant proportion of participants agreed that "*People taking PrEP receive praise for being responsible*" (54.9%), expressed anticipation that "*My friends would be supportive of me taking PrEP*" (77.6%), and held the belief that "*People on PrEP are taking care of their health*" (79.4%).

Next, analyses of variance (ANOVA) tests were conducted to examine the differences in the level of PrEP stigma across participants' sociodemographic characteristics. Higher levels of PrEP stigma were associated with younger age and lower education attainment (had an education

level below college vs. college and above, $p < 0.05$ for both). Individuals who reported as bisexual reported a significant higher level of PrEP stigma compared to those who were gay ($p < 0.05$).

Table 6. HIV PrEP stigma scale and agreement distributions.

No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I would feel ashamed to take PrEP pills in front of others.	104 (37.5%)	85 (30.7%)	71 (25.6%)	9 (3.2%)	8 (2.9%)
2.	Someone taking PrEP should keep their pills hidden.	84 (30.3%)	93 (33.6%)	84 (30.3%)	13 (4.7%)	3 (1.1%)
3.	People experience negative judgment because they take PrEP.	26 (9.4%)	68 (24.5%)	106 (38.3%)	65 (23.5%)	12 (4.3%)
4.	Someone taking PrEP would be seen by others as slutty.	30 (10.8%)	59 (21.3%)	94 (33.9%)	81 (29.2%)	13 (4.7%)
5.	People experience problems when they tell their sex partner(s) they are taking PrEP.	55 (19.9%)	96 (34.7%)	101 (36.5%)	21 (7.6%)	4 (1.4%)
6.	People taking PrEP experience verbal harassment.	57 (13.8%)	149 (36.2%)	149 (36.2%)	47 (11.4%)	10 (2.4%)
7.	I would have sex with someone who is taking PrEP.	0 (%)	3 (1.1%)	46 (16.6%)	67 (24.2%)	161 (58.1%)
8.	People taking PrEP receive praise for being responsible.	3 (1.1%)	16 (5.8%)	106 (38.3%)	111 (40.1%)	41 (14.8%)
9.	My friends would be supportive of me taking PrEP.	2 (0.7%)	1 (0.4%)	59 (21.3%)	63 (22.7%)	152 (54.9%)

10.	I would feel proud to take PrEP every day.	1 (0.4%)	10 (3.6%)	90 (32.5%)	55 (19.9%)	121 (43.7%)
11.	People on PrEP are taking care of their health.	1 (0.4%)	4 (1.4%)	52 (18.8%)	52 (18.8%)	168 (60.6%)
12.	My family would be supportive of me taking PrEP.	24 (8.7%)	38 (13.7%)	80 (28.9%)	60 (21.7%)	75 (27.1%)

The Mediating Effect of Nicotine Use Between IPV Victimization and PrEP utilization

To test the hypothesis regarding the mediating effect of substance use on the relationship between IPV victimization and PrEP utilization, a series of bivariable regressions and correlations were first calculated to examine how each type of alcohol, nicotine, methamphetamine, and marijuana use might influence the connection between IPV victimization and PrEP utilization. Results suggested that only nicotine use might potentially have a mediating effect and therefore, we conducted similar path analyses to test these effects.

Figure 1 illustrates the direct effect and indirect effect of experiencing frequent physical IPV in the last year (IV) on current PrEP use (DV) through nicotine use. First, experiencing physical/sexual IPV victimization (IV) was positively correlated with nicotine use (M) ($b=0.236$, $p<0.05$) and nicotine use (M) was negatively associated with current PrEP use (DV) ($b=-0.141$, $p<0.01$), while experiencing frequent physical/sexual IPV victimization in the last year (IV) and current PrEP use was also associated with current PrEP use (DV) ($b=-0.176$, $p=0.06$). Thus, a partial mediation of the relationship between experiencing the IV and DV through nicotine use was observed among the study sample. Approximately 16% of the effect of experiencing frequent physical/sexual IPV victimization on currently using PrEP was mediated by nicotine use. Similarly, nicotine use fully mediated the association between experiencing frequent monitoring IPV victimization (IV) and current PrEP use (DV), and approximately 72% of the effect of the IV on DV was mediated by nicotine use (Figure 2). Similar approaches were used to test the mediating effect of nicotine use on the relationship between experiencing IPV victimization and excellent PrEP adherence. However, nicotine use did not mediate this association among our study sample.

Next, we conducted the same analyses to test the mediating effects of PrEP stigma on the relationship between experiencing IPV victimization and PrEP utilization (Figure 3). Similar to the findings above, the association between experiencing frequent emotional IPV (IV) was positively associated with PrEP stigma (M) ($b=0.138$, $p<0.05$), and PrEP stigma was negatively associated with having excellent PrEP adherence ($b=-0.194$, $p<0.01$), while the association between the IV and DV was no longer statistically significant. Therefore, a complete mediating effect of PrEP stigma was observed in the relationship between experiencing frequent emotional IPV in the past year and having excellent PrEP adherence.

Figure 1. Path analysis for the direct and indirect effects of experiencing frequent physical/sexual IPV victimization in the past year on current PrEP use through nicotine use

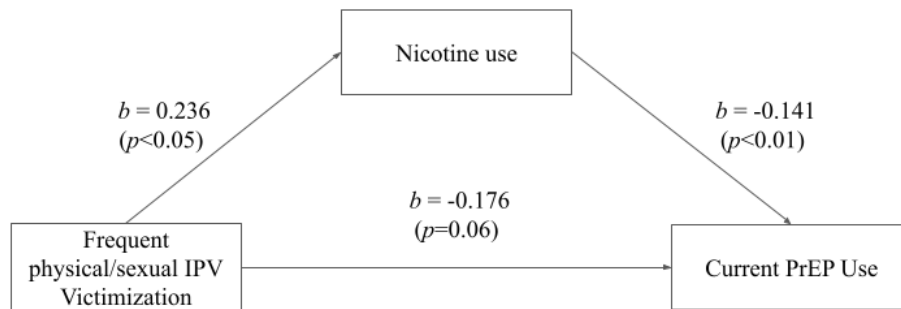


Figure 2. Path analysis for the direct and indirect effects of experiencing frequent monitoring IPV victimization in the past year on current PrEP use through nicotine use

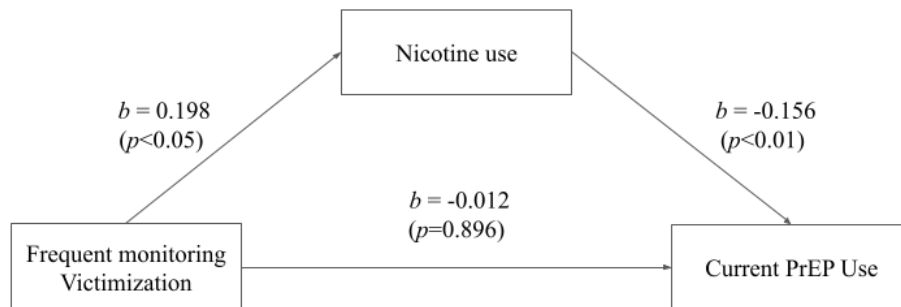
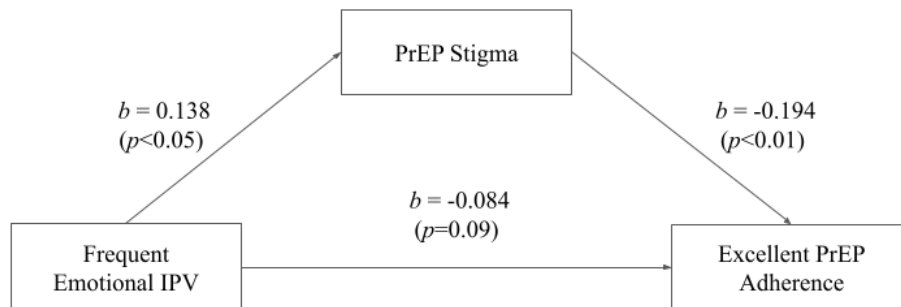


Figure 3. Path analysis for the direct and indirect effects of experiencing frequent emotional IPV victimization in the past year on current PrEP use through PrEP stigma



IPV victimization prediction using social media and mobile phone use data

To test the hypothesis outlined in *Aim 3*, which examines the potential of social media and mobile phone usage data to predict self-reported IPV victimization outcomes among study participants, classification models were developed to predict each IPV victimization outcome based on the IPV-GBM scale. Caution is warranted when interpreting the ensuing results, as only a subset of $n=65$ participants using Android mobile phones were included by the time the analysis was conducted due to limitations in data collection via the eWellness app.

The F1 scores for predicting self-reported IPV victimization are detailed in Table 7. The results showed that lifetime IPV victimization experiences, including several specific forms of IPV victimization could be predicted well using the combined social media and mobile phone use data through a combination of different features. For instance, the F1 score for predicting lifetime physical/sexual IPV victimization was 0.85, while those for lifetime emotional IPV, HIV-related IPV, and controlling IPV victimization were 0.76, 0.74, and 0.71, respectively. Additionally, predictions for emotional IPV and controlling IPV victimization within the past year were also reasonable, with F1 scores of 0.67 and 0.6, respectively. However, predictive models were only moderately successful in determining monitoring and HIV-related IPV within the past year. Lastly, the models demonstrated acceptable accuracy in predicting frequent IPV victimization in the past year, achieving an F1 score of 0.71, while showing moderate accuracy in predicting frequent emotional IPV victimization within the past year ($F1 = 0.57$).

Table 7. F1 scores for predicting self-reported IPV victimization using social media and mobile phone use data and machine learning models

	F1 scores		
	Lifetime	Past year	Frequent
Any type of IPV	0.61	0.49	<u>0.71</u>
Physical/sexual IPV	<u>0.85</u>	0.19	0.29
Monitoring IPV	0.44	0.40	0.40
Controlling IPV	<u>0.71</u>	<u>0.63</u>	0.00
Emotional IPV	<u>0.76</u>	<u>0.67</u>	0.57
HIV-related IPV	<u>0.74</u>	0.40	0.00

CHAPTER 6: DISCUSSION

The current study aimed to describe the prevalence of intimate partner violence (IPV) victimization, perpetration, and bi-directional violence, understand the associations between experiencing different types of IPV victimization and HIV pre-exposure prophylaxis (PrEP) utilization among a sample of cisgender young SMM who have sex with men and use substances. It also detected the level of HIV PrEP stigma among this study sample and explored the mediating role of PrEP stigma and alcohol, tobacco, and other drug (ATOD) use in the relationships between IPV victimization and PrEP utilization. In addition, the current study utilized advanced approaches such as machine learning models to predict IPV-related outcomes using social media and mobile phone data. These outcomes contribute to the literature by providing information and evidence that should be areas of focuses for academic researchers, healthcare providers, and public health policymakers.

This analysis, conducted among a sample of racially and ethnically diverse cisgender young SMM recruited from the internet, revealed high rates of IPV victimization, perpetration, and bi-directional violence both in their lifetime and in the past year. Despite the high risk of HIV, only about half of the study participants were using PrEP for HIV prevention, and PrEP adherence is suboptimal. Furthermore, young SMM experienced varying degrees of PrEP-related stigma, and PrEP stigma mediated the relationship between IPV victimization and PrEP use and adherence, and so did nicotine use. Lastly, machine learning models using social media and mobile phone use data could predict IPV-related outcomes with high accuracy. This chapter focuses on comparing the study results to existing research, exploring potential explanations, and identifying implications for future research, practice, and policy. Additionally, suggestions are

provided for the next steps to improve IPV and PrEP outcomes among this vulnerable population.

High prevalence of IPV victimization, perpetration, and bi-directional violence

The results of the current study revealed alarmingly high rates of IPV victimization, perpetration, and bi-directional violence among cisgender young SMM who have sex with men and use substances in *Aim 1*. The findings contribute to the literature by providing prevalence not only at different time points but also for different types of IPV experiences, using a previously validated scale developed specifically for the sexual and gender minority population.

In this study, 70% of cisgender young SMM reported experiencing IPV victimization at least once in their lifetime, with over half reporting such experiences in the past year. Specifically, physical/sexual IPV and emotional IPV emerged as the most common forms of victimization, with substantial proportions of study participants reporting frequent experiences of these in the past year. These results amplify existing evidence on the vulnerability of SMM population to intimate partner violence, especially in the context of substance use and HIV risk. Notably, the rates of IPV victimization observed in current study were significantly higher compared to existing research. For example, a systematic review and meta-analysis of IPV victimization among sexual minority men found that the pooled prevalence of IPV victimization across all recall period was 33%, with emotional violence was the highest estimated type of IPV victimization (Liu et al., 2021). A more recent study conducted among a sample of online gay and bisexual men in the United States through the Men's Body Project found that the prevalence of sexual IPV, non-physical coercion, and physical IPV was 22.2%, 21.9%, and 16.4%, respectively (Rustagi et al., 2023). While it is impossible to compare these outcomes directly due to differences in sample characteristics, recruitment methodologies, and measurement tools, the

substantially higher rates of IPV victimization observed in our study underscore the heightened vulnerability of young SMM to IPV and highlight the urgent need for targeted interventions and support services tailored to the specific needs of young SMM.

Similarly, the results of the current study revealed the alarmingly high rates of IPV perpetration and bi-directional IPV among a sample of cisgender young SMM. Approximately half of the study participants reported perpetrating IPV at least once in their lifetime, with a substantial proportion reporting such behaviors in the past year. Recent physical/sexual IPV and monitoring IPV were the most prevalent forms of perpetration, mirroring the patterns observed in victimization. The rate of past-year IPV perpetration was higher than those reported in previous studies conducted among sexual minority men in the U.S., Canada, and China (Stephenson & Finneran, 2017b; Stults, Javdani, Greenbaum, Barton, et al., 2015; Wei et al., 2021). Moreover, a significant proportion of participants reported engaging bi-directional violence – indicating reciprocal patterns of aggression within their intimate relationships, particularly on physical/sexual IPV, monitoring IPV, and emotional IPV. These findings not only extend previous research by providing insights into the prevalence of IPV perpetration and bi-directional violence within the young SMM but also underscore the importance of examining perpetration behaviors to gain a more comprehensive understanding of IPV dynamics within this community. This includes understanding the influence of victimization on perpetration and vice versa, and under what circumstances bi-directional violence would occur within intimate relationships.

Consistent with previous studies and evidence in the literature (Kubicek et al., 2015b; Stephenson et al., 2011; Wang et al., 2018), experiencing IPV victimization among SMM was associated with lower levels of education attainment. Previous studies have hypothesized that lower education levels might be associated with lower income levels and limited access to

resources and social capital (Stephenson et al., 2011), creating an imbalance in power between partners that may trigger intimate partner violence. Future studies should aim to further understand the mechanisms through which educational attainment influences the risk of IPV victimization among SMM, considering factors such as economic insecurity, social support networks, and access to help seeking services.

Bisexual individuals were more likely to report experiencing IPV victimization compared to those who identified as gay. This is consistent with previous research that suggests the high vulnerability of bisexual individuals in intimate partner relationships. A recent study using the data from the National Longitudinal Study of Adolescent to Adult Health in the U.S. also found that bisexual male in their sample reported nearly as 3.5 times more likely to report experiencing IPV victimization compared to those were heterosexual and gay (Swiatlo et al., 2020). This is particularly concerning given the already existing health disparities and lack of social support and health services experienced by bisexual individuals (Feinstein & Dyar, 2017). Previous research has pointed out that bisexual individuals were less likely to engage in sexual health and mental health services compared to gay individuals (Feinstein et al., 2019; Feinstein & Dodge, 2020; Hong, Feinstein, et al., 2022), and the high rates of experienced IPV may further exacerbate these health disparities. More importantly, such strategies must consider and prioritize approaches that recognize and address the intersectional vulnerabilities (e.g., race, economic status, education attainment) that shape the experiences of intimate partner violence.

Associations between IPV victimization and PrEP utilization

As hypothesized in *Aim 2*, the findings of the current study revealed the complex relationships between experiencing IPV victimization and PrEP utilization among cisgender young sexual and gender minority individuals. For instance, participants who experienced

controlling IPV in the last year and frequent physical/sexual IPV were less likely to currently use PrEP for HIV prevention. These results suggest the need to delve deeper into the nuanced differences in different forms of IPV and their impact on PrEP utilization. While previous research on understanding the association between IPV and PrEP use has predominantly considered IPV as one construct rather than specifying its different forms (Y.-T. Chen et al., 2021; M. R. Friedman et al., 2019; John et al., 2018), these findings align with evidence in the literature suggesting that experiencing IPV victimization is multifaceted and could have differential effects on health behaviors and health outcomes (Buller et al., 2014; W.-T. Chen et al., 2019; Davis et al., 2015). Understanding these complexities is critical for tailoring interventions that effectively address the diverse needs and unique experiences of individuals facing IPV within the context of HIV prevention and sexual health promotion.

A persistent association observed in this study is that experiencing controlling and monitoring IPV was consistently associated with suboptimal PrEP utilizations among young SMM. This trend persisted across those who had encountered such behaviors throughout their lifetime, as well as those who had experienced them more recently and frequently. One possible explanation for this finding is the profound impact that controlling and monitoring behaviors can have on an individual's autonomy and decision-making ability. In relationships influenced by controlling IPV and monitoring, cisgender young SMM may face significant barriers to accessing healthcare services, due to the exertion of power and control by their partners. In fact, the existing literature on the relationship between experiencing controlling IPV and PrEP use is notably limited, with research presenting equivocal findings. For instance, an analysis of a national online survey comprising n=863 men who have sex with men (MSM) in the U.S. discovered that MSM who had encountered controlling behaviors from their partners were more

inclined to use PrEP compared to those who had not experienced controlling IPV (Braksmajer et al., 2020). Conversely, a study conducted among Chinese MSM using the same IPV-GBM scale revealed that experiencing controlling IPV victimization showed no association with willingness to use daily oral PrEP for HIV prevention. However, it did exhibit a negative association with the willingness to use long-acting injectable PrEP (Guo et al., 2023). The IPV-GBM scale assesses controlling IPV by asking the respondents questions such as “*Your partner prevented you from seeing your friends or family*” (Stephenson & Finneran, 2013). It is important to note that controlling and monitoring behavior may manifest in various, such as social isolation, restricting access to seeking social support and connections, limiting financial resources, etc. It is important to note that these behaviors may manifest in various forms, such as social isolation, restricting access to seeking social support and connections, limiting financial resources, and more. Future research should aim to understand these types of IPV in a more holistic and nuanced manner, taking into account the impacts of such behavior on individuals' HIV risk and help-seeking behaviors.

Similarly, the results revealed negative associations between experiencing emotional IPV and PrEP utilization, including both current PrEP use and excellent PrEP adherence among current PrEP users. This is consistent with a previous study by Braksmajer et al., which found that SMM experiencing emotional IPV were less likely to take PrEP than those who did not report such forms of IPV victimization (Braksmajer et al., 2020). Emotional violence was estimated to be the most prevalent form of IPV among sexual minority men (Liu et al., 2021) is associated with adverse health and mental health outcomes, including an increased risk of alcohol use, engaging in condomless anal sex, and mental distress (Davis et al., 2020, 2016; Duncan et al., 2018). In the current study, experiencing emotional IPV was significantly

associated with suboptimal PrEP adherence among current PrEP users. This is particularly concerning as it underscores the potential impact on the effectiveness of PrEP for HIV prevention within this vulnerable population. One potential explanation is that emotional abuse could erode one's self-esteem and confidence (Liu et al., 2018; Pereira et al., 2021), thereby leading to feelings of worthlessness that may impede their ability to prioritize their health needs. It is also possible that there is an underlying mechanism between experiencing emotional IPV and PrEP adherence, such as mental distress serving as a mediator or moderator. For example, there is evidence suggests that experiencing emotional violence and abuse is associated with increased levels of mental distress, such as depression and anxiety (James et al., 2012; Reuter et al., 2017), and these mental health outcomes have been found to be negatively correlated with PrEP utilization among sexual minority men (Miller et al., 2021). It is also possible that multiple forms of IPV, such as emotional IPV and controlling IPV, could occur simultaneously and mutually reinforce the negative effects of each other. Future research should seek to understand the underlying mechanisms linking emotional IPV and PrEP utilization such as testing the potential mediating roles of mental distress and utilize qualitative evidence to understand the lived experience of young SMM who have experienced emotional abuse and the potential impact on PrEP use and adherence in the context of HIV prevention.

PrEP Stigma and its Mediating Effect on the Relationship Between IPV Victimization and PrEP utilization

To test the hypothesis regarding the mediating effect of stigma on the relationship between IPV victimization in *Aim 2*, the current study initially measured HIV PrEP stigma using

a pre-validated scale – the HIV PrEP Stigma Scale (Siegler et al., 2020). Despite the overall level of PrEP stigma being assessed as low to moderate within the sample, several notable items stood out, warranting attention and further exploration. In particular, a significant proportion of young SMM participants endorsed stigmatizing beliefs such as "*People experience negative judgment because they take PrEP*" and "*Someone taking PrEP would be seen by others as slutty.*" These findings resonate with previous research by Siegler et al., whose study originally developed and validated the scale. It's worth noting that Siegler et al.'s factor analysis yielded a unidimensional factor despite the original scale's design based on a stigma framework encompassing internal, anticipated, and experienced stigma. Taken together, these findings underscore the importance of future research to unravel the multifaceted nature of PrEP-related stigma and explore various dimensions such as internalized and anticipated stigma. Interestingly, certain items related to experienced or internalized stigma, such as "*I would feel proud to take PrEP every day*" and "*I would have sex with someone who is taking PrEP*" garnered largely favorable responses among the study participants. These nuanced differences highlight the complexity of stigma perceptions based on observations and experiences and underscore the importance of contexts and factors that may shape stigma perceptions and PrEP utilizations. For example, social and cultural norms play a significant role in shaping attitudes towards HIV prevention strategies such as PrEP within different communities. Furthermore, minority stressors such as internalized homophobia and experienced discrimination and violence may exacerbate PrEP-related stigma among young SMM individuals. Individuals who have faced discrimination or violence based on their sexual orientation or gender identity may internalize negative societal attitudes, leading to heightened stigma towards HIV prevention strategies like PrEP. These findings underscore the importance of comprehensive interventions that not only address individual-level stigma but also understand

the structural and intersecting factors that contribute to stigma generation. Such interventions should aim to create supportive environments and promote social inclusion to mitigate the impact of minority stressors and reduce PrEP-related stigma within sexual and gender diverse communities.

We found that higher levels of PrEP stigma was associated with suboptimal PrEP utilization. These findings align with previous research indicating the persistent impact of stigma on health seeking behaviors particularly on HIV prevention, treatment and care outcomes (Babel et al., 2021). For instance, studies have documented how HIV stigma influences adherence to antiretroviral therapy and other health outcomes among people living with HIV (Babel et al., 2021; Breet et al., 2014; Hong et al., 2023). Additionally, recent studies have suggested that experienced stigma and prejudice shape the experiences of sexual minority men in using PrEP (Brooks et al., 2019, 2020; Dubov et al., 2018). The current study extend this literature by providing evidence and highlighting the specific role of PrEP-related stigma in shaping PrEP utilization among a subpopulation that experience elevated risk of HIV. This mediating effect might be explained by the syndemic theory and the minority stress theory (Meyer, 2003; Stall et al., 2007). In this context, IPV victimization and HIV risk can be interconnected and mutually reinforcing the negative effects of each other and together further exacerbate health disparities within marginalized communities such as young sexual and gender minorities. In the current study, the syndemic of IPV victimization and PrEP stigma may create a pattern whereby experiences of IPV victimization may contribute to high levels of PrEP stigma, which in turn impedes PrEP utilization. Within the minority stress model, experiences of IPV victimization and PrEP stigma represent unique manifestations of minority stressors, leading to heightened internalized stress that could create additional burdens for individuals within these communities,

potentially impacting their willingness to seek out and utilize essential health and mental health services. Given the heightened level of PrEP stigma among particular subgroups including racial and ethnic minorities and sexual and gender diverse individuals, these results suggest that future interventions aimed at reducing the negative effects of experiencing IPV on PrEP utilization must consider stigma reduction and must consider the complex interplay of social, cultural, and structural factors shaping health behaviors and health outcomes among young SMM. However, comprehending the interplay between IPV and PrEP stigma, as well as their effects on PrEP utilization, requires further thorough investigation. It is important to note that many components within the PrEP stigmas scale also encompass an individual's perceived and encountered stigma related to sexual orientation, sexual behaviors, homophobia, and family and social support. It is plausible that there exist more intricate underlying mechanisms that could elucidate these observed correlations. Future research should delve deeper into these complexities to provide a more nuanced understanding of the dynamics at play.

Mediating Role of Nicotine in the Relationship Between IPV Victimization and PrEP Use

Similarly, the current found that nicotine use was negatively associated with PrEP utilization, and it served as a significant mediator in the relationship between experiencing controlling IPV victimization and current PrEP among cisgender young SMM. These results underscore the importance of considering substance use as a critical factor influencing HIV prevention behaviors among young SMM experiencing IPV victimization.

The negative impacts of nicotine and tobacco use on health behaviors and health outcomes have been well documented in the literature (LoSchiavo et al., 2021; Ompad et al., 2014; Santos et al., 2019), but the current study is among the first to examine its association with HIV PrEP. In the current study, nicotine use was associated with both lower likelihoods of

current using PrEP and suboptimal PrEP adherence among those who were using PrEP. These negative associations indicate the importance of considering nicotine and tobacco use patterns in HIV prevention efforts targeting young SMM. Alcohol, tobacco, and other drug use, particularly nicotine use, may hinder the engagement in HIV prevention services and influence one's ability to adhere to PrEP regimens, thereby reducing the effectiveness of this biomedical HIV prevention strategy. Recent study also showed the disparities in nicotine use among sexual and gender diverse individuals among young sexual and gender minority (Krueger et al., 2023). Interventions aimed to improve PrEP uptake and PrEP adherence among young SMM must address nicotine use disparities as a potential barrier and provide tailored resources and services to help individuals to overcome nicotine related challenges.

The findings on nicotine use's mediating role in the relationship between IPV victimization and current PrEP use suggest that nicotine use may play a significant role in linking experiences of IPV to PrEP utilization among young SMM. While the exact mechanism driving this mediating effect remains unclear, it is plausible that individuals may turn to nicotine use as a coping strategy in response to the stress and trauma associated with IPV victimization. However, the negative effects of nicotine use could subsequently undermine engagement in HIV prevention services such as PrEP utilization. This mediation effect highlights the need to consider the broader context of ATOD use when addressing the intersection of IPV and HIV risk and vulnerabilities. Health services and interventions aimed at reducing the negative effects of IPV victimization and promoting PrEP utilization should incorporate strategies to address nicotine use as a key factor influencing health behaviors within cisgender young SMM.

In conclusion, the mediating effects of PrEP stigma and nicotine use in the association between IPV victimization and PrEP utilization underscore the importance of adopting a holistic

approach to address the intersection epidemics of violence, trauma, substance use, and HIV among young SMM. Interventions must consider the complex interplay of these individual epidemics within the lived experienced of cisgender young SMM. Future research should also aim to understand additional epidemics and minority stressors such as mental health, socioeconomic disparities, discrimination, and internalized homophobia in the relationship between intimate partner violence and HIV PrEP utilization.

Harnessing Machine Learning in Predicting IPV Victimization

The *Aim 3* of the current study presented a novel approach to test and verify the extent to which machine learning models can predict self-reported IPV victimization using social media and mobile phone use data. Despite being exploratory, this is among the first study to utilize machine learning and advanced statistical approaches in IPV research among a sample of sexual and gender minorities, predominantly consisting of sexual minority men. The results of the predictive models employing social media and mobile phone usage data to anticipate self-reported IPV victimization outcomes present a groundbreaking advancement in the field of intimate partner violence research among a population that is often neglected in violence research. Previous research on examining such approach has mainly conducted among women and using electronic health records (Amusa et al., 2022; Z. Chen et al., 2023; Dehingia et al., 2022). The optimistic outcomes contribute not only to the literature by demonstrating the feasibility of using subjective data to predict traditionally hard-to-identify outcomes among sexual minority men but also provide valuable insights to inform future eHealth and technology-based interventions aimed at addressing IPV within this population.

The high F1 scores attained for predicting lifetime physical/sexual IPV victimization and other IPV victimization experiences such as controlling and monitoring violence suggests the

robust predictive capabilities of these models when combining different features. By harnessing the vast amount of information technology and data obtained from the study participants, such as their online interactions, communication patterns, and geolocation information, these models offer a novel approach to identifying individuals at risk of experiencing various forms of IPV victimization over time. A major barrier to IPV research among men in the past is that this population often doesn't report IPV experiences due to limited awareness, stigma, and lack of resources (Callan et al., 2021; Scott-Storey et al., 2023; Tsang, 2015). Therefore, the potential of predicting IPV using social media and mobile phone data presents a promising avenue for early intervention and support for individuals who may otherwise go unrecognized and underserved. This innovative approach has the potential to revolutionize IPV prevention and intervention efforts, particularly among populations historically underrepresented in research and support services.

Compared to previous research using machine learning to predict IPV risk factors and victimization (Amusa et al., 2022; Dehingia et al., 2022), the current study advanced these results by providing prediction performances on different types of IPV and IPV frequency, utilizing the preliminary data collected in the study. This is particularly significant because it allows for a more comprehensive understanding of the nuanced dynamics of IPV and its various manifestations, especially given the findings in the current study and evidence in the literature that sexual minority men and other sexual and gender minority individuals experience disproportionately high rates of specific forms of violence over others. This not only contributes to the advancement of IPV prediction methodologies but also lays the groundwork for future tailored interventions and support services targeting individuals at heightened risk of experiencing IPV, especially in a timely manner. The predicting models tested and verified in the

current study provide a proactive approach to IPV prevention by enabling early identification of individuals at risk of experiencing various forms of IPV victimization, such early detections could facilitate timely intervention and support services, potentially triggering further harm and promoting safety and well-being. For individuals in abusive relationships, the ability to recognize patterns of abusive behavior through predictive models may empower them to seek help and break free from cycles of violence. In addition, such approach also suggests the potential of integrating other sexual health and mental health service delivery among young SMM who experience IPV, given the high rates of co-occurring vulnerabilities in these domains (Buller et al., 2014).

However, it is also important to approach these findings with great caution and acknowledgement of significant limitations. First, the sample size utilized in the model building and testing was relatively small, comprising only a subset of participants who use Android mobile devices due to the data collection constraints. This restricted sample may limit the generalizability of the findings and indicate the need for further validation and replication across larger and more diverse users and populations. Moreover, considerations surrounding privacy, data security, and consent must be carefully addressed to ensure the safety of potential users and protection of sensitive data.

Limitations and Implications for Research, Practice, and Policy

This study has several limitations. First, the study participants were recruited from an ongoing cohort study among cisgender young SMM who have sex with men and use substances. The generalizability of the study findings to other populations is unknown. The eligibility criteria for the parent study encompass recent substance use and a history of engaging in sexual risk behaviors associated with HIV. These restrictions may impact and potentially overestimate the prevalence of main study outcomes including the rates of IPV, PrEP utilization, and ATOD use compared to the general SMM population. All study data were collected cross-sectionally, and results were reported as associations. Therefore, causalities cannot be established. Most of the study measures, including IPV experiences and PrEP adherence, were self-reported, which may be subject to social desirability bias and recall bias. Some study measures can be further improved as well. For example, PrEP-related outcomes were only assessed based on an oral daily regimen instead of considering PrEP modalities such as event-driven PrEP and long-acting injectable PrEP. It is possible that young SMM who experienced IPV may prefer one method over the others (Stephenson et al., 2022). This could potentially underestimate the PrEP use outcome among our study sample as well. Nicotine use was measured by a single-item question. A more comprehensive assessment, such as using the Penn State Nicotine Dependence Index (Foulds et al., 2015), as well as other substance use outcomes might provide a holistic understanding of ATOD use in the context of IPV and PrEP utilization. Lastly, only a small number of participants and their associated data were included in the machine learning prediction model, given the restrictions on the data collection tools. The limited sample size may affect the robustness and generalizability of the predictive models.

Despite these limitations, the findings of the current study not only contribute to the literature on intimate partner violence (IPV), PrEP Stigma, substance use, and HIV prevention among cisgender young SMM but also have significant implications for research, practice, and policy, particularly in addressing the intersection of these health disparities.

First, the study results underscore the complexity of IPV among cisgender young SMM, highlighting the need for further research to understand the specific dynamics of IPV within intimate relationships. While the current study has documented the prevalence of different forms of IPV victimization, perpetration, and bi-directional violence among a specific population that is particularly vulnerable to IPV, future studies should examine these phenomena over time and delve deeper into the intersections of IPV with other minority stressors such as discrimination, internalized homophobia, and psychological distress. Understanding the complex associations between these syndemics among young SMM is crucial. These intersecting syndemics could further exacerbate the risk and negative effects of IPV on health and mental health outcomes, collectively lowering the overall health profiles within this population. By exploring these nuanced intersections, researchers could develop and test more comprehensive frameworks to understand and address IPV-related disparities among young SMM. In addition, the mixed findings on the associations between different types of IPV and PrEP utilization suggest the need for longitudinal studies to understand the long-term effects of IPV on these health behaviors and outcomes. Future research should also explore the acceptability of utilizing alternative PrEP options such as on-demand PrEP and long-acting injectable PrEP among young SMM who may be at the risk of or experiencing IPV, given the increased discretion and reduced adherence burden associated with these methods. Additionally, qualitative studies could provide an in-depth

understanding of how IPV influences PrEP engagement and other health behaviors among young SMM.

The promising results from using social media and mobile phone data to predict IPV victimization also provide insights and suggest new directions for future IPV research, especially among men and sexual minority men. These findings not only suggest the feasibility of using subjective data to predict historically hard-to-measure and highly stigmatized outcomes, but they also indicate the opportunity to integrate these models into existing web- and internet-based interventions and strategies that could avoid traditional barriers and deliver services more efficiently. Future research should continue refining these predictive models using larger datasets and more general data and evaluate the models' generalizability across different contexts. One approach is to consider generating synthetic data by algorithms to train machine learning models that mimics real-world data (Raghunathan, 2021). Such application can help overcome the limitation of data scarcity and concerns about privacy, providing a robust alternative for model training and validation (Jordon et al., 2022). Additionally, this model development and adaptation must be conducted with ethical considerations such as privacy, consent, and data security.

Next, the findings of the current study also provide valuable insights to inform clinical social work and public health practices. The high prevalence of IPV victimization, perpetration, and bi-directional violence suggested the need for increased IPV screening across various settings, including healthcare facilities, community health centers, and social service agencies. Such screening services for IPV can help identify victims and survivors and provide early and timely support services to prevent further and more severe harm. This also includes developing and testing effective screening tools that are culturally appropriate and assess IPV in a sensitive

and non-judgmental manner. These approaches could enhance the detection and support of IPV cases and improve intervention strategies. In addition, adopting a trauma-informed care approach is critical in supporting sexual and gender minority individual who experienced violence, especially from their intimate partners. These practices recognize the persistent and complex impacts of traumatic experiences such as violence and abuse (Bath, 2008; Kimberg & Wheeler, 2019; Reeves, 2015), and prioritize building strengths and resilience of individuals (Center for Substance Abuse Treatment (US), 2014). Implementing trauma-informed care and practices in mental health and sexual health settings could empower SMM, enhance their engagement in health services such as PrEP utilization, and foster a trusting provider-patient relationship. Meanwhile, the findings also suggested that practitioners working with SMM should create an integrated service line to addressing multilevel vulnerabilities, including IPV, substance use, stigma reduction, and HIV prevention. Comprehensive support services that address these intersecting issues are essential given that many of them may co-occur within the young SMM communities. Integrating these services could reduce the barriers and burdens young SMM face when seeking help, making it easier for them to access the necessary support. In addition, creating multidisciplinary service teams that include medical doctors, nurse practitioners, social workers, and mental health counselors, and community health providers can enhance the effectiveness of comprehensive sexual health and mental health services provided to cisgender young SMM.

Lastly, the findings of the current study suggest that policy efforts should focus on enforcing comprehensive legislation that protects individuals and provides services to IPV victims and survivors from sexually and gender-diverse backgrounds. Previous evidence suggests that men are less likely to report and seek help after experiencing IPV because of

gender-biased social and policy responses and external social service barriers (Scott-Storey et al., 2023; Tsang, 2015). By addressing these issues, policymakers can ensure that victims and survivors have access to the necessary support and resources. Such efforts also entail comprehensive sexual health education that recognizes IPV as an issue among sexually and gender-diverse individuals, encourages conversations on fostering healthy relationships, and empowers individuals to seek help when experiencing violent and traumatic behaviors.

CONCLUSION

In conclusion, the current study contributes to the literature by describing intimate partner violence (IPV) among a sample of cisgender young sexual minority men who have sex with men and use substances. It provides a foundation for further exploration of how IPV may influence PrEP (pre-exposure prophylaxis) utilization for HIV prevention in these populations. The results offer insights into understanding the underlying mechanisms of the relationship between IPV and PrEP utilization by integrating the Syndemic Theory and the Minority Stress Model. Additionally, the findings demonstrate the potential of using machine learning and data from social media and mobile phone use to predict IPV experiences among a highly stigmatized population. This approach offers a new pathway for delivering IPV-related services to individuals who face multiple barriers when seeking help. These results can be utilized to develop and tailor interventions and services aimed at addressing health disparities and promoting health equity within young sexual minority men.

Reference:

- Al-Garadi, M. A., Kim, S., Guo, Y., Warren, E., Yang, Y.-C., Lakamana, S., & Sarker, A. (2022). Natural language model for automatic identification of Intimate Partner Violence reports from Twitter. *Array*, 15, 100217. <https://doi.org/10.1016/j.array.2022.100217>
- Amusa, L. B., Bengesai, A. V., & Khan, H. T. A. (2022). Predicting the Vulnerability of Women to Intimate Partner Violence in South Africa: Evidence from Tree-based Machine Learning Techniques. *Journal of Interpersonal Violence*, 37(7–8), NP5228–NP5245. <https://doi.org/10.1177/0886260520960110>
- Anderson, E. J., Krause, K. C., Meyer Krause, C., Welter, A., McClelland, D. J., Garcia, D. O., Ernst, K., Lopez, E. C., & Koss, M. P. (2021). Web-Based and mHealth Interventions for Intimate Partner Violence Victimization Prevention: A Systematic Review. *Trauma, Violence, & Abuse*, 22(4), 870–884. <https://doi.org/10.1177/1524838019888889>
- Anderson, E. J., McClelland, J., Krause, C. M., Krause, K. C., Garcia, D. O., & Koss, M. P. (2019). Web-based and mHealth interventions for intimate partner violence prevention: A systematic review protocol. *BMJ Open*, 9(8), e029880. <https://doi.org/10.1136/bmjopen-2019-029880>
- Ayala, G., Makofane, K., Santos, G.-M., Beck, J., Do, T. D., Hebert, P., Wilson, P. A., Pyun, T., & Arreola, S. (2013). Access to basic HIV-related services and PrEP acceptability among men who have sex with men worldwide: Barriers, facilitators, and implications for combination prevention. *Journal of Sexually Transmitted Diseases*, 2013.
- Babel, R. A., Wang, P., Alessi, E. J., Raymond, H. F., & Wei, C. (2021). Stigma, HIV Risk, and Access to HIV Prevention and Treatment Services Among Men Who have Sex with Men (MSM) in the United States: A Scoping Review. *AIDS and Behavior*, 25(11), 3574–3604.

<https://doi.org/10.1007/s10461-021-03262-4>

- Baeten, J. M., Donnell, D., Ndase, P., Mugo, N. R., Campbell, J. D., Wangisi, J., Tappero, J. W., Bukusi, E. A., Cohen, C. R., Katabira, E., Ronald, A., Tumwesigye, E., Were, E., Fife, K. H., Kiarie, J., Farquhar, C., John-Stewart, G., Kakia, A., Odoyo, J., ... Celum, C. (2012). Antiretroviral Prophylaxis for HIV Prevention in Heterosexual Men and Women. *New England Journal of Medicine*, 367(5), 399–410. <https://doi.org/10.1056/NEJMoa1108524>
- Balsam, K. F., Lehavot, K., & Beadnell, B. (2011). Sexual revictimization and mental health: A comparison of lesbians, gay men, and heterosexual women. *Journal of Interpersonal Violence*, 26(9), 1798–1814.
- Bao, Y., Medland, N. A., Fairley, C. K., Wu, J., Shang, X., Chow, E. P. F., Xu, X., Ge, Z., Zhuang, X., & Zhang, L. (2021). Predicting the diagnosis of HIV and sexually transmitted infections among men who have sex with men using machine learning approaches. *Journal of Infection*, 82(1), 48–59. <https://doi.org/10.1016/j.jinf.2020.11.007>
- Bath, H. (2008). The three pillars of trauma-informed care. *Reclaiming Children and Youth*, 17(3), 17–21.
- Bauermeister, J. A., Tingler, R. C., Demers, M., & Harper, G. W. (2017). Development of a tailored HIV prevention intervention for single young men who have sex with men who meet partners online: Protocol for the myDEx project. *JMIR Research Protocols*, 6(7), e7965.
- BCompH, V. H. (2021). The syndemics of emergency: How COVID-19 demands a holistic view of public health promotion and preparedness. *American Journal of Public Health*, 111(3), 353–354.
- Bell, K. M., & Naugle, A. E. (2008). Intimate partner violence theoretical considerations:

- Moving towards a contextual framework. *Clinical Psychology Review*, 28(7), 1096–1107.
<https://doi.org/10.1016/j.cpr.2008.03.003>
- Beymer, M. R., Holloway, I. W., Pulsipher, C., & Landovitz, R. J. (2019). Current and Future PrEP Medications and Modalities: On-demand, Injectables, and Topicals. *Current HIV/AIDS Reports*, 16(4), 349–358. <https://doi.org/10.1007/s11904-019-00450-9>
- Black, M. C., Basile, K. C., Breiding, M. J., & Ryan, G. W. (2014). Prevalence of sexual violence against women in 23 states and two US territories, BRFSS 2005. *Violence against Women*, 20(5), 485–499.
- Bonoto, B. C., de Araújo, V. E., Godói, I. P., de Lemos, L. L. P., Godman, B., Bennie, M., Diniz, L. M., & Junior, A. A. G. (2017). Efficacy of mobile apps to support the care of patients with diabetes mellitus: A systematic review and meta-analysis of randomized controlled trials. *JMIR mHealth and uHealth*, 5(3), e6309.
- Braksmajer, A., Leblanc, N. M., El-Bassel, N., Urban, M. A., & McMahon, J. M. (2019). Feasibility and acceptability of pre-exposure prophylaxis use among women in violent relationships. *AIDS Care*, 31(4), 475–480.
- Braksmajer, A., Walters, S. M., Crean, H. F., Stephenson, R., & McMahon, J. M. (2020). Pre-exposure Prophylaxis Use Among Men Who Have Sex with Men Experiencing Partner Violence. *AIDS and Behavior*, 24(8), 2299–2306. <https://doi.org/10.1007/s10461-020-02789-2>
- Breet, E., Kagee, A., & Seedat, S. (2014). HIV-related stigma and symptoms of post-traumatic stress disorder and depression in HIV-infected individuals: Does social support play a mediating or moderating role? *AIDS Care*, 26(8), 947–951.
<https://doi.org/10.1080/09540121.2014.901486>

- Breiding, M., Basile, K. C., Smith, S. G., Black, M. C., & Mahendra, R. R. (2015). *Intimate partner violence surveillance: Uniform definitions and recommended data elements. Version 2.0.*
- Brooks, R. A., Landrian, A., Nieto, O., & Fehrenbacher, A. (2019). Experiences of Anticipated and Enacted Pre-exposure Prophylaxis (PrEP) Stigma Among Latino MSM in Los Angeles. *AIDS and Behavior*, 23(7), 1964–1973. <https://doi.org/10.1007/s10461-019-02397-9>
- Brooks, R. A., Nieto, O., Landrian, A., Fehrenbacher, A., & Cabral, A. (2020). Experiences of Pre-Exposure Prophylaxis (PrEP)–Related Stigma among Black MSM PrEP Users in Los Angeles. *Journal of Urban Health*, 97(5), 679–691. <https://doi.org/10.1007/s11524-019-00371-3>
- Buller, A. M., Devries, K. M., Howard, L. M., & Bacchus, L. J. (2014). Associations between Intimate Partner Violence and Health among Men Who Have Sex with Men: A Systematic Review and Meta-Analysis. *PLOS Medicine*, 11(3), e1001609. <https://doi.org/10.1371/journal.pmed.1001609>
- Burge, S. K., Becho, J., Ferrer, R. L., Wood, R. C., Talamantes, M., & Katerndahl, D. A. (2014). Safely examining complex dynamics of intimate partner violence. *Families, Systems, & Health*, 32(3), 259.
- Bush, K., Kivlahan, D. R., McDonell, M. B., Fihn, S. D., Bradley, K. A., & Project (ACQUIP, A. C. Q. I. (1998). The AUDIT alcohol consumption questions (AUDIT-C): An effective brief screening test for problem drinking. *Archives of Internal Medicine*, 158(16), 1789–1795.
- Callan, A., Corbally, M., & McElvaney, R. (2021). A Scoping Review of Intimate Partner

- Violence as It Relates to the Experiences of Gay and Bisexual Men. *Trauma, Violence, & Abuse*, 22(2), 233–248. <https://doi.org/10.1177/1524838020970898>
- Calton, J. M., Cattaneo, L. B., & Gebhard, K. T. (2016). Barriers to Help Seeking for Lesbian, Gay, Bisexual, Transgender, and Queer Survivors of Intimate Partner Violence. *Trauma, Violence, & Abuse*, 17(5), 585–600. <https://doi.org/10.1177/1524838015585318>
- Camp, J., Vitoratou, S., & Rimes, K. A. (2020). LGBTQ+ self-acceptance and its relationship with minority stressors and mental health: A systematic literature review. *Archives of Sexual Behavior*, 49(7), 2353–2373.
- Capaldi, D. M., Knoble, N. B., Shortt, J. W., & Kim, H. K. (2012). A systematic review of risk factors for intimate partner violence. *Partner Abuse*, 3(2), 231–280.
- Carmo, R., Grams, A., & Magalhães, T. (2011). Men as victims of intimate partner violence. *Journal of Forensic and Legal Medicine*, 18(8), 355–359.
- Center for Substance Abuse Treatment (US). (2014). Trauma-Informed Care: A Sociocultural Perspective. In *Trauma-Informed Care in Behavioral Health Services*. Substance Abuse and Mental Health Services Administration (US).
<https://www.ncbi.nlm.nih.gov/books/NBK207195/>
- Centers for Disease Control and Prevention. (2015). *The social-ecological model: A framework for prevention*. <https://www.cdc.gov/violenceprevention/about/social-ecologicalmodel.html>
- Centers for Disease Control and Prevention. (2019, January 21). *Suicide and Violence Prevention Among Gay and Bisexual Men*. <https://www.cdc.gov/msmhealth/suicide-violence-prevention.htm>
- Centers for Disease Control and Prevention. (2020, May 7). *Diagnoses of HIV Infection in the*

- United States and Dependent Areas. <https://www.cdc.gov/hiv/library/reports/hiv-surveillance/vol-31/index.html>
- Centers for Disease Control and Prevention. (2022, July 12). *About PrEP | PrEP | HIV Basics | HIV/AIDS | CDC*. <https://www.cdc.gov/hiv/basics/prep/about-prep.html>
- Centers for Disease Control and Prevention, & Service, U. P. H. (2018). *Preexposure prophylaxis for the prevention of HIV infection in the United States—2017 Update: A clinical practice guideline*.
- Chai, P. R., Mohamed, Y., Goodman, G., Bustamante, M. J., Sullivan, M. C., Najarro, J., Mendez, L., Mayer, K. H., Boyer, E. W., O’Cleirigh, C., & Rosen, R. K. (2021). Development of a digital pill and respondent behavioral intervention (PrEPSteps) for HIV pre-exposure prophylaxis adherence among stimulant using men who have sex with men. *Translational Behavioral Medicine*, ibab117. <https://doi.org/10.1093/tbm/ibab117>
- Chancellor, S., Baumer, E. P., & De Choudhury, M. (2019). Who is the "human" in human-centered machine learning: The case of predicting mental health from social media. *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW), 1–32.
- Chen, W.-T., Shiu, C., Yang, J. P., Chuang, P., Berg, K., Chen, L.-C., & Chi, P.-C. (2019). Tobacco, Alcohol, Drug Use, and Intimate Partner Violence Among MSM Living With HIV. *The Journal of the Association of Nurses in AIDS Care : JANAC*, 30(6), 610–618. <https://doi.org/10.1097/JNC.0000000000000090>
- Chen, Y.-T., Duncan, D. T., Del Vecchio, N., Timmins, L., Pagkas-Bather, J., Lacap, S., Hotton, A., Knox, J., Hanson, H., & Koli, K. (2021). COVID-19–Related Stressors, Sex Behaviors, and HIV Status Neutral Care Among Black Men Who Have Sex With Men and Transgender Women in Chicago, USA. *Journal of Acquired Immune Deficiency*

- Syndromes* (1999), 88(3), 261.
- Chen, Z., Ma, W., Li, Y., Guo, W., Wang, S., Zhang, W., & Chen, Y. (2023). Using machine learning to estimate the incidence rate of intimate partner violence. *Scientific Reports*, 13(1), 5533. <https://doi.org/10.1038/s41598-023-31846-8>
- Choi, A. Y., Israel, T., & Nylund-Gibson, K. (2020). Syndemic behavioral risk and suicidality among bisexual adolescents: A latent class analysis. *Journal of Consulting and Clinical Psychology*, 88(7), 597.
- Choo, E. K., Zlotnick, C., Strong, D. R., Squires, D. D., Tapé, C., & Mello, M. J. (2016). BSAFER: A Web-based intervention for drug use and intimate partner violence demonstrates feasibility and acceptability among women in the emergency department. *Substance Abuse*, 37(3), 441–449.
- Choopanya, K., Martin, M., Suntharasamai, P., Sangkum, U., Mock, P. A., Leethochawalit, M., Chiamwongpaet, S., Kitisin, P., Natrujirote, P., Kittimunkong, S., Chuachoowong, R., Gvetadze, R. J., McNicholl, J. M., Paxton, L. A., Curlin, M. E., Hendrix, C. W., & Vanichseni, S. (2013). Antiretroviral prophylaxis for HIV infection in injecting drug users in Bangkok, Thailand (the Bangkok Tenofovir Study): A randomised, double-blind, placebo-controlled phase 3 trial. *The Lancet*, 381(9883), 2083–2090. [https://doi.org/10.1016/S0140-6736\(13\)61127-7](https://doi.org/10.1016/S0140-6736(13)61127-7)
- Cordoba, E., Parcesepe, A. M., Gallis, J. A., Headley, J., Soffo, C., Tchatchou, B., Hembling, J., & Baumgartner, J. N. (2021). The syndemic effects of mental ill health, household hunger, and intimate partner violence on adherence to antiretroviral therapy among pregnant women living with HIV in Yaoundé, Cameroon. *PLoS One*, 16(2), e0246467.
- Cox, D. R. (1958). The regression analysis of binary sequences. *Journal of the Royal Statistical*

- Society Series B: Statistical Methodology*, 20(2), 215–232.
- Crown, W. H. (2015). Potential application of machine learning in health outcomes research and some statistical cautions. *Value in Health*, 18(2), 137–140.
- Davis, A., Best, J., Wei, C., Luo, J., Van Der Pol, B., Meyerson, B., Dodge, B., Aalsma, M., Tucker, J., & Group, S. E. for S. H. R. (2015). Intimate Partner Violence and Correlates With Risk Behaviors and HIV/STI Diagnoses Among Men Who Have Sex With Men and Men Who Have Sex With Men and Women in China: A Hidden Epidemic. *Sexually Transmitted Diseases*, 42(7), 387–392. <https://doi.org/10.1097/OLQ.0000000000000302>
- Davis, A., Kaighobadi, F., Stephenson, R., Rael, C., & Sandfort, T. (2016). Associations Between Alcohol Use and Intimate Partner Violence Among Men Who Have Sex with Men. *LGBT Health*, 3(6), 400–406. <https://doi.org/10.1089/lgbt.2016.0057>
- Davis, Rock, A., Santa Luce, R., McNaughton-Reyes, L., & Barrington, C. (2020). Intimate Partner Violence Victimization and Mental Health Among Men Who Have Sex With Men Living With HIV in Guatemala. *Journal of Interpersonal Violence*, 0886260520928960. <https://doi.org/10.1177/0886260520928960>
- De Boni, R. B., Machado, I. K., De Vasconcellos, M. T. L., Hoagland, B., Kallas, E. G., Madruga, J. V., Fernandes, N. M., Cerqueira, N. B., Moreira, R. I., Goulart, S. P., Veloso, V. G., Grinsztejn, B., & Luz, P. M. (2018). Syndemics among individuals enrolled in the PrEP Brasil Study. *Drug and Alcohol Dependence*, 185, 168–172. <https://doi.org/10.1016/j.drugalcdep.2017.12.016>
- De Santis, J. P., Gonzalez-Guarda, R., Provencio-Vasquez, E., & Deleon, D. A. (2014). The tangled branches (Las Ramas Enredadas) sexual risk, substance abuse, and intimate partner violence among hispanic men who have sex with men. *Journal of Transcultural*

Nursing, 25(1), 23–32.

Dehingia, N., Dey, A. K., McDougal, L., McAuley, J., Singh, A., & Raj, A. (2022). Help seeking behavior by women experiencing intimate partner violence in india: A machine learning approach to identifying risk factors. *PLOS ONE*, 17(2), e0262538.

<https://doi.org/10.1371/journal.pone.0262538>

Devlin, J., Chang, M.-W., Lee, K., & Toutanova, K. (2018). Bert: Pre-training of deep bidirectional transformers for language understanding. *arXiv Preprint arXiv:1810.04805*.

Diaz, R. M., & Ayala, G. (2001). *Social Discrimination and Health: The Case of Latino Gay Men and HIV Risk*. Policy Institute of the National Gay and Lesbian Task Force.

Díaz, R. M., Ayala, G., & Bein, E. (2004). Sexual risk as an outcome of social oppression: Data from a probability sample of Latino gay men in three U.S. cities. *Cultural Diversity & Ethnic Minority Psychology*, 10(3), 255–267. <https://doi.org/10.1037/1099-9809.10.3.255>

Dicola, D., & Spaar, E. (2016). Intimate Partner Violence. *American Family Physician*, 94(8), 646–651.

Doupe, P., Faghmous, J., & Basu, S. (2019). Machine learning for health services researchers. *Value in Health*, 22(7), 808–815.

Dubov, A., Galbo, P., Altice, F. L., & Fraenkel, L. (2018). Stigma and Shame Experiences by MSM Who Take PrEP for HIV Prevention: A Qualitative Study. *American Journal of Men's Health*, 12(6), 1843–1854. <https://doi.org/10.1177/1557988318797437>

Duncan, D. T., Goedel, W. C., Stults, C. B., Brady, W. J., Brooks, F. A., Blakely, J. S., & Hagen, D. (2018). A Study of Intimate Partner Violence, Substance Abuse, and Sexual Risk Behaviors Among Gay, Bisexual, and Other Men Who Have Sex With Men in a Sample of Geosocial-Networking Smartphone Application Users. *American Journal of Men's*

- Health*, 12(2), 292–301. <https://doi.org/10.1177/1557988316631964>
- Dürrbaum, T., & Sattler, F. A. (2020). Minority stress and mental health in lesbian, gay male, and bisexual youths: A meta-analysis. *Journal of LGBT Youth*, 17(3), 298–314.
- Edeza, A., Karina Santamaria, E., Valente, P. K., Gomez, A., Ogunbajo, A., & Biello, K. (2021). Experienced barriers to adherence to pre-exposure prophylaxis for HIV prevention among MSM: A systematic review and meta-ethnography of qualitative studies. *AIDS Care*, 33(6), 697–705. <https://doi.org/10.1080/09540121.2020.1778628>
- Edwards, K. M., Sylaska, K. M., & Neal, A. M. (2015). Intimate partner violence among sexual minority populations: A critical review of the literature and agenda for future research. *Psychology of Violence*, 5(2), 112.
- English, D., Rendina, H. J., & Parsons, J. T. (2018). The effects of intersecting stigma: A longitudinal examination of minority stress, mental health, and substance use among Black, Latino, and multiracial gay and bisexual men. *Psychology of Violence*, 8(6), 669.
- Estcourt, C., Yeung, A., Nandwani, R., Goldberg, D., Cullen, B., Steedman, N., Wallace, L., & Hutchinson, S. (2021). Population-level effectiveness of a national HIV preexposure prophylaxis programme in MSM. *AIDS (London, England)*, 35(4), 665–673. <https://doi.org/10.1097/QAD.0000000000002790>
- Feinstein, B. A., & Dodge, B. (2020). Meeting the Sexual Health Needs of Bisexual Men in the Age of Biomedical HIV Prevention: Gaps and Priorities. *Archives of Sexual Behavior*, 49(1), 217–232. <https://doi.org/10.1007/s10508-019-01468-1>
- Feinstein, B. A., Dodge, B., Korpak, A. K., Newcomb, M. E., & Mustanski, B. (2019). Improving the health of cisgender men who identify as bisexual: What do they want from interventions? *Sexuality Research and Social Policy*, 16(3), 385–391.

- Feinstein, B. A., & Dyar, C. (2017). Bisexuality, Minority Stress, and Health. *Current Sexual Health Reports*, 9(1), 42–49. <https://doi.org/10.1007/s11930-017-0096-3>
- Fingerhut, A. W., Peplau, L. A., & Gable, S. L. (2010). Identity, minority stress and psychological well-being among gay men and lesbians. *Psychology & Sexuality*, 1(2), 101–114.
- Finlayson, T., Cha, S., Xia, M., Trujillo, L., Denson, D., Prejean, J., Kanny, D., Wejnert, C., Abrego, M., & Al-Tayyib, A. (2019). Changes in HIV preexposure prophylaxis awareness and use among men who have sex with men—20 urban areas, 2014 and 2017. *Morbidity and Mortality Weekly Report*, 68(27), 597.
- Finneran, C., & Stephenson, R. (2013). Intimate Partner Violence Among Men Who Have Sex With Men: A Systematic Review. *Trauma, Violence, & Abuse*, 14(2), 168–185. <https://doi.org/10.1177/1524838012470034>
- Finneran, C., & Stephenson, R. (2014a). Antecedents of intimate partner violence among gay and bisexual men. *Violence and Victims*, 29(3), 422–435.
- Finneran, C., & Stephenson, R. (2014b). Intimate Partner Violence, Minority Stress, and Sexual Risk-Taking Among U.S. Men Who Have Sex With Men. *Journal of Homosexuality*, 61(2), 288–306. <https://doi.org/10.1080/00918369.2013.839911>
- Flentje, A., Heck, N. C., Brennan, J. M., & Meyer, I. H. (2020). The relationship between minority stress and biological outcomes: A systematic review. *Journal of Behavioral Medicine*, 43(5), 673–694.
- Folger, S. F., & Wright, M. O. (2013). Altering risk following child maltreatment: Family and friend support as protective factors. *Journal of Family Violence*, 28(4), 325–337.
- Foulds, J., Veldheer, S., Yingst, J., Hrabovsky, S., Wilson, S. J., Nichols, T. T., & Eissenberg, T.

- (2015). Development of a Questionnaire for Assessing Dependence on Electronic Cigarettes Among a Large Sample of Ex-Smoking E-cigarette Users. *Nicotine & Tobacco Research*, 17(2), 186–192. <https://doi.org/10.1093/ntr/ntu204>
- Freeland, R., Goldenberg, T., & Stephenson, R. (2018). Perceptions of Informal and Formal Coping Strategies for Intimate Partner Violence Among Gay and Bisexual Men. *American Journal of Men's Health*, 12(2), 302–312. <https://doi.org/10.1177/1557988316631965>
- Friedman, J. H. (2001). Greedy function approximation: A gradient boosting machine. *Annals of Statistics*, 1189–1232.
- Friedman, M. R., Sang, J. M., Bukowski, L. A., Chandler, C. J., Egan, J. E., Eaton, L. A., Matthews, D. D., Ho, K., Raymond, H. F., & Stall, R. (2019). Prevalence and Correlates of PrEP Awareness and Use Among Black Men Who Have Sex with Men and Women (MSMW) in the United States. *AIDS and Behavior*, 23(10), 2694–2705. <https://doi.org/10.1007/s10461-019-02446-3>
- Fulginiti, A., Rhoades, H., Mamey, M. R., Klemmer, C., Srivastava, A., Weskamp, G., & Goldbach, J. T. (2021). Sexual minority stress, mental health symptoms, and suicidality among LGBTQ youth accessing crisis services. *Journal of Youth and Adolescence*, 50(5), 893–905.
- Gebbru, N. M., Benvenuti, M. C., Rowland, B. H. P., Kalkat, M., Chauca, P. G., & Leeman, R. F. (2022). Relationships among Substance Use, Sociodemographics, Pre-Exposure Prophylaxis (PrEP) Awareness and Related Attitudes among Young Adult Men Who Have Sex with Men. *Substance Use & Misuse*, 0(0), 1–13. <https://doi.org/10.1080/10826084.2022.2040030>

- Ghosh, S., Dasgupta, A., & Swetapadma, A. (2019). A study on support vector machine based linear and non-linear pattern classification. *2019 International Conference on Intelligent Sustainable Systems (ICISS)*, 24–28.
- Gilbert, L., Goddard-Eckrich, D., Hunt, T., Ma, X., Chang, M., Rowe, J., McCrimmon, T., Johnson, K., Goodwin, S., Almonte, M., & Shaw, S. A. (2016). Efficacy of a Computerized Intervention on HIV and Intimate Partner Violence Among Substance-Using Women in Community Corrections: A Randomized Controlled Trial. *American Journal of Public Health*, 106(7), 1278–1286. <https://doi.org/10.2105/AJPH.2016.303119>
- Godley, B. A., & Adimora, A. A. (2020). Syndemic theory, structural violence and HIV among African–Americans. *Current Opinion in HIV and AIDS*, 15(4), 250–255. <https://doi.org/10.1097/COH.0000000000000634>
- Goldenberg, T., Stephenson, R., Freeland, R., Finneran, C., & Hadley, C. (2016). ‘Struggling to be the alpha’: Sources of tension and intimate partner violence in same-sex relationships between men. *Culture, Health & Sexuality*, 18(8), 875–889.
- Golub, S. A., Gamarel, K. E., Rendina, H. J., Surace, A., & Lelutiu-Weinberger, C. L. (2013). From Efficacy to Effectiveness: Facilitators and Barriers to PrEP Acceptability and Motivations for Adherence Among MSM and Transgender Women in New York City. *AIDS Patient Care and STDs*, 27(4), 248–254. <https://doi.org/10.1089/apc.2012.0419>
- González-Guarda, R. M., Florom-Smith, A. L., & Thomas, T. (2011). A syndemic model of substance abuse, intimate partner violence, HIV infection, and mental health among Hispanics. *Public Health Nursing*, 28(4), 366–378.
- Gonzalez-Guarda, R. M., Ortega, J., Vasquez, E. P., & De Santis, J. (2010). La mancha negra: Substance abuse, violence, and sexual risks among Hispanic males. *Western Journal of*

- Nursing Research*, 32(1), 128–148.
- Grant, R. M., Lama, J. R., Anderson, P. L., McMahan, V., Liu, A. Y., Vargas, L., Goicochea, P., Casapía, M., Guanira-Carranza, J. V., Ramirez-Cardich, M. E., Montoya-Herrera, O., Fernández, T., Veloso, V. G., Buchbinder, S. P., Chariyalertsak, S., Schechter, M., Bekker, L.-G., Mayer, K. H., Kallás, E. G., ... Glidden, D. V. (2010). Preexposure Chemoprophylaxis for HIV Prevention in Men Who Have Sex with Men. *New England Journal of Medicine*, 363(27), 2587–2599. <https://doi.org/10.1056/NEJMoa1011205>
- Gravlee, C. C. (2020). Systemic racism, chronic health inequities, and COVID-19: A syndemic in the making? *American Journal of Human Biology*.
- Greenwood, G. L., Relf, M. V., Huang, B., Pollack, L. M., Canchola, J. A., & Catania, J. A. (2002). Battering victimization among a probability-based sample of men who have sex with men. *American Journal of Public Health*, 92(12), 1964–1969.
- Grulich, A. E., Jin, F., Bavinton, B. R., Yeung, B., Hammoud, M. A., Amin, J., Cabrera, G., Clackett, S., Ogilvie, E., Vaccher, S., Vickers, T., McNulty, A., Smith, D. J., Dharan, N. J., Selvey, C., Power, C., Price, K., Zablotska, I., Baker, D. A., ... Guy, R. (2021). Long-term protection from HIV infection with oral HIV pre-exposure prophylaxis in gay and bisexual men: Findings from the expanded and extended EPIC-NSW prospective implementation study. *The Lancet HIV*, 8(8), e486–e494. [https://doi.org/10.1016/S2352-3018\(21\)00074-6](https://doi.org/10.1016/S2352-3018(21)00074-6)
- Guo, P., Hou, F., Cao, W., Guo, Y., Wei, D., Li, J., & Hao, Y. (2022). Intimate Partner Violence and Willingness to Use Pre-Exposure Prophylaxis Among Men Who Have Sex With Men in Chengdu, China. *Journal of Interpersonal Violence*, 08862605221127197. <https://doi.org/10.1177/08862605221127197>

- Guo, P., Hou, F., Cao, W., Guo, Y., Wei, D., Li, J., & Hao, Y. (2023). Intimate Partner Violence and Willingness to Use Pre-Exposure Prophylaxis Among Men Who Have Sex With Men in Chengdu, China. *Journal of Interpersonal Violence*, 38(7–8), 5824–5848.
<https://doi.org/10.1177/08862605221127197>
- Hall, E. W., Heneine, W., Sanchez, T., Sineath, R. C., & Sullivan, P. (2016). Preexposure Prophylaxis Modality Preferences Among Men Who Have Sex With Men and Use Social Media in the United States. *Journal of Medical Internet Research*, 18(5), e111.
<https://doi.org/10.2196/jmir.5713>
- Heffron, R., MUGO, N., WERE, E., KIARIE, J., BUKUSI, E. A., MUJUGIRA, A., FRENKEL, L., DONNELL, D., RONALD, A., CELUM, C., & BAETEN, J. M. (2014). PrEP is Efficacious for HIV-1 prevention among Women using DMPA for Contraception. *AIDS (London, England)*, 28(18), 2771–2776.
<https://doi.org/10.1097/QAD.0000000000000493>
- Hesser, H., Axelsson, S., Bäcké, V., Engstrand, J., Gustafsson, T., Holmgren, E., Jeppsson, U., Pollack, M., Nordén, K., Rosenqvist, D., & Andersson, G. (2017). Preventing intimate partner violence via the Internet: A randomized controlled trial of emotion-regulation and conflict-management training for individuals with aggression problems. *Clinical Psychology & Psychotherapy*, 24(5), 1163–1177. <https://doi.org/10.1002/cpp.2082>
- Holloway, I. W., Beltran, R., Shah, S. V., Cordero, L., Garth, G., Smith, T., Wilson, B. D., & Ochoa, A. M. (2021). Structural Syndemics and Antiretroviral Medication Adherence Among Black Sexual Minority Men Living With HIV. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 88(1), S12.
- Holloway, I. W., Wu, E. S. C., Boka, C., Young, N., Hong, C., Fuentes, K., Kärkkäinen, K.,

- Beikzadeh, M., Avendaño, A., Juaregui, J. C., Zhang, A., Sevillano, L., Fyfe, C., Brisbin, C. D., Beltran, R. M., Cordero, L., Parsons, J. T., & Sarrafzadeh, M. (2024). *Novel Machine-Learning HIV Intervention for Sexual and Gender Minority Young People Who Have Sex with Men (uTECH): Protocol for Randomized Comparison Trial (Preprint)*. <https://doi.org/10.2196/preprints.58448>
- Homan, C. M., Schradling, J. N., Ptucha, R. W., Cerulli, C., & Alm, C. O. (2020). Quantitative Methods for Analyzing Intimate Partner Violence in Microblogs: Observational Study. *Journal of Medical Internet Research*, 22(11), e15347. <https://doi.org/10.2196/15347>
- Hong, C., Feinstein, B. A., Holloway, I. W., Yu, F., Huang, W., Sullivan, P. S., Siegler, A. J., & Mi, G. (2022). Differences in Sexual Behaviors, HIV Testing, and Willingness to Use PrEP between Gay and Bisexual Men Who Have Sex with Men in China. *International Journal of Sexual Health*, 34(3), 424–431. <https://doi.org/10.1080/19317611.2022.2053922>
- Hong, C., Ochoa, A. M., Wilson, B. D. M., Wu, E. S. C., Thomas, D., & Holloway, I. W. (2023). The associations between HIV stigma and mental health symptoms, life satisfaction, and quality of life among Black sexual minority men with HIV. *Quality of Life Research*, 32(6), 1693–1702. <https://doi.org/10.1007/s11136-023-03342-z>
- Hong, C., Stephenson, R., Santos, G.-M., Garner, A., Howell, S., & Holloway, I. (2022). Intimate Partner Violence Victimization During the COVID-19 Pandemic Among a Global Online Sample of Sexual Minority Men. *Journal of Family Violence*. <https://doi.org/10.1007/s10896-022-00461-y>
- Houston, E., & McKirnan, D. J. (2007). Intimate partner abuse among gay and bisexual men: Risk correlates and health outcomes. *Journal of Urban Health*, 84(5), 681–690.

- Hubach, R. D., Currin, J. M., Sanders, C. A., Durham, A. R., Kavanaugh, K. E., Wheeler, D. L., & Croff, J. M. (2017). Barriers to Access and Adoption of Pre-Exposure Prophylaxis for the Prevention of HIV Among Men Who Have Sex With Men (MSM) in a Relatively Rural State. *AIDS Education and Prevention: Official Publication of the International Society for AIDS Education*, 29(4), 315–329. <https://doi.org/10.1521/aeap.2017.29.4.315>
- Huntley, A. L., Potter, L., Williamson, E., Malpass, A., Szilassy, E., & Feder, G. (2019). Help-seeking by male victims of domestic violence and abuse (DVA): A systematic review and qualitative evidence synthesis. *BMJ Open*, 9(6), e021960. <https://doi.org/10.1136/bmjopen-2018-021960>
- Illangasekare, S., Burke, J., Chander, G., & Gielen, A. (2013). The syndemic effects of intimate partner violence, HIV/AIDS, and substance abuse on depression among low-income urban women. *Journal of Urban Health*, 90(5), 934–947.
- Iribarren, S. J., Akande, T. O., Kamp, K. J., Barry, D., Kader, Y. G., & Suelzer, E. (2021). Effectiveness of Mobile Apps to Promote Health and Manage Disease: Systematic Review and Meta-analysis of Randomized Controlled Trials. *JMIR mHealth and uHealth*, 9(1), e21563. <https://doi.org/10.2196/21563>
- Islam, N., Lacey, B., Shabnam, S., Erzurumluoglu, A. M., Dambha-Miller, H., Chowell, G., Kawachi, I., & Marmot, M. (2021). Social inequality and the syndemic of chronic disease and COVID-19: County-level analysis in the USA. *J Epidemiol Community Health*, 75(6), 496–500.
- James, C. A., Schwartz, D. R., Roberts, K. E., Hart, T. A., Loutfy, M. R., Myers, T., & Calzavara, L. (2012). Childhood emotional abuse and psychological distress in gay and bisexual men. *Journal of Aggression, Maltreatment & Trauma*, 21(8), 851–869.

- Jing, F., Ye, Y., Zhou, Y., Ni, Y., Yan, X., Lu, Y., Ong, J. J., Tucker, J. D., Wu, D., Xiong, Y., Xu, C., He, X., Huang, S., Li, X., Jiang, H., Wang, C., Dai, W., Huang, L., Mei, W., ... Tang, W. (2021). *Identification of Key Influencers for Secondary Distribution of HIV Self-Testing among Chinese MSM: A Machine Learning Approach* [Preprint]. HIV/AIDS. <https://doi.org/10.1101/2021.04.19.21255584>
- Jiwatram-Negrón, T., Michalopoulos, L. M., & El-Bassel, N. (2018). The syndemic effect of injection drug use, intimate partner violence, and HIV on mental health among drug-involved women in Kazakhstan. *Global Social Welfare*, 5(2), 71–81.
- John, S. A., Starks, T. J., Rendina, H. J., Grov, C., & Parsons, J. T. (2018). Should I Convince My Partner to Go on Pre-Exposure Prophylaxis (PrEP)? The Role of Personal and Relationship Factors on PrEP-Related Social Control among Gay and Bisexual Men. *AIDS and Behavior*, 22(4), 1239–1252. <https://doi.org/10.1007/s10461-017-1835-1>
- Jordon, J., Szpruch, L., Houssiau, F., Bottarelli, M., Cherubin, G., Maple, C., Cohen, S. N., & Weller, A. (2022). *Synthetic Data—What, why and how?* (arXiv:2205.03257). arXiv. <https://doi.org/10.48550/arXiv.2205.03257>
- Kalichman, S. C., Benotsch, E., Rompa, D., Gore-Felton, C., Austin, J., Luke, W., DiFonzo, K., Buckles, J., Kyomugisha, F., & Simpson, D. (2001). Unwanted sexual experiences and sexual risks in gay and bisexual men: Associations among revictimization, substance use, and psychiatric symptoms. *Journal of Sex Research*, 38(1), 1–9.
- Kanny, D., Jeffries, W. L., Chapin-Bardales, J., Denning, P., Cha, S., Finlayson, T., Wejnert, C., & National HIV Behavioral Surveillance Study Group. (2019). Racial/Ethnic Disparities in HIV Preexposure Prophylaxis Among Men Who Have Sex with Men—23 Urban Areas, 2017. *MMWR. Morbidity and Mortality Weekly Report*, 68(37), 801–806.

<https://doi.org/10.15585/mmwr.mm6837a2>

- Kazan, D., Calex, A. L., & Batterham, P. J. (2016). The impact of intimate partner relationships on suicidal thoughts and behaviours: A systematic review. *Journal of Affective Disorders*, 190, 585–598. <https://doi.org/10.1016/j.jad.2015.11.003>
- Kimberg, L., & Wheeler, M. (2019). Trauma and Trauma-Informed Care. In M. R. Gerber (Ed.), *Trauma-Informed Healthcare Approaches: A Guide for Primary Care* (pp. 25–56). Springer International Publishing. https://doi.org/10.1007/978-3-030-04342-1_2
- Klitzman, R. L., Pope Jr, H. G., & Hudson, J. I. (2000). MDMA (“Ecstasy”) abuse and high-risk sexual behaviors among 169 gay and bisexual men. *American Journal of Psychiatry*, 157(7), 1162–1164.
- Koblin, B. A., Torian, L., Xu, G., Guilin, V., Makki, H., Mackellar, D., & Valleroy, L. (2006). Violence and HIV-related risk among young men who have sex with men. *AIDS Care*, 18(8), 961–967.
- Koziol-McLain, J., Vandal, A. C., Wilson, D., Nada-Raja, S., Dobbs, T., McLean, C., Sisk, R., Eden, K. B., & Glass, N. E. (2018). Efficacy of a Web-Based Safety Decision Aid for Women Experiencing Intimate Partner Violence: Randomized Controlled Trial. *Journal of Medical Internet Research*, 20(1), e8617. <https://doi.org/10.2196/jmir.8617>
- Krueger, E. A., Hong, C., Cunningham, N. J., Berteau, L. (Katy), Cordero, L., Wu, E. S. C., & Holloway, I. W. (2023). Prevalence of Nicotine and Tobacco Product Use by Sexual Identity, Gender Identity, and Sex Assigned at Birth Among Emerging Adult Tobacco Users in California, United States. *Nicotine & Tobacco Research*, 25(7), 1378–1385. <https://doi.org/10.1093/ntr/ntad048>
- Kubicek, K. (2018). Setting an Agenda to Address Intimate Partner Violence Among Young

- Men Who Have Sex With Men: A Conceptual Model and Review. *Trauma, Violence, & Abuse*, 19(4), 473–487. <https://doi.org/10.1177/1524838016673599>
- Kubicek, K., McNeeley, M., & Collins, S. (2015a). “Same-sex relationship in a straight world” individual and societal influences on power and control in young men’s relationships. *Journal of Interpersonal Violence*, 30(1), 83–109.
- Kubicek, K., McNeeley, M., & Collins, S. (2015b). “Same-Sex Relationship in a Straight World”: Individual and Societal Influences on Power and Control in Young Men’s Relationships. *Journal of Interpersonal Violence*, 30(1), 83–109. <https://doi.org/10.1177/0886260514532527>
- Kuhns, L. M., Garofalo, R., Hidalgo, M., Hirshfield, S., Pearson, C., Bruce, J., Batey, D. S., Radix, A., Belkind, U., Jia, H., & Schnall, R. (2020). A randomized controlled efficacy trial of an mHealth HIV prevention intervention for sexual minority young men: MyPEEPS mobile study protocol. *BMC Public Health*, 20(1), 65. <https://doi.org/10.1186/s12889-020-8180-4>
- Laurenzi, C., Field, S., & Honikman, S. (2020). Food insecurity, maternal mental health, and domestic violence: A call for a syndemic approach to research and interventions. *Maternal and Child Health Journal*, 24(4), 401–404.
- Learning, M. (2017). Heart disease diagnosis and prediction using machine learning and data mining techniques: A review. *Advances in Computational Sciences and Technology*, 10(7), 2137–2159.
- Linn, A. J., Vervloet, M., van Dijk, L., Smit, E. G., & Van Weert, J. C. (2011). Effects of eHealth interventions on medication adherence: A systematic review of the literature. *Journal of Medical Internet Research*, 13(4), e1738.

- Liu, C., Chen, X., Song, P., Lu, A., Wang, L., Zhang, X., Huang, Z., & Zheng, D. (2018). Relationship Between Childhood Emotional Abuse and Self-Esteem: A Dual Mediation Model of Attachment. *Social Behavior and Personality: An International Journal*, 46(5), 793–800. <https://doi.org/10.2224/sbp.6655>
- Liu, Cai, X., Hao, G., Li, W., Chen, Q., Chen, Y., & Xiong, P. (2021). Prevalence of Intimate Partner Violence Among Men Who Have Sex With Men: An Updated Systematic Review and Meta-Analysis. *Sexual Medicine*, 9(6), 100433. <https://doi.org/10.1016/j.esxm.2021.100433>
- LoSchiavo, C., Acuna, N., & Halkitis, P. N. (2021). Evidence for the Confluence of Cigarette Smoking, Other Substance Use, and Psychosocial and Mental Health in a Sample of Urban Sexual Minority Young Adults: The P18 Cohort Study. *Annals of Behavioral Medicine*, 55(4), 308–320. <https://doi.org/10.1093/abm/kaaa052>
- Lytle, M. C., Vaughan, M. D., Rodriguez, E. M., & Shmerler, D. L. (2014). Working with LGBT individuals: Incorporating positive psychology into training and practice. *Psychology of Sexual Orientation and Gender Diversity*, 1, 335–347. <https://doi.org/10.1037/sgd0000064>
- Maffulli, N., Rodriguez, H. C., Stone, I. W., Nam, A., Song, A., Gupta, M., Alvarado, R., Ramon, D., & Gupta, A. (2020). Artificial intelligence and machine learning in orthopedic surgery: A systematic review protocol. *Journal of Orthopaedic Surgery and Research*, 15(1), 478. <https://doi.org/10.1186/s13018-020-02002-z>
- Maloney, K. M., Bratcher, A., Wilkerson, R., & Sullivan, P. S. (2020). Electronic and other new media technology interventions for HIV care and prevention: A systematic review. *Journal of the International AIDS Society*, 23(1), e25439.

<https://doi.org/10.1002/jia2.25439>

- Marcus, J. L., Hurley, L. B., Krakower, D. S., Alexeeff, S., Silverberg, M. J., & Volk, J. E. (2019). Use of electronic health record data and machine learning to identify candidates for HIV pre-exposure prophylaxis: A modelling study. *The Lancet HIV*, 6(10), e688–e695. [https://doi.org/10.1016/S2352-3018\(19\)30137-7](https://doi.org/10.1016/S2352-3018(19)30137-7)
- Marczinski, C. A., Hertenberg, H., Goddard, P., Maloney, S. F., Stamates, A. L., & O'Connor, K. (2016). Alcohol-related Facebook activity predicts alcohol use patterns in college students. *Addiction Research & Theory*, 24(5), 398–405.
- Mendenhall, E., Kohrt, B. A., Logie, C. H., & Tsai, A. C. (2022). Syndemics and clinical science. *Nature Medicine*, 28(7), Article 7. <https://doi.org/10.1038/s41591-022-01888-y>
- Meraj, S. S., Yaakob, R., Azman, A., Rum, S. N. M., & Nazri, A. S. A. (2019). Artificial intelligence in diagnosing tuberculosis: A review. *International Journal on Advanced Science, Engineering and Information Technology*, 9(1), 81–91.
- Merrill, G. S., & Wolfe, V. A. (2000). Battered Gay Men: An Exploration of Abuse, Help Seeking, and Why They Stay. *Journal of Homosexuality*, 39(2), 1–30. https://doi.org/10.1300/J082v39n02_01
- Messing, J. T., Ward-Lasher, A., Thaller, J., & Bagwell-Gray, M. E. (2015). The state of intimate partner violence intervention: Progress and continuing challenges. In *Social Work* (Vol. 60, Issue 4, pp. 305–313). Oxford University Press.
- Meyer, I. H. (1995). Minority Stress and Mental Health in Gay Men. *Journal of Health and Social Behavior*, 36(1), 38–56. <https://doi.org/10.2307/2137286>
- 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. <https://doi.org/10.1037/0033-2909.129.5.674>

Mezzina, R., Gopikumar, V., Jenkins, J., Saraceno, B., & Sashidharan, S. P. (2022). Social Vulnerability and Mental Health Inequalities in the “Syndemic”: Call for Action.

Frontiers in Psychiatry, 13.

Miller, S. J., Harrison, S. E., & Sanasi-Bhola, K. (2021). A Scoping Review Investigating Relationships between Depression, Anxiety, and the PrEP Care Continuum in the United States. *International Journal of Environmental Research and Public Health, 18*(21), Article 21. <https://doi.org/10.3390/ijerph182111431>

Miltz, Lampe, F. C., Bacchus, L. J., McCormack, S., Dunn, D., White, E., Rodger, A., Phillips, A. N., Sherr, L., Clarke, A., McOwan, A., Sullivan, A., & Gafos, M. (2019). Intimate partner violence, depression, and sexual behaviour among gay, bisexual and other men who have sex with men in the PROUD trial. *BMC Public Health, 19*(1), 431.

<https://doi.org/10.1186/s12889-019-6757-6>

Muessig, K. E., Nekkanti, M., Bauermeister, J., Bull, S., & Hightow-Weidman, L. B. (2015). A systematic review of recent smartphone, Internet and Web 2.0 interventions to address the HIV continuum of care. *Current Hiv/Aids Reports, 12*(1), 173–190.

Nelson, H. D., Bougatsos, C., & Blazina, I. (2012). Screening women for intimate partner violence: A systematic review to update the US Preventive Services Task Force recommendation. *Annals of Internal Medicine, 156*(11), 796–808.

Ngiam, K. Y., & Khor, I. W. (2019). Big data and machine learning algorithms for health-care delivery. *The Lancet Oncology, 20*(5), e262–e273. [https://doi.org/10.1016/S1470-2045\(19\)30149-4](https://doi.org/10.1016/S1470-2045(19)30149-4)

Nieves-Rosa, L. E., Carballo-Diequez, A., & Dolezal, C. (2000). Domestic Abuse and HIV-Risk

- Behavior in Latin American Men Who Have Sex with Men in New York City. *Journal of Gay & Lesbian Social Services*, 11(1), 77–90. https://doi.org/10.1300/J041v11n01_04
- Ollen, E. W., Link to external site, this link will open in a new window, Ameral, V. E., Palm Reed, K., & Hines, D. A. (2017). Sexual minority college students' perceptions on dating violence and sexual assault. *Journal of Counseling Psychology*, 64(1), 112–119. <https://doi.org/10.1037/cou0000180>
- O'Malley, T. L., Hawk, M. E., Egan, J. E., Krier, S. E., & Burke, J. G. (2020). Intimate Partner Violence and Pre-exposure Prophylaxis (PrEP): A Rapid Review of Current Evidence for Women's HIV Prevention. *AIDS and Behavior*, 24(5), 1342–1357. <https://doi.org/10.1007/s10461-019-02743-x>
- Ompad, D. C., Kingdon, M., Kupprat, S., Halkitis, S. N., Storholm, E. D., & Halkitis, P. N. (2014). Smoking and HIV-related Health Issues among Older HIV-positive Gay, Bisexual, and Other Men Who Have Sex with Men. *Behavioral Medicine*, 40(3), 99–107. <https://doi.org/10.1080/08964289.2014.889067>
- Ovalle, A., Goldstein, O., Kachuee, M., Wu, E. S. C., Hong, C., Holloway, I. W., & Sarrafzadeh, M. (2021). Leveraging Social Media Activity and Machine Learning for HIV and Substance Abuse Risk Assessment: Development and Validation Study. *Journal of Medical Internet Research*, 23(4), e22042. <https://doi.org/10.2196/22042>
- Pachankis, J. E. (2014). Uncovering clinical principles and techniques to address minority stress, mental health, and related health risks among gay and bisexual men. *Clinical Psychology: Science and Practice*, 21(4), 313.
- Pagliari, C., Sloan, D., Gregor, P., Sullivan, F., Detmer, D., Kahan, J. P., Oortwijn, W., & MacGillivray, S. (2005). What is eHealth (4): A scoping exercise to map the field.

- Journal of Medical Internet Research*, 7(1), e391.
- Pagoto, S., Waring, M. E., May, C. N., Ding, E. Y., Kunz, W. H., Hayes, R., & Oleski, J. L. (2016). Adapting behavioral interventions for social media delivery. *Journal of Medical Internet Research*, 18(1), e5086.
- Pantalone, D. W., Schneider, K. L., Valentine, S. E., & Simoni, J. M. (2012). Investigating partner abuse among HIV-positive men who have sex with men. *AIDS and Behavior*, 16(4), 1031–1043.
- Parsons, J. T., Grov, C., & Golub, S. A. (2012). Sexual compulsivity, co-occurring psychosocial health problems, and HIV risk among gay and bisexual men: Further evidence of a syndemic. *American Journal of Public Health*, 102(1), 156–162.
- Parsons, J. T., Millar, B. M., Moody, R. L., Starks, T. J., Rendina, H. J., & Grov, C. (2017). Syndemic conditions and HIV transmission risk behavior among HIV-negative gay and bisexual men in a US national sample. *Health Psychology*, 36(7), 695.
- Parsons, J. T., Rendina, H. J., Moody, R. L., Ventuneac, A., & Grov, C. (2015). Syndemic production and sexual compulsivity/hypersexuality in highly sexually active gay and bisexual men: Further evidence for a three group conceptualization. *Archives of Sexual Behavior*, 44(7), 1903–1913.
- Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., & Dubourg, V. (2011). Scikit-learn: Machine learning in Python. *The Journal of Machine Learning Research*, 12, 2825–2830.
- Peng, She, R., Gu, J., Hao, C., Hou, F., Wei, D., & Li, J. (2020). The mediating role of self-stigma and self-efficacy between intimate partner violence (IPV) victimization and depression among men who have sex with men in China. *BMC Public Health*, 20(1), 2.

<https://doi.org/10.1186/s12889-019-8125-y>

- Pennebaker, J. W., Francis, M. E., & Booth, R. J. (2001). Linguistic inquiry and word count: LIWC 2001. *Mahway: Lawrence Erlbaum Associates*, 71(2001), 2001.
- Pereira, A., Santos, J. P., Sardinha, P., Cardoso, J., Ramos, C., & Almeida, T. (2021). The impact of childhood abuse on adult self-esteem and emotional regulation. *Annals of Medicine*, 53(sup1), S164–S164. <https://doi.org/10.1080/07853890.2021.1896171>
- Petering, R., Um, M. Y., Fard, N. A., Tavabi, N., Kumari, R., & Gilani, S. N. (2018). Artificial intelligence to predict intimate partner violence perpetration. *Artificial Intelligence and Social Work*, 195.
- Peters, D. J., Monnat, S. M., Hochstetler, A. L., & Berg, M. T. (2020). The Opioid Hydra: Understanding Overdose Mortality Epidemics and Syndemics Across the Rural-Urban Continuum. *Rural Sociology*, 85(3), 589–622.
- Pinto, R. M., Berringer, K. R., Melendez, R., & Mmeje, O. (2018). Improving PrEP implementation through multilevel interventions: A synthesis of the literature. *AIDS and Behavior*, 22(11), 3681–3691.
- Platteau, T., Herrijgers, C., & de Wit, J. (2020). Digital chemsex support and care: The potential of just-in-time adaptive interventions. *International Journal of Drug Policy*, 85, 102927.
- Poteat, T., Millett, G. A., Nelson, L. E., & Beyrer, C. (2020). Understanding COVID-19 risks and vulnerabilities among black communities in America: The lethal force of syndemics. *Annals of Epidemiology*, 47, 1–3.
- Raghunathan, T. E. (2021). Synthetic Data. *Annual Review of Statistics and Its Application*, 8(Volume 8, 2021), 129–140. <https://doi.org/10.1146/annurev-statistics-040720-031848>
- Ramirez, J. L., & Paz Galupo, M. (2019). Multiple minority stress: The role of proximal and

- distal stress on mental health outcomes among lesbian, gay, and bisexual people of color. *Journal of Gay & Lesbian Mental Health*, 23(2), 145–167.
- Reeves, E. (2015). A Synthesis of the Literature on Trauma-Informed Care. *Issues in Mental Health Nursing*, 36(9), 698–709. <https://doi.org/10.3109/01612840.2015.1025319>
- Relf, M. V. (2001). Battering and HIV in men who have sex with men: A critique and synthesis of the literature. *Journal of the Association of Nurses in AIDS Care*, 12(3), 41–48.
- Reuter, T. R., Newcomb, M. E., Whitton, S. W., & Mustanski, B. (2017). Intimate partner violence victimization in LGBT young adults: Demographic differences and associations with health behaviors. *Psychology of Violence*, 7(1), 101–109. <https://doi.org/10.1037/vio0000031>
- Roberts, S. T., Haberer, J., Celum, C., Mugo, N., Ware, N. C., Cohen, C. R., Tappero, J. W., Kiarie, J., Ronald, A., & Mujugira, A. (2016). Intimate partner violence and adherence to HIV pre-exposure prophylaxis (PrEP) in African women in HIV serodiscordant relationships: A prospective cohort study. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 73(3), 313.
- Robinson, S. R., Ravi, K., & Voth Schrag, R. J. (2021). A systematic review of barriers to formal help seeking for adult survivors of IPV in the United States, 2005–2019. *Trauma, Violence, & Abuse*, 22(5), 1279–1295.
- Rollè, L., Giardina, G., Caldarera, A. M., Gerino, E., & Brustia, P. (2018). When Intimate Partner Violence Meets Same Sex Couples: A Review of Same Sex Intimate Partner Violence. *Frontiers in Psychology*, 9. <https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01506>
- Rustagi, K., JadKarim, L., Birk, N., & Tran, A. (2023). Discrimination and intimate partner

- violence among a sample of bisexual and gay men in the United States: A cross-sectional study. *Frontiers in Public Health*, 11. <https://doi.org/10.3389/fpubh.2023.1182263>
- Saha, K., Yousuf, A., Boyd, R. L., Pennebaker, J. W., & De Choudhury, M. (2022). Social media discussions predict mental health consultations on college campuses. *Scientific Reports*, 12(1), 1–11.
- Santos, G.-M., Ackerman, B., Rao, A., Wallach, S., Ayala, G., Lamontagne, E., Garner, A., Holloway, I. W., Arreola, S., Silenzio, V., Strömdahl, S., Yu, L., Strong, C., Adamson, T., Yakusik, A., Doan, T. T., Huang, P., Cerasuolo, D., Bishop, A., ... Howell, S. (2021). Economic, Mental Health, HIV Prevention and HIV Treatment Impacts of COVID-19 and the COVID-19 Response on a Global Sample of Cisgender Gay Men and Other Men Who Have Sex with Men. *AIDS and Behavior*, 25(2), 311–321. <https://doi.org/10.1007/s10461-020-02969-0>
- Santos, G.-M., Hong, C., Wilson, N., Nutor, J. J., Harris, O., Garner, A., Holloway, I., Ayala, G., & Howell, S. (2022). Persistent disparities in COVID-19-associated impacts on HIV prevention and care among a global sample of sexual and gender minority individuals. *Global Public Health*, 17(6), 827–842.
- Santos, G.-M., Tan, J., Turner, C., & Raymond, H. F. (2019). Demographic, Behavioral, and Social Characteristics Associated With Smoking and Vaping Among Men Who Have Sex With Men in San Francisco. *American Journal of Men's Health*, 13(3), 1557988319847833. <https://doi.org/10.1177/1557988319847833>
- Schmidt, C. W. (2012). *Trending now: Using social media to predict and track disease outbreaks*. National Institute of Environmental Health Sciences.
- Schnall, R., Kuhns, L. M., Pearson, C., Batey, D. S., Bruce, J., Hidalgo, M. A., Hirshfield, S.,

- Janulis, P., Jia, H., Radix, A., Belkind, U., Rodriguez, R. G., & Garofalo, R. (2022). Efficacy of MyPEEPS Mobile, an HIV Prevention Intervention Using Mobile Technology, on Reducing Sexual Risk Among Same-Sex Attracted Adolescent Males: A Randomized Clinical Trial. *JAMA Network Open*, 5(9), e2231853.
<https://doi.org/10.1001/jamanetworkopen.2022.31853>
- Schwartz, D. R., Stratton, N., & Hart, T. A. (2016). Minority stress and mental and sexual health: Examining the psychological mediation framework among gay and bisexual men. *Psychology of Sexual Orientation and Gender Diversity*, 3(3), 313.
- Scott-Storey, K., O'Donnell, S., Ford-Gilboe, M., Varcoe, C., Wathen, N., Malcolm, J., & Vincent, C. (2023). What About the Men? A Critical Review of Men's Experiences of Intimate Partner Violence. *Trauma, Violence, & Abuse*, 24(2), 858–872.
<https://doi.org/10.1177/15248380211043827>
- Sharps, P. W., Njie-Carr, V. P., & Alexander, K. (2021). The syndemic interaction of intimate partner violence, sexually transmitted infections, and HIV infection among African American women: Best practices and strategies. *Journal of Aggression, Maltreatment & Trauma*, 30(6), 811–827.
- Shim, R. S., & Starks, S. M. (2021). COVID-19, structural racism, and mental health inequities: Policy implications for an emerging syndemic. *Psychiatric Services*, 72(10), 1193–1198.
- Shuper, P. A., Joharchi, N., Bogoch, I. I., Loutfy, M., Crouzat, F., El-Helou, P., Knox, D. C., Woodward, K., & Rehm, J. (2020). Alcohol consumption, substance use, and depression in relation to HIV Pre-Exposure Prophylaxis (PrEP) nonadherence among gay, bisexual, and other men-who-have-sex-with-men. *BMC Public Health*, 20(1), 1782.
<https://doi.org/10.1186/s12889-020-09883-z>

- Siegler, A. J., Wiatrek, S., Mouhanna, F., Amico, K. R., Dominguez, K., Jones, J., Patel, R. R., Mena, L. A., & Mayer, K. H. (2020). Validation of the HIV pre-exposure prophylaxis stigma scale: Performance of likert and semantic differential scale versions. *AIDS and Behavior*, 24(9), 2637–2649.
- Sileo, K. M., Sparks, C. S., & Luttinen, R. (2022). Spatial analysis of the alcohol, intimate partner violence, and HIV syndemic among women in South Africa. *AIDS and Behavior*, 1–11.
- Simoni, J. M., Kutner, B. A., & Horvath, K. J. (2015). Opportunities and challenges of digital technology for HIV treatment and prevention. *Current HIV/AIDS Reports*, 12(4), 437–440.
- Singer, M. (1994). Aids and the health crisis of the U.S. urban poor; the perspective of critical medical anthropology. *Social Science & Medicine*, 39(7), 931–948.
[https://doi.org/10.1016/0277-9536\(94\)90205-4](https://doi.org/10.1016/0277-9536(94)90205-4)
- Singer, M. (2009). *Introduction to syndemics: A critical systems approach to public and community health*. John Wiley & Sons.
- Singer, M., Bulled, N., Ostrach, B., & Mendenhall, E. (2017). Syndemics and the biosocial conception of health. *The Lancet*, 389(10072), 941–950. [https://doi.org/10.1016/S0140-6736\(17\)30003-X](https://doi.org/10.1016/S0140-6736(17)30003-X)
- Slagboom, M. N., Reis, R., Tsai, A. C., Büchner, F. L., van Dijk, D. A., & Crone, M. R. (2021). Psychological distress, cardiometabolic diseases and musculoskeletal pain: A cross-sectional, population-based study of syndemic ill health in a Dutch fishing village. *Journal of Global Health*, 11.
- Stall, R., Friedman, M., & Catania, J. A. (2007). Interacting Epidemics and Gay Men's Health: A

- Theory of Syndemic Production among Urban Gay Men. In R. J. Wolitski, R. Stall, & R. O. Valdiserri (Eds.), *Unequal Opportunity: Health Disparities Affecting Gay and Bisexual Men in the United States* (p. 0). Oxford University Press.
<https://doi.org/10.1093/acprof:oso/9780195301533.003.0009>
- Stephenson, R., Chavanduka, T. M. D., Rosso, M. T., Sullivan, S. P., Pitter, R. A., Hunter, A. S., & Rogers, E. (2021). COVID-19 and the Risk for Increased Intimate Partner Violence Among Gay, Bisexual and Other Men Who Have Sex With Men in the United States. *Journal of Interpersonal Violence*, 0886260521997454.
<https://doi.org/10.1177/0886260521997454>
- Stephenson, R., & Finneran, C. (2013). The IPV-GBM Scale: A New Scale to Measure Intimate Partner Violence among Gay and Bisexual Men. *PLOS ONE*, 8(6), e62592.
<https://doi.org/10.1371/journal.pone.0062592>
- Stephenson, R., & Finneran, C. (2017a). Minority Stress and Intimate Partner Violence Among Gay and Bisexual Men in Atlanta. *American Journal of Men's Health*, 11(4), 952–961.
<https://doi.org/10.1177/1557988316677506>
- Stephenson, R., & Finneran, C. (2017b). Receipt and Perpetration of Intimate Partner Violence and Condomless Anal Intercourse Among Gay and Bisexual Men in Atlanta. *AIDS and Behavior*, 21(8), 2253–2260. <https://doi.org/10.1007/s10461-017-1709-6>
- Stephenson, R., Hall, C. D., Williams, W., Sato, K., & Finneran, C. (2013). Towards the Development of an Intimate Partner Violence Screening Tool for Gay and Bisexual Men. *Western Journal of Emergency Medicine*, 14(4), 390–400.
<https://doi.org/10.5811/westjem.3.2013.15597>
- Stephenson, R., Rentsch, C., Salazar, L. F., & Sullivan, P. S. (2011). Dyadic Characteristics and

- Intimate Partner Violence among Men Who Have Sex with Men. *Western Journal of Emergency Medicine*, 12(3), 324–332.
- Stephenson, R., Rogers, E., Mansergh, G., Hirshfield, S., & Sullivan, P. (2022). Intimate Partner Violence and Preferences for Pre-exposure Prophylaxis (PrEP) Modes of Delivery Among A Sample of Gay, Bisexual, and Other Men Who Have Sex with Men. *AIDS and Behavior*, 26(7), 2425–2434. <https://doi.org/10.1007/s10461-022-03587-8>
- Stephenson, R., Sato, K. N., & Finneran, C. (2013). Dyadic, Partner, and Social Network Influences on Intimate Partner Violence among Male-Male Couples. *Western Journal of Emergency Medicine*, 14(4), 316–323. <https://doi.org/10.5811/westjem.2013.2.15623>
- Stoicescu, C., Ameilia, R., Praptoraharjo, I., & Mahanani, M. (2019). Syndemic and synergistic effects of intimate partner violence, crystal methamphetamine, and depression on HIV sexual risk behaviors among women who inject drugs in Indonesia. *Journal of Urban Health*, 96(3), 477–496.
- Strong, C., Wu, H.-J., Tseng, Y.-C., Yuan, C.-W., Yu, Y.-F., Liao, J. C., Chen, Y.-W., Hung, Y.-C., Li, C.-W., Huang, P.-H., Ko, N.-Y., & Ku, S. W.-W. (2020). Mobile App (UPrEPU) to Monitor Adherence to Pre-exposure Prophylaxis in Men Who Have Sex With Men: Protocol for a User-Centered Approach to Mobile App Design and Development. *JMIR Research Protocols*, 9(12), e20360. <https://doi.org/10.2196/20360>
- Stults, C. B., Javdani, S., Greenbaum, C. A., Barton, S. C., Kapadia, F., & Halkitis, P. N. (2015). Intimate partner violence perpetration and victimization among YMSM: The P18 cohort study. *Psychology of Sexual Orientation and Gender Diversity*, 2(2), 152–158. <https://doi.org/10.1037/sgd0000104>
- Stults, C. B., Javdani, S., Greenbaum, C. A., Kapadia, F., & Halkitis, P. N. (2015). Intimate

- partner violence and substance use risk among young men who have sex with men: The P18 cohort study. *Drug and Alcohol Dependence*, 154, 54–62.
- Swiatlo, A. D., Kahn, N. F., & Halpern, C. T. (2020). Intimate Partner Violence Perpetration and Victimization Among Young Adult Sexual Minorities. *Perspectives on Sexual and Reproductive Health*, 52(2), 97–105. <https://doi.org/10.1363/psrh.12138>
- Tankard, M. E., & Iyengar, R. (2018). Economic Policies and Intimate Partner Violence Prevention: Emerging Complexities in the Literature. *Journal of Interpersonal Violence*, 33(21), 3367–3387. <https://doi.org/10.1177/0886260518798354>
- Tsang, W. W.-H. (2015). Do male victims of intimate partner violence (ipv) deserve help? Some reflections based on a systematic review. *The Hong Kong Journal of Social Work*, 49(01n02), 51–63. <https://doi.org/10.1142/S0219246215000066>
- van den Elshout, M. A. M., Hoornenborg, E., Achterbergh, R. C. A., Coyer, L., Anderson, P. L., Davidovich, U., de Vries, H. J. C., Prins, M., van der Loeff, M. F. S., & Initiative (H-TEAM), on behalf of the A. P. P. team in the H. T. E. Am. (2021). Improving adherence to daily preexposure prophylaxis among MSM in Amsterdam by providing feedback via a mobile application. *AIDS*, 35(11), 1823–1834. <https://doi.org/10.1097/QAD.0000000000002949>
- Wall, K. M., Sullivan, P. S., Kleinbaum, D., & Stephenson, R. (2014). Actor-partner effects associated with experiencing intimate partner violence or coercion among male couples enrolled in an HIV prevention trial. *BMC Public Health*, 14(1), 209. <https://doi.org/10.1186/1471-2458-14-209>
- Walsh, A. R., Sullivan, S., & Stephenson, R. (2021). Intimate Partner Violence Experiences During COVID-19 Among Male Couples. *Journal of Interpersonal Violence*,

08862605211005135. <https://doi.org/10.1177/08862605211005135>

- Walters, S. M., Braksmajer, A., Coston, B., Yoon, I., Grov, C., Downing, M. J., Teran, R., & Hirshfield, S. (2020). A Syndemic Model of Exchange Sex Among HIV-Positive Men Who Have Sex With Men. *Archives of Sexual Behavior*, 49(6), 1965–1978. <https://doi.org/10.1007/s10508-020-01628-8>
- Wang, H., Wang, N., Chu, Z., Zhang, J., Mao, X., Geng, W., Jiang, Y., Shang, H., & Xu, J. (2018). Intimate partner violence correlates with a higher HIV incidence among MSM: a 12-month prospective cohort study in Shenyang, China. *Scientific Reports*, 8(1), 1–9.
- Weaver, L. J., & Kaiser, B. N. (2020). Syndemics theory must take local context seriously: An example of measures for poverty, mental health, and food insecurity. *Social Science & Medicine*, 113304.
- Wei, D., Cao, W., Hou, F., Hao, C., Gu, J., Peng, L., & Li, J. (2020). Multilevel factors associated with perpetration of five types of intimate partner violence among men who have sex with men in China: An ecological model-informed study. *AIDS Care*, 32(12), 1544–1555.
- Wei, D., Hou, F., Cao, W., Hao, C., Gu, J., Peng, L., & Li, J. (2020). Effects of emotion regulation and perpetrator-victim roles in intimate partner violence on mental health problems among men who have sex with men in China. *Epidemiology and Psychiatric Sciences*, 29, e159. <https://doi.org/10.1017/S2045796020000712>
- Wei, D., Hou, F., Hao, C., Gu, J., Dev, R., Cao, W., Peng, L., Gilmour, S., Wang, K., & Li, J. (2021). Prevalence of Intimate Partner Violence and Associated Factors Among Men Who Have Sex with Men in China. *Journal of Interpersonal Violence*, 36(21–22), NP11968–NP11993. <https://doi.org/10.1177/0886260519889935>

- Willie, T. C., Stockman, J. K., Overstreet, N. M., & Kershaw, T. S. (2018). Examining the impact of intimate partner violence type and timing on pre-exposure prophylaxis awareness, interest, and coercion. *AIDS and Behavior*, 22(4), 1190–1200.
- Willie, T., Kershaw, T., Campbell, J. C., & Alexander, K. A. (2017). Intimate partner violence and PrEP acceptability among low-income, young black women: Exploring the mediating role of reproductive coercion. *AIDS and Behavior*, 21(8), 2261–2269.
- Wilton, L., Chiasson, M. A., Nandi, V., Lelutiu-Weinberger, C., Frye, V., Hirshfield, S., Hoover, D. R., Downing, M. J., Lucy, D., Usher, D., & Koblin, B. (2018). Characteristics and Correlates of Lifetime Suicidal Thoughts and Attempts Among Young Black Men Who Have Sex With Men (MSM) and Transgender Women. *Journal of Black Psychology*, 44(3), 273–290. <https://doi.org/10.1177/0095798418771819>
- Wirtz, A. L., Burns, P. A., Poteat, T., Malik, M., White, J. J., Brooks, D., Kasaie, P., & Beyrer, C. (2022). Abuse in the Continuum: HIV Prevention and Care Outcomes and Syndemic Conditions Associated with Intimate Partner Violence Among Black Gay and Bisexual Men in the Southern United States. *AIDS and Behavior*, 26(11), 3761–3774. <https://doi.org/10.1007/s10461-022-03705-6>
- World Health Organization. (2012). *Understanding and addressing violence against women: Intimate partner violence*. World Health Organization.
- World Health Organization. (2015). *Policy brief: Pre-exposure prophylaxis (PrEP): WHO expands recommendation on oral pre-exposure prophylaxis of HIV infection (PrEP)*. World Health Organization.
- Wu, E., El-Bassel, N., McVinney, L. D., Hess, L., Fopeano, M. V., Hwang, H. G., Charania, M., & Mansergh, G. (2015). The Association Between Substance Use and Intimate Partner

- Violence Within Black Male Same-Sex Relationships. *Journal of Interpersonal Violence*, 30(5), 762–781. <https://doi.org/10.1177/0886260514536277>
- Yang, X., Zhang, J., Chen, S., Weissman, S., Olatosi, B., & Li, X. (2021). Utilizing electronic health record data to understand comorbidity burden among people living with HIV: A machine learning approach. *AIDS*, 35, S39. <https://doi.org/10.1097/QAD.0000000000002736>
- Zheng, L., Hart, T. A., Noor, S. W., & Wen, G. (2020). Stressors based on sexual orientation and mental health among lesbian, gay, and bisexual individuals in China: Minority stress and perceived pressure to get married. *Archives of Sexual Behavior*, 49(5), 1769–1782.
- Zlotnick, C., Tzilos Wernette, G., & Raker, C. A. (2019). A randomized controlled trial of a computer-based brief intervention for victimized perinatal women seeking mental health treatment. *Archives of Women's Mental Health*, 22(3), 315–325. <https://doi.org/10.1007/s00737-018-0895-1>