



The Effect of Sexualized Drug Use (SDU) on Sexual Risk Behavior and Mental Health Among HIV-Infected Men Who Have Sex with Men (MSM): A Longitudinal Study

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Abstract

Introduction Sexualized drug use (SDU) is prevalent among men who have sex with men (MSM) and has been identified as a risk factor for sexual risk behaviors (SRBs), HIV infection, and poor mental health. However, little is known about their dynamic changes and associations over time in China.

Methods This longitudinal study is aimed at assessing the prevalence and dynamic associations between SDU, SRBs, depression, and anxiety in 384 HIV-infected MSM in Guilin, China, from 2021 to 2023.

Results From 2021 to 2023, no statistically significant differences were observed in the prevalence rates of SDU (from 18.5 to 14.6%), SRBs (from 51.8 to 55.7%), depression (from 35.9 to 32.3%), and anxiety (from 30.5 to 28.6%), all with $P > 0.05$. Our logistic regression analyses demonstrated that SDU (adjusted odds ratio (aOR) 2.86, 95% confidence interval (CI) 1.49–5.47) was a robust predictor of SRBs. Moreover, both SDU (aOR 1 3.36, 95%CI 1.58–7.18) and SRBs (aOR 3.47, 95%CI 1.86–6.45) were identified as predictive factors for depression. Simultaneously, SDU (aOR 2.94, 95%CI 1.35–6.43) and SRBs (aOR 2.83, 95%CI 1.41–5.66) demonstrated predictive links to anxiety.

Conclusions In summary, our study underscores the persistently high prevalence of SDU among HIV-infected MSM in Guilin, which is associated with elevated odds of engaging in SRBs, experiencing depression, and suffering from anxiety.

Policy Implications This study necessitates multifaceted policy interventions focusing on reducing SDU through targeted public health campaigns, integrating mental health and substance abuse treatment within HIV care, enhancing service accessibility, destigmatizing HIV and SDU, and training healthcare providers in sensitivity to MSM's unique needs.

Keywords Sexualized drug use (SDU) · Sexual risk behavior (SRB) · Mental health · HIV · MSM

Introduction

Sexualized drug use (SDU) is highly prevalent among men who have sex with men (MSM) and has been identified as a risk factor for HIV infection (Íncera-Fernández et al., 2023; Nevendorff et al., 2023). SDU refers to the intentional use of psychoactive drugs before and during sexual intercourse to facilitate, enhance, and prolong sexual experiences (Edmundson et al., 2018). SDU is characterized by the use

of mephedrone, crystal methamphetamine, and GHB/GBL, which are also known as chemsex, particularly in Europe (Wang et al., 2020a). The goals of SDU use include enhancing sexual pleasure, prolonging sexual duration, and practicing sexual fantasies and practices (Glynn et al., 2018; Hegazi et al., 2017). Due to the different definitions, operationalizations, locations, and recall periods, the reported prevalence of SDU among MSM varies across studies and countries, including 13% in Asian countries (Nevendorff et al., 2023), 18% in European countries (Guerras et al., 2021), 24% in Latin American countries (Van Hout et al., 2019), 36% in Brazil (Torres et al., 2020), 41% in the United Kingdom (Hibbert et al., 2019), and 54% in the Netherlands (Evers et al., 2019). Noticeably, SDU has been reported to be disproportionally concentrated on certain high-risk populations, including MSM living with HIV (Bracchi et al., 2015; Daskalopoulou et al., 2014; González-Baeza et al.,

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2018). The United Nations Office on Drugs and Crime also emphasizes the importance of addressing SDU among key populations, such as HIV-infected MSM, to prevent further HIV transmission (UNODC, 2019).

MSM with SDU tend to present a cluster of risk factors for risk behaviors and poor health. SDU predisposes MSM to sexual risk behaviors (SRBs) due to reduced risk perception and response during sexual encounters (Wang et al., 2020b). A large body of research has indicated that SDU among MSM is associated with an increased risk of SRBs such as condomless anal sex (CAS), commercial sex, group sex, and sexual violence, which may further lead to higher risks of HIV and other STIs (Deimel et al., 2016; Van Hout et al., 2019). Notably, the risk of SRBs among MSM with SDU is not the same for all MSM, and serosorting plays an essential role in these processes. Serosorting is a seroadaptative behavior and a risk reduction strategy by selecting sexual partners or behaviors based on HIV serostatus (seroconcordance or serodiscordance) to diminish the risk of HIV infection (Purcell et al., 2017; Villa-Rueda et al., 2021). Serosorting is a “form of sexual creativity” during the HIV epidemic, as it differs from traditional HIV prevention strategies such as condom use (Eaton et al., 2007; White Hughto et al., 2016). Serosorting is a common practice in the MSM community, especially among HIV-positive MSM, with studies showing 40% of them having sex exclusively with HIV-positive partners (Mizuno et al., 2010). Serosorting is a complex process affected by multilevel elements encompassing individual level (such as HIV knowledge, attitudes, disclosure, and serostatus), interpersonal level (such as social networks, sexual behavior negotiation, and communication), community level (such as stigma, social norms, and access to HIV-related services), and structural level (such as political context, HIV-related funding, and public policies) (Villa-Rueda et al., 2021). Therefore, the associations between serosorting, SDU, and SRBs are also complicated. Chen et al.’s (2012) study showed that HIV-positive MSM with SDU was more likely to have serosorting and potentially discordant unprotected anal intercourse events than nonusers, leading to an increased risk of HIV infection and transmission. Conflicting evidence exists on the effect of HIV serosorting on SRBs and HIV infection, with some studies showing a decreased risk (Cassels et al., 2009; Philip et al., 2010), while other studies show no effect or increased risk of SRBs and HIV infections (Golden et al., 2012; Heymer & Wilson, 2010; Wilson et al., 2010).

In addition, research also suggests that SDU is linked to poor mental health (Pufall et al., 2018). Several systematic reviews have consistently shown significant associations between SDU and adverse mental health outcomes, including depression, anxiety, and suicide ideation among MSM (Tomkins et al., 2019; Maxwell et al., 2019; Incera-Fernández et al., 2021). Multiple reasons may explain the poor

mental health outcomes among MSM with SDU, including formal factors (such as legal sanctions and social stigma) or informal factors (such as prejudice and victimization) (Hylton et al., 2017; Burton et al., 2013; Russell & Fish, 2016). According to the minority stress theory, MSM are already exposed to multiple stressors such as harassment, rejection, and violence because of their sexual minority identities (McConnell et al., 2018; Sattler et al., 2016). These pressures could be exacerbated by SDU due to decreased effectiveness of HIV-preventive efforts and increased vulnerability to HIV infections, thus leading to elevated psychological distress and poor mental health outcomes (Incera-Fernández et al., 2021; Sun et al., 2020). The long-term adverse effects of SDU on MSM’s SRBs and mental health have been well-demonstrated by numerous studies, indicating an urgent need to address such issues.

Although SDU and its associations with SRBs and mental health have been widely reported in the literature, most were cross-sectional in design, providing only a snapshot of the association at a specific time. The lack of follow-up observations hampers our understanding of the long-term trends and dynamic interaction of SDU, SRBs, and mental health among HIV-infected MSM. In addition, most studies were focused on Western countries, which have different definitions, epidemics, and cultural and legal environments for SDU than Asian countries such as China. Chinese scholars have traditionally approached the issues of drug use and sexual behavior separately when studying SDU in the MSM population, which fails to acknowledge their close association. Regrettably, there is currently no specific term in Chinese that adequately captures the concept of “Sexualized Drug Use” in the context of MSM. In recent years, China has seen an increasing trend of SDU among MSM, including methamphetamine, Magu, ketamine, and ecstasy. The number of HIV cases has reached 1.26 million in China, with a significant portion resulting from sexual transmission among MSM (National Center for AIDS/STD Control and Prevention, China CDC, 2023). Despite HIV infection, many MSM still engage in SDU and SRBs (Wang et al., 2020b; Zhang et al., 2022), worsening the risk of HIV transmission and new infections. It is thus important to investigate the dynamic changes and associations between SDU, SRBs, and mental health among HIV-infected MSM in China.

To address these research gaps, we conducted the current longitudinal study to track 384 HIV-infected MSM’s engagement in SDU, SRBs, and mental health in Guilin, China, starting in 2020 and following up in 2023. We aimed to investigate the changes in the prevalence of SDU, SRBs, depression, and anxiety and whether SDU was associated with an increased risk of SRBs, depression, and anxiety. By analyzing data from these two surveys taken 2 years apart, we aimed to reveal the dynamic associations between SDU, SRBs, depression,

and anxiety among HIV-infected MSM. The findings will inform targeted psychosocial and behavioral interventions to improve the well-being of HIV-infected MSM in the future.

Methods

Participants and Procedure

This study was conducted at the Department of Infectious Diseases within Guilin's Third People's Hospital, which carries the significant responsibilities of HIV prevention, quality assurance, clinical technical guidance, and healthcare personnel training for the extensive population residing in Northern Guangxi.

In China, every person diagnosed with HIV is mandated to document their modes of HIV transmission, such as male-to-male sexual contact, heterosexual contact, or blood-borne transmission, within the Center for Disease Control and Prevention's database. This systematic record-keeping enables us to gain comprehensive insights into the transmission routes among all people living with HIV (PLWH). As of June 2020, the Infectious Disease Department of the Third People's Hospital of Guilin provided ART for over 3500 PLWHs, approximately 15% of whom are MSM.

This study utilized the following inclusion criteria: self-identification as MSM, aged ≥ 18 , undergoing ART, willing to participate with informed consent, and able to complete the study with normal cognitive function. We excluded those who were unable to complete the research due to severe physical and mental illness.

The baseline study was conducted from June to December 2020, 428 eligible MSM participants receiving ART at the hospital were consecutively recruited in our study. The follow-up study was conducted from January to June 2023, and 384 MSM from the baseline study completed the follow-up survey (89.7% response rate). There were no significant differences in the baseline characteristics between the 384 participants who completed the follow-up survey and the 44 participants who were lost to follow-up. Ethical approval (GXNU:20200507003) was obtained, and participants provided written informed consent before participating in the study. Anonymity and data reliability were ensured during the self-administered web questionnaire process using designated iPads on the Questionnaire Star platform. No survey instructor was present during the questionnaire filling to ensure participant privacy and data reliability. Data from both surveys were matched using participants' unique treatment numbers.

Measures

Basic Information

A self-designed information sheet was used to collect participants' demographic details (such as sexual orientation, age, marital status, education, occupation, and monthly income) and HIV-related clinical characteristics (including time since HIV diagnosis, CD4 cell count, comorbidities with other chronic diseases, and recent physical examination results), with the latter being recorded through case book review.

SDU

Participants were asked about whether they had used any specific drugs for sexual purposes in the past 6 months, including methamphetamine, Capsule 0 or liquid stimulant, Magu, ecstasy, cannabis e-cigarette, K powder, Happy Water, and other substances. Participants who answered yes to any of the listed drugs were defined as having engaged in SDU.

SRBs

Participants were asked about whether they had engaged in the following four types of sexual behaviors: commercial sex (engaging in sexual activity for monetary gain), CAS (condomless anal sex), group sex (sexual intercourse with three or more participants at the same time), and sexual violence (experiencing non-consensual sex due to partner or lover abuse or coercion) within the past 6 months. Participants who answered yes to any of the listed behaviors were defined as having engaged in SRBs.

Depression and Anxiety

Depression was assessed using the Center for Epidemiological Studies Depression Scale (CES-D) (Liu et al., 2020), comprising 20 items. Participants rated their symptoms from 0 (occasionally or none) to 3 (most of the time or consistently), reflecting the frequency of symptoms experienced in the prior week. A cumulative score of 60, with scores ≥ 20 indicating depressive symptoms, was utilized. The CES-D demonstrated a Cronbach's α of 0.82 in this study, indicating good internal consistency. Anxiety was measured with the Self-Rating Anxiety Scale (SAS) (Zung, 1971), also including 20 items and employing a 1 to 4 rating scale. The total of these item scores was multiplied by 1.25 and rounded to yield a standard score, with ≥ 50 indicating anxiety.

symptoms. The Cronbach's α for the SAS in this study was 0.83, indicating good internal consistency.

Data Analysis

All statistical analyses were conducted using SPSS 26.0. Categorical variables were assessed using frequencies and percentages, while continuous variables were summarized with means and standard deviations. For the Pearson Chi-square test, we categorized certain continuous variables in this study, such as age, CD4 cell count, and duration since HIV diagnosis, into two groups based on their means. To compare baseline and final data, we employed the Pearson Chi-square test for sociodemographic characteristics, SDU types, SRBs, depression, and anxiety, and baseline and follow-up CD4 cell counts were compared using a paired t-test. Additionally, the Pearson Chi-square test was further utilized to examine differences in the incidence of SRBs, depression, and anxiety at follow-up among participants with different baseline characteristics.

After controlling for demographic characteristics, HIV-related clinical factors, and baseline SRBs, we analyzed the impact of baseline SDU on follow-up SRBs. Similarly, after adjusting for demographic characteristics, HIV-related clinical factors, and baseline depression and anxiety, we examined the effects of baseline SDU and baseline SRBs on follow-up depression and follow-up anxiety. We carried out three separate binary logistic regression analyses. Initially, we examined SDU's potential as a predictor of SRBs, using SRBs at follow-up as the dependent variable and SDU at baseline as the independent variable. Subsequently, we explored the predictive capacity of SDU and SRBs for depression and anxiety, treating these conditions as dependent variables and SDU and SRBs at baseline as independent variables. Statistical significance was set at $\alpha=0.05$, with a threshold of $P<0.05$ indicating significant differences.

Results

Sample Characteristics and Changes

A total of 384 participants were included in the study. The baseline sample characteristics are presented in Table 1. For sociodemographic characteristics, the participants had an average age of 34.30 ± 7.66 years. The majority were gay men (68.8%), unmarried (68.2%), and with a monthly income exceeding 4001 yuan (57.8%). Slightly over half had a bachelor's degree or higher (52.9%) and were enterprise employees (51.8%). In general, MSM in our sample corresponds to a profile of young, single gay men with relatively stable socioeconomic status, which is consistent with that of previous studies on MSM in other parts of China (Duan et al., 2021; Wang et al., 2020a, b).

Regarding HIV-related clinical characteristics, the average time since HIV diagnosis was 34.2 ± 23.40 months, and the current average CD4 cell count was 405.4 ± 208.4 . Among the participants, 43.0% reported having other chronic diseases, and 77.6% had normal results in their most recent physical examinations. At the follow-up in 2023, there were no significant changes in sociodemographic indicators compared to the baseline data in 2020, except for a 2-year increase in age and time to HIV diagnosis ($P>0.05$). See Table 1 for details.

SDU, SRBs, Depression, Anxiety, and Changes

Among 384 participants, the baseline rates of SDU, SRBs, depression, and anxiety were 18.5%, 51.8%, 35.9%, and 30.5%, respectively, while the follow-up rates were 14.6%, 55.7%, 32.3%, and 28.6%, respectively, with no significant differences (all $P>0.05$). The most common sexualized drug was capsule 0 or liquid stimulant (baseline 8.6%, follow-up 5.7%), followed by methamphetamine (baseline 8.3%, follow-up 6.8%), other drugs (baseline 7.0%, follow-up 4.2%), and Magu (baseline 3.9%, follow-up 2.6%). See Table 1 for details.

The results of the χ^2 analysis indicated respondents with abnormal physical examination results, and engaging in SDU exhibited the highest prevalence of SRBs. Additionally, participants with abnormal physical examination results, involvement in SDU, and SRBs had a higher risk of depression. Factors such as being unemployed or a student, having a monthly income below 4000 yuan, a duration since HIV diagnosis of less than 34 months, abnormal physical examination results, engagement in SDU, and SRBs were significantly associated with a heightened risk of anxiety ($P<0.05$). Detailed findings are presented in Table 2.

Associations Between SDU and SRBs, Depression, and Anxiety

Table 3 displays the findings from logistic regression analyses examining whether baseline SDU predicted SRBs at follow-up and whether baseline SDU and baseline SRBs predicted depression and anxiety at follow-up after adjusting for baseline characteristics.

The results indicated SDU (aOR 2.86, 95%CI 1.49–5.47) as a predictor of SRBs, and the model was significant at $\chi^2=28.65$ ($P<0.001$), explaining 9.6% of the total variance of SRBs. Furthermore, SDU (aOR 3.36, 95%CI 1.58–7.18) and SRBs (aOR 3.47, 95%CI 1.86–6.45) showed a predictive relationship with depression, and the model was significant at $\chi^2=165.65$ ($P<0.001$), explaining 49.0% of the total variance of depression. Simultaneously, both SDU (aOR 2.94, 95%CI 1.35–6.43) and SRBs (aOR 2.83, 95%CI 1.41–5.66)

Table 1 Presents the general sample characteristics and their changes over time, and SDU, SRBs, depression, anxiety, and changes ($n = 384$)

Variables	Baseline data $n (\%)/\bar{x} \pm S$	Follow-up data $n (\%)/\bar{x} \pm S$	χ^2/t	P values	Variables	Baseline data $n (\%)$	Follow-up data $n (\%)$	χ^2	P values
Sexual orientation					II SRBs (total)				
Gay men	264 (68.8)	264 (68.8)			No	185 (48.2)	170 (44.3)	1.18	0.278
Bisexual men	120 (31.2)	120 (31.2)			Yes	199 (51.8)	214 (55.7)		
Age (years)	34.30 ± 7.66	36.30 ± 7.66			(a) Commercial sex				
Marital status					No	351 (91.4)	336 (87.5)	3.11	0.078
Unmarried	262 (68.2)	249 (64.8)	0.99	0.320	Yes	33 (8.6)	48 (12.5)		
Married	122 (31.8)	135 (35.2)			Buyer				
Education level					No	365 (95.1)	357 (93.0)	1.48	0.224
Below bachelor's degree	181 (47.1)	181 (47.1)	3.83	0.430	Yes	19 (4.9)	27 (7.0)		
Bachelor's degree or above	203 (52.9)	203 (52.9)			Seller				
Occupation					No	368 (95.8)	362 (94.3)	1.00	0.318
Unemployed	22 (5.7)	13 (3.4)	3.13	0.536	Yes	16 (4.2)	22 (5.7)		
Students	12 (3.1)	9 (2.3)			(b) CAS				
Civil servants and institutions	44 (11.5)	49 (12.8)			No	213 (55.5)	191 (49.7)	2.53	0.112
Enterprise employee	199 (51.8)	206 (53.6)			Yes	171 (44.5)	193 (50.3)		
Freelancer/other	107 (27.9)	107 (27.9)			(c) Group sex				
Monthly income (RMB)					No	348 (90.6)	336 (87.5)	1.93	0.165
< 4000	162 (42.2)	149 (38.8)	0.91	0.339	Yes	36 (9.4)	48 (12.5)		
≥ 4001	222 (57.8)	235 (61.2)			(d) Sexual violence				
The duration since HIV diagnosis (months)	34.2 ± 23.4	58.2 ± 23.45			No	355 (92.4)	359 (93.5)	0.32	0.572
CD4 cell count	405.4 ± 208.4	420 ± 175.0	-1.09	0.276	Yes	29 (7.6)	25 (6.5)		
Are there any chronic diseases other than HIV					III Depression				
No	219 (57.0)	243 (63.3)	3.13	0.077	No	246 (64.1)	260 (67.7)	1.14	0.287
Yes	165 (43.0)	141 (36.7)			Yes	138 (35.9)	124 (32.3)		
Whether all indicators of the last physical examination are normal					IV Anxiety				
Yes	298 (77.6)	286 (74.5)	1.03	0.310	No	267 (69.5)	274 (71.4)	0.31	0.580
No	86 (22.4)	98 (25.5)			Yes	117 (30.5)	110 (28.6)		
SDU (total)									
No	313 (81.5)	328 (85.4)	2.12	0.145					
Yes	71 (18.5)	56 (14.6)							
(a) Methamphetamine									
No	352 (91.7)	358 (93.2)	0.67	0.413					
Yes	32 (8.3)	26 (6.8)							
(b) Capsule 0 or liquid stimulant									
No	351 (91.4)	362 (94.3)	2.37	0.124					
Yes	33 (8.6)	22 (5.7)							
(c) Magu									

Table 1 (continued)

Variables	Baseline data <i>n</i> (%)/ $\bar{x} \pm S$	Follow-up data <i>n</i> (%)/ $\bar{x} \pm S$	χ^2/t	<i>P</i> values	Variables	Baseline data <i>n</i> (%)	Follow-up data <i>n</i> (%)	χ^2	<i>P</i> values
No	369 (96.1)	374 (97.4)	1.03	0.309					
Yes	15 (3.9)	10 (2.6)							
(d) Other drugs									
No	357 (93.0)	368 (95.8)	2.98	0.084					
Yes	27 (7.0)	16 (4.2)							

indicated a predictive connection to anxiety, and the model was significant at $\chi^2 = 185.62$ ($P < 0.001$), explaining 54.9% of the total variance of anxiety.

Discussion

Summary of the Findings

This longitudinal study followed 384 HIV-infected MSM who were surveyed twice in 2021 and 2023. The analysis examined the prevalence and associations between SDU, SRBs, depression, and anxiety. In 2021 and 2023, the rates of SDU, SRBs, depression, and anxiety among respondents were 18.5%, 51.8%, 35.9%, 30.5%, and 14.6%, 55.7%, 32.3%, and 28.6%, respectively, with no statistically significant differences ($P > 0.05$). The findings suggest SDU as a predictor of SRBs. Additionally, SDU and SRBs exhibit potential predictability for depression and concomitantly for anxiety, too.

Prevalence of SDU

In our study, the prevalence of SDU among men who have sex with men (MSM) was 18.5% in 2020 and 14.6% in 2023. These figures indicate that nearly one-fifth of HIV-infected MSM continue to engage in sexual activities even after contracting HIV, which is close to the reported pooled prevalence of 13.0% by a recent meta-analysis (Nevendorff et al., 2023). The common use of SDU among MSM can be attributed to several factors. MSM often face social stigma and pressure, leading them to use drugs as a coping strategy (Sun et al., 2020). Additionally, social networks and community culture significantly influence SDU behaviors, with certain community activities potentially promoting drug use (Wang et al., 2020a, b). Easy access to drugs and their low cost are also important factors (Wang et al., 2020a, b). The lack of adequate medical and support services further drives MSM to rely on drugs to manage their problems (Wang et al., 2020a, b). Finally, drug use, particularly stimulants and hallucinogens such as methamphetamine (crystal meth) and

gamma-hydroxybutyrate (GHB), can significantly increase sexual desire, enhance sexual pleasure, and prolong sexual activity, which may further contribute to SDU (Wang et al., 2020a, b). These combined factors likely result in the high prevalence of SDU among the MSM population.

SDU and SRBs

Our study showed that SDU was associated with an increased risk of SRBs, which was consistent with the literature. González-Baeza et al. (2018) found that MSM with SDU were more likely to have had high-risk sexual behaviors and a diagnosis of sexually transmitted infections (STI) than MSM without SDU. Other studies also reported higher engagement of SRBs such as commercial sex, CAS, group sex, and sexual violence among MSM with SDU than those without (Chen et al., 2019; He et al., 2018; Miller et al., 2020; Nevendorff et al., 2023). The positive association between SDU and SRBs may be explained by multiple factors, including reduced pain relief, muscle relaxation, increased libido, decreased risk awareness, and impulsive behaviors associated with SDU, further contributing to the increased risk of SRBs (Coyer et al., 2022; He et al., 2018; Nevendorff et al., 2023). The popularity of SDU is attributed not only to drug availability but also to hook-up apps, which offer instant messaging and location services for discreet connections (Drückler et al., 2018). Some MSM illicitly purchase drugs through these apps and engage in sexual encounters with online strangers, significantly heightening the risk of HIV transmission or acquisition (Patten et al., 2020).

SDU and Mental Health

Our study also showed that SDU was associated with poor mental health. This association may be explained by the enduring stressors experienced by MSM with SDU, such as prejudice, discrimination, and social stigma, further leading to aggravated mental health outcomes (Hylton et al., 2017; Yang et al., 2022). Specifically, Burton et al. (2013) propose that sexual minorities often have declining psychological wellness relative to heterosexual counterparts, with contributing elements including direct formal factors like legal

Table 2 Comparison of SRBs, depression, and anxiety in samples with different characteristics from baseline data at follow-up ($n = 384$)

Variables (baseline)		Follow-up SRBs				Follow-up depression				Follow-up anxiety			
		n (%)		No	Yes	χ^2	P values	No	Yes	χ^2	P values	No	Yes
Sexual orientation	Gay men	264 (68.8)	119 (64.3)	145 (72.9)	3.26	0.071		171 (65.8)	93 (75.0)	3.33	0.068	182 (66.4)	82 (74.5)
	Bisexual men	120 (31.2)	66 (35.7)	54 (27.1)				89 (34.2)	31 (25.0)			92 (33.6)	28 (25.5)
Age	< 34	199 (51.8)	99 (53.5)	100 (50.3)	0.41	0.523		138 (53.1)	61 (49.2)	0.51	0.476	146 (53.3)	53 (48.2)
	≥ 34	185 (48.2)	86 (46.5)	99 (49.7)				122 (46.9)	63 (50.8)			128 (46.7)	57 (51.8)
Marital status	Unmarried	262 (68.2)	120 (64.9)	142 (71.4)	1.86	0.172		174 (66.9)	88 (71.0)	0.63	0.426	184 (67.2)	78 (70.9)
	Married	122 (31.8)	65 (35.1)	57 (28.6)				86 (33.1)	36 (29.0)			90 (32.8)	32 (29.1)
Education level	Below bachelor's degree	181 (47.1)	88 (47.6)	93 (46.7)	0.03	0.870		120 (46.2)	61 (49.2)	0.31	0.577	125 (45.6)	56 (50.9)
	Bachelor's degree or above	203 (52.9)	97 (52.4)	106 (53.3)				140 (53.8)	63 (50.8)			149 (54.4)	54 (49.1)
Occupation	Unemployed	22 (5.7)	8 (4.3)	14 (7.0)	4.29	0.369		12 (4.6)	10 (8.1)	4.05	0.400	11 (4.0)	11 (10.0)
	Students	12 (3.1)	4 (2.2)	8 (4.0)				6 (2.3)	6 (4.8)			5 (1.8)	7 (6.4)
	Civil servants and institutions	44 (11.5)	19 (10.3)	25 (12.6)				30 (11.5)	14 (11.3)			31 (11.3)	13 (11.8)
Monthly income/RMB	Enterprise employee	199 (51.8)	96 (51.9)	103 (51.8)				136 (52.3)	63 (50.8)			151 (55.1)	48 (43.6)
	Freelancer/ther	107 (27.9)	58 (31.4)	49 (24.6)				76 (29.2)	31 (25.0)			76 (27.7)	31 (28.2)
	< 4000	162 (42.2)	79 (42.7)	83 (41.7)	0.04	0.844		109 (41.9)	53 (42.7)	0.02	0.879	106 (38.7)	56 (50.9)
The duration since HIV diagnosis (months)	≥ 4000	222 (57.8)	106 (57.3)	116 (58.3)				151 (58.1)	71 (57.3)			168 (61.3)	54 (49.1)
	< 34	136 (35.4)	57 (30.8)	79 (39.7)	3.31	0.069		84 (32.3)	52 (41.9)	3.40	0.065	84 (30.7)	52 (47.3)
	≥ 35	248 (64.6)	128 (69.2)	120 (60.3)				176 (67.7)	72 (58.1)			190 (69.3)	58 (52.7)
CD4 cell count	< 405	196 (51.0)	88 (47.6)	108 (54.3)	1.72	0.189		129 (49.6)	67 (54.0)	0.66	0.418	137 (50.0)	59 (53.6)
	≥ 405	188 (49.0)	97 (52.4)	91 (45.7)				131 (50.4)	57 (46.0)			137 (50.0)	51 (46.4)
Are there any chronic diseases other than HIV	No	219 (57.0)	113 (61.1)	106 (53.3)	2.39	0.122		154 (59.2)	65 (52.4)	1.59	0.207	163 (59.5)	56 (50.9)
	Yes	165 (43.0)	72 (38.9)	93 (46.7)				106 (40.8)	59 (47.6)			111 (40.5)	54 (49.1)
Whether all indicators of the last physical examination are normal	Yes	298 (77.6)	152 (82.2)	146 (73.4)	4.27	0.039		214 (82.3)	84 (67.7)	10.25	0.001	223 (81.4)	75 (68.2)
	No	86 (22.4)	33 (17.8)	53 (26.6)				46 (17.7)	40 (32.3)			51 (18.6)	35 (31.8)
SDU	No	313 (81.5)	151 (88.8)	162 (75.7)	10.83	0.001		239 (91.9)	74 (59.7)	57.93	< 0.001	248 (90.5)	65 (59.1)
	Yes	71 (18.5)	19 (11.2)	52 (24.3)				21 (8.1)	50 (40.3)			26 (9.5)	45 (40.9)
SRBs	No	185 (48.2)	Not applicable					164 (63.1)	21 (16.9)	71.60	< 0.001	166 (60.6)	19 (17.3)
	Yes	199 (51.8)						96 (36.9)	103 (83.1)			108 (39.4)	91 (82.7)

Table 3 Logistic regression with SRBs, depression, and anxiety as dependent variables^{a,b}

	Dependent variable		Independent variable		β	SE	Wald χ^2	R ² (%)	aOR (95%CI)	P values
Model 1	Follow-up SRBs	No	Baseline SDU	No	1.05	0.33	10.01	9.6	2.86 (1.49~5.47)	0.002
		Yes		Yes					1	
Model 2	Follow-up depression	No	Baseline SDU	No	1.21	0.39	9.82	49.0	3.36 (1.58~7.18)	0.002
				Yes					1	
		Yes	Baseline SRBs	No	1.24	0.36	15.39		3.47 (1.86~6.45)	<0.001
Model 3	Follow-up anxiety			Yes					1	
		No	Baseline SDU	No	1.08	0.40	7.31	54.9	2.94 (1.35~6.43)	0.007
				Yes					1	
		Yes	Baseline SRBs	No	1.04	0.35	8.59		2.83 (1.41~5.66)	0.003
				Yes					1	

^aThe beta parameters of each regression model were estimated after controlling for the following factors: sexual orientation, age, marital status, education level, occupation, monthly income, the duration since HIV diagnosis, are there any chronic diseases other than HIV, whether all indicators of the last physical examination are normal

^bWhen analyzing the impact of baseline SDU on follow-up SRBs, we controlled for baseline SRBs. Additionally, when examining the effects of baseline SDU and SRBs on follow-up depression and anxiety, we also controlled for baseline levels of depression and anxiety

sanctions or indirect informal factors like victimization. Evidence suggests that victimization-related experiences result in elevated levels of depression, suicidal ideation, suicide attempts, substance misuse, and absenteeism in youth (Poteat et al., 2011). The minority stress theory (Meyer, 2003) provides valuable insight into the psychological aftermath of those in sexual minorities. It suggests these individuals are persistently subjected to unique stressors, incorporating harassment and victimization, expectation of rejection, concealment behaviors, prevalent biases, and violence exposure risk specific to their sexual identities (Katz-Wise & Hyde, 2012; McConnell et al., 2018). These strains can have significant effects on the emotional health and overall well-being of MSM and are often intensified with the decrease in social support systems available to alleviate them (Sattler et al., 2016). The potential psychological health symptoms in individuals practicing SDU could contribute to heightened susceptibility to sexually transmitted infections (STIs) and potentially undermine the effectiveness of preventive measures against HIV infections (Sun et al., 2020).

Limitations

This study had several limitations. First, our sample was a clinical, patient-based sample recruited from a hospital in Guilin rather than the community. It may not represent other HIV-infected MSM in the communities of different parts of China. Future research could address this by including clinical and community samples from various parts of China for a more comprehensive understanding. Second, during the two data collection periods, we did not collect information on COVID-19-related information, such as its

impact on employment, social interaction, and daily life. The baseline study was conducted during the peak of COVID-19 when the Chinese government implemented rigorous social-distancing measures, while the follow-up was conducted post-COVID-19 when the government transitioned to living with COVID-19. Such changes may have influenced MSM's SDU, SRBs, and mental health, which warrants further research. Third, all data were collected based on self-report, which may introduce recall bias and social desirability bias and affect the accuracy of the results. For instance, MSM may underreport their engagement in SDU and SRBs as these behaviors are not socially acceptable. They may also underreport their depression and anxiety as mental illnesses are highly stigmatized. Future studies may consider using objective measures such as biomarkers or medical records to enhance data credibility. Fourth, in the measurement of SRBs, we clustered all four types of SRBs into a single item rather than examining certain types of SRBs individually. Although comprehensive and inclusive, this assessment may fail to capture the unique characteristics of each specific risk behavior. Future studies are warranted to gain a deeper insight into each individual risk behavior. Fifth, although we tried our best to distinguish drugs used instrumentally for sexual purposes from sex under the influence of drugs in our measurement of SDU, it is likely that there may be some overlapping in our measurement. Future studies should consider focusing on only one or two SDUs to get a more accurate assessment. Finally, other unmeasured confounding variables may affect the observed associations despite controlling for some factors. Future studies should consider including additional potential confounders for more reliable and valid results.

Implications

Our findings carry significant clinical, research, and political implications. From a clinical perspective, healthcare providers are encouraged to incorporate screening of SDU and mental illness into the routine HIV care of MSM and provide timely treatment or referral to those who have screened positive for those problems. This may involve multidisciplinary collaboration from professionals from various fields, including STD, substance abuse, mental illness, and public health. From a research perspective, building upon our findings, future research should focus on developing a feasible and cost-effective comprehensive intervention model concentrated on reducing and preventing SDU among MSM while addressing the accompanying SRBs and mental health issues and testing its effects. From a political perspective, a multifaceted policy approach that includes education, integrated healthcare, stigma reduction, and provider training is crucial to address the high prevalence of SDU and its associated risks among HIV-infected MSM in Guilin.

Conclusions

This longitudinal study of 384 HIV-infected MSM in Guilin, China, revealed a consistently high prevalence of SDU, SRBs, depression, and anxiety. SDU was associated with an increased risk of SRBs, depression, and anxiety, while SRBs were also linked to higher rates of depression and anxiety. Addressing SDU and its impact is essential for improving the well-being of HIV-infected MSM and preventing HIV transmission. Our findings contribute key practical and theoretical insights to guide psychosocial and behavioral intervention and prevention programs in the future.

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Author Contribution All authors contributed to the study conception and design. Material preparation and data collection were performed by Yong YU, Keke Qin, Jiahong LI, and Liman Huang. Data analysis was performed by Yong YU, Keke Qin, Jiahong LI, and Liman Huang and contributed to the interpretation of data. The first draft of the article was written by Yong YU, and all authors commented on previous versions of the article. All authors read and approved the final article.

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Data Availability The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethical Approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Guangxi Normal University (GXNU:20200507003). Informed consent was obtained from all individual participants included in this study.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Consent for Publication Not applicable.

Conflict of Interest The authors declare no competing interests.

References

- Bracchi, M., Stuart, D., Castles, R., Khoo, S., Back, D., & Boffito, M. (2015). Increasing use of 'party drugs' in people living with HIV on antiretrovirals: A concern for patient safety. *AIDS (London, England)*, 29(13), 1585–1592. <https://doi.org/10.1097/QAD.0000000000000786>
- Burton, C. M., Marshal, M. P., Chisolm, D. J., Sucato, G. S., & Friedman, M. S. (2013). Sexual minority-related victimization as a mediator of mental health disparities in sexual minority youth: A longitudinal analysis. *Journal of Youth and Adolescence*, 42(3), 394–402. <https://doi.org/10.1007/s10964-012-9901-5>
- Cassels, S., Menza, T. W., Goodreau, S. M., & Golden, M. R. (2009). HIV serosorting as a harm reduction strategy: evidence from Seattle, Washington. *AIDS (London, England)*, 23(18), 2497–2506. <https://doi.org/10.1097/QAD.0b013e328330ed8a>
- 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. H., Vallabhaneni, S., Raymond, H. F., & McFarland, W. (2012). Predictors of serosorting and intention to serosort among men who have sex with men, San Francisco. *AIDS Education and Prevention : Official Publication of the International Society for AIDS Education*, 24(6), 564–573. <https://doi.org/10.1521/aeap.2012.24.6.564>
- Coyer, L., Boyd, A., Davidovich, U., van Bilsen, W. P. H., Prins, M., & Matser, A. (2022). Increase in recreational drug use between 2008 and 2018: Results from a prospective cohort study among HIV-negative men who have sex with men. *Addiction (abingdon, England)*, 117(3), 656–665. <https://doi.org/10.1111/add.15666>
- Daskalopoulou, M., Rodger, A., Phillips, A. N., Sherr, L., Speakman, A., Collins, S., Elford, J., Johnson, M. A., Gilson, R., Fisher, M., Wilkins, E., Anderson, J., McDonnell, J., Edwards, S., Perry, N., O'Connell, R., Lascar, M., Jones, M., Johnson, A. M., Hart, G., . . . Lampe, F. C. (2014). Recreational drug use, polydrug use, and sexual behaviour in HIV-diagnosed men who have sex with men in the UK: Results from the cross-sectional ASTRA study. *The Lancet HIV*, 1(1), e22–e31. [https://doi.org/10.1016/S2352-3018\(14\)70001-3](https://doi.org/10.1016/S2352-3018(14)70001-3)
- Deimel, D., Stöver, H., Höfelbarth, S., Dichtl, A., Graf, N., & Gebhardt, V. (2016). Drug use and health behaviour among German men who have sex with men: Results of a qualitative, multi-centre study. *Harm Reduction Journal*, 13(1), 36. <https://doi.org/10.1186/s12954-016-0125-y>

- Drückler, S., van Rooijen, M. S., & de Vries, H. J. C. (2018). Chemsex among men who have sex with men: A sexualized drug use survey among clients of the sexually transmitted infection outpatient clinic and users of a gay dating app in Amsterdam, the Netherlands. *Sexually Transmitted Diseases*, 45(5), 325–331. <https://doi.org/10.1097/OLQ.0000000000000753>
- Duan, Z., Wang, L., Guo, M., Ding, C., Huang, D., Yan, H., Wilson, A., & Li, S. (2021). Psychosocial characteristics and HIV-related sexual behaviors among cisgender, transgender, and gender non-conforming MSM in China. *BMC Psychiatry*, 21(1), 196. <https://doi.org/10.1186/s12888-021-03189-z>
- Eaton, L. A., Kalichman, S. C., Cain, D. N., Cherry, C., Stearns, H. L., Amaral, C. M., Flanagan, J. A., & Pope, H. L. (2007). Serosorting sexual partners and risk for HIV among men who have sex with men. *American Journal of Preventive Medicine*, 33(6), 479–485. <https://doi.org/10.1016/j.amepre.2007.08.004>
- Edmundson, C., Heinsbroek, E., Glass, R., Hope, V., Mohammed, H., White, M., & Desai, M. (2018). Sexualised drug use in the United Kingdom (UK): A review of the literature. *The International Journal on Drug Policy*, 55, 131–148. <https://doi.org/10.1016/j.drugpo.2018.02.002>
- Evers, Y. J., Van Liere, G. A. F. S., Hoebe, C. J. P. A., & Dukers-Muijers, N. H. T. M. (2019). Chemsex among men who have sex with men living outside major cities and associations with sexually transmitted infections: A cross-sectional study in the Netherlands. *PLoS ONE*, 14(5), e0216732. <https://doi.org/10.1371/journal.pone.0216732>
- Glynn, R. W., Byrne, N., O'Dea, S., Shanley, A., Codd, M., Keenan, E., Ward, M., Igoe, D., & Clarke, S. (2018). Chemsex, risk behaviours and sexually transmitted infections among men who have sex with men in Dublin, Ireland. *The International Journal on Drug Policy*, 52, 9–15. <https://doi.org/10.1016/j.drugpo.2017.10.008>
- Golden, M. R., Dombrowski, J. C., Kerani, R. P., & Stekler, J. D. (2012). Failure of serosorting to protect African American men who have sex with men from HIV infection. *Sexually Transmitted Diseases*, 39(9), 659–664. <https://doi.org/10.1097/OLQ.0b013e31825727cb>
- González-Baeza, A., Dolengevich-Segal, H., Pérez-Valero, I., Cabello, A., Téllez, M. J., Sanz, J., Pérez-Latorre, L., Bernardino, J. I., Troya, J., De La Fuente, S., Bisbal, O., Santos, I., Arponen, S., Hontañón, V., Casado, J. L., & Ryan, P. (2018). Sexualized drug use (chemsex) is associated with high-risk sexual behaviors and sexually transmitted infections in HIV-positive men who have sex with men: Data from the U-SEX GESIDA 9416 study. *AIDS Patient Care and STDs*, 32(3), 112–118. <https://doi.org/10.1089/apc.2017.0263>
- Guerras, J. M., Hoyos Miller, J., Agustí, C., Chanos, S., Pichon, F., Kuske, M., Cigan, B., Fuertes, R., Stefanescu, R., Ooms, L., Casabona, J., de la Fuente, L., Belza, M. J., & Euro HIV EDAT Working Group. (2021). Association of sexualized drug use patterns with HIV/STI transmission risk in an internet sample of men who have sex with men from seven European countries. *Archives of Sexual Behavior*, 50(2), 461–477. <https://doi.org/10.1007/s10508-020-01801-z>
- He, L., Pan, X., Wang, N., Yang, J., Jiang, J., Luo, Y., Zhang, X., & Li, X. (2018). New types of drug use and risks of drug use among men who have sex with men: A cross-sectional study in Hangzhou. *China. BMC Infectious Diseases*, 18(1), 182. <https://doi.org/10.1186/s12879-018-3091-z>
- Hegazi, A., Lee, M. J., Whittaker, W., Green, S., Simms, R., Cutts, R., Nagington, M., Nathan, B., & Pakianathan, M. R. (2017). Chemsex and the city: Sexualised substance use in gay bisexual and other men who have sex with men attending sexual health clinics. *International Journal of STD & AIDS*, 28(4), 362–366. <https://doi.org/10.1177/0956462416651229>
- Heymer, K. J., & Wilson, D. P. (2010). Available evidence does not support serosorting as an HIV risk reduction strategy. *AIDS (London, England)*, 24(6), 935–938. <https://doi.org/10.1097/QAD.0b013e328337b029>
- Hibbert, M. P., Brett, C. E., Porcellato, L. A., & Hope, V. D. (2019). Psychosocial and sexual characteristics associated with sexualised drug use and chemsex among men who have sex with men (MSM) in the UK. *Sexually Transmitted Infections*, 95(5), 342–350. <https://doi.org/10.1136/sextrans-2018-053933>
- Hylton, E., Wirtz, A. L., Zelaya, C. E., Latkin, C., Peryshkina, A., Mogilnyi, V., Dzhigun, P., Kostetskaya, I., Galai, N., & Beyrer, C. (2017). Sexual identity, stigma, and depression: The role of the “Anti-gay Propaganda Law” in mental health among men who have sex with men in Moscow, Russia. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, 94(3), 319–329. <https://doi.org/10.1007/s11524-017-0133-6>
- Íncera-Fernández, D., Gámez-Guadix, M., & Moreno-Guillén, S. (2021). Mental health symptoms associated with sexualized drug use (chemsex) among men who have sex with men: A systematic review. *International Journal of Environmental Research and Public Health*, 18(24), 13299. <https://doi.org/10.3390/ijerph182413299>
- Íncera-Fernández, D., Román, F. J., Moreno-Guillén, S., & Gámez-Guadix, M. (2023). Understanding sexualized drug use: Substances, reasons, consequences, and self-perceptions among men who have sex with other men in Spain. *International Journal of Environmental Research and Public Health*, 20(3), 2751. <https://doi.org/10.3390/ijerph20032751>
- Katz-Wise, S. L., & Hyde, J. S. (2012). Victimization experiences of lesbian, gay, and bisexual individuals: A meta-analysis. *Journal of Sex Research*, 49(2–3), 142–167. <https://doi.org/10.1080/00224499.2011.637247>
- Liu, J., Zhong, X., Lu, Z., Peng, B., Zhang, Y., Liang, H., Dai, J., Zhang, J., & Huang, A. (2020). Anxiety and depression associated with anal sexual practices among HIV-negative men who have sex with men in Western China. *International Journal of Environmental Research and Public Health*, 17(2), 464. <https://doi.org/10.3390/ijerph17020464>
- Maxwell, S., Shahmanesh, M., & Gafos, M. (2019). Chemsex behaviours among men who have sex with men: A systematic review of the literature. *International Journal of Drug Policy*, 63, 74–89.
- McConnell, E. A., Janulis, P., Phillips, G., 2nd., Truong, R., & Birkett, M. (2018). Multiple minority stress and LGBT community resilience among sexual minority men. *Psychology of Sexual Orientation and Gender Diversity*, 5(1), 1–12. <https://doi.org/10.1037/sgd0000265>
- 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>
- Miller, W. M., Miller, W. C., Barrington, C., Weir, S. S., Chen, S. Y., Emch, M. E., Pettifor, A. E., & Paz-Bailey, G. (2020). Sex work, discrimination, drug use and violence: A pattern for HIV risk among transgender sex workers compared to MSM sex workers and other MSM in Guatemala. *Global Public Health*, 15(2), 262–274. <https://doi.org/10.1080/17441692.2019.1671984>
- Mizuno, Y., Purcell, D. W., Latka, M. H., Metsch, L. R., Ding, H., Gomez, C. A., & Knowlton, A. R. (2010). Is sexual serosorting occurring among HIV-positive injection drug users? Comparison between those with HIV-positive partners only, HIV-negative partners only, and those with any partners of unknown status. *AIDS and Behavior*, 14, 92–102.
- National Center for AIDS/STD Control and Prevention, China CDC. (2023). The national AIDS STD epidemic in the second quarter of 2023. *Chinese Journal of AIDS & STD*, 29(9), 953. <https://doi.org/10.13419/j.cnki.aids.2023.09.01>

- Nevendorff, L., Schroeder, S. E., Pedrana, A., Bourne, A., & Stoové, M. (2023). Prevalence of sexualized drug use and risk of HIV among sexually active MSM in East and South Asian countries: Systematic review and meta-analysis. *Journal of the International AIDS Society*, 26(1), e26054. <https://doi.org/10.1002/jia2.26054>
- Patten, S., Doria, N., Joy, P., Sinno, J., Spencer, R., Leblanc, M. A., . . . Numer, M. (2020). Sexualized drug use in virtual space: A scoping review of how gay, bisexual and other men who have sex with men interact online. *The Canadian Journal of Human Sexuality*, 29(1), 106–126. <https://doi.org/10.3138/cjhs.2019-0052>
- Philip, S. S., Yu, X., Donnell, D., Vittinghoff, E., & Buchbinder, S. (2010). Serosorting is associated with a decreased risk of HIV seroconversion in the EXPLORE Study Cohort. *PloS one*, 5(9), e12662. <https://doi.org/10.1371/journal.pone.0012662>
- Poteat, V. P., Mereish, E. H., DiGiovanni, C. D., & Koenig, B. W. (2011). The effects of general and homophobic victimization on adolescents' psychosocial and educational concerns: The importance of intersecting identities and parent support. *Journal of Counseling Psychology*, 58(4), 597–609. <https://doi.org/10.1037/a0025095>
- Pufall, E. L., Kall, M., Shahmanesh, M., Nardone, A., Gilson, R., Delpech, V., Ward, H., Voices, P., & study group,. (2018). Sexualized drug use ('chemsex') and high-risk sexual behaviours in HIV-positive men who have sex with men. *HIV Medicine*, 19(4), 261–270. <https://doi.org/10.1111/hiv.12574>
- Purcell, D. W., Higa, D., Mizuno, Y., & Lyles, C. (2017). Quantifying the harms and benefits from serosorting among HIV-negative gay and bisexual men: A systematic review and meta-analysis. *AIDS and Behavior*, 21(10), 2835–2843. <https://doi.org/10.1007/s10461-017-1800-z>
- Russell, S. T., & Fish, J. N. (2016). Mental health in lesbian, gay, bisexual, and transgender (LGBT) youth. *Annual Review of Clinical Psychology*, 12, 465–487. <https://doi.org/10.1146/annurev-clinpsy-021815-093153>
- Sattler, F. A., Wagner, U., & Christiansen, H. (2016). Effects of minority stress, group-level coping, and social support on mental health of German gay men. *PLoS ONE*, 11(3), e0150562. <https://doi.org/10.1371/journal.pone.0150562>
- Sun, S., Pachankis, J. E., Li, X., & Operario, D. (2020). Addressing minority stress and mental health among men who have sex with men (MSM) in China. *Current HIV/AIDS Reports*, 17(1), 35–62. <https://doi.org/10.1007/s11904-019-00479-w>
- Tomkins, A., George, R., & Kliner, M. (2019). Sexualised drug taking among men who have sex with men: A systematic review. *Perspectives in Public Health*, 139(1), 23–33. <https://doi.org/10.1177/1757913918778872>
- Torres, T. S., Bastos, L. S., Kamel, L., Bezerra, D. R. B., Fernandes, N. M., Moreira, R. I., Garner, A., Veloso, V. G., Grinsztejn, B., & De Boni, R. B. (2020). Do men who have sex with men who report alcohol and illicit drug use before/during sex (chemsex) present moderate/high risk for substance use disorders? *Drug and Alcohol Dependence*, 209, 107908. <https://doi.org/10.1016/j.drugalcdep.2020.107908>
- UNODC. (2019). HIV prevention, treatment, care and support for people who use stimulant drugs: Technical guide. UNODC.
- Van Hout, M. C., Crowley, D., O'Dea, S., & Clarke, S. (2019). Chasing the rainbow: Pleasure, sex-based sociality and consumerism in navigating and exiting the Irish Chemsex scene. *Culture, Health & Sexuality*, 21(9), 1074–1086. <https://doi.org/10.1080/13691058.2018.1529336>
- Villa-Rueda, A. A., Onofre-Rodríguez, D. J., Churchill, S., Ramírez-Barajas, F., & Benavides-Torres, R. A. (2021). Multilevel elements associated with HIV serosorting for sexual encounters: A scoping literature review. *Ciência & Saúde Coletiva*, 26, 2183–2194.
- Wang, Z., Mo, P. K. H., Ip, M., Fang, Y., & Lau, J. T. F. (2020a). Uptake and willingness to use PrEP among Chinese gay, bisexual and other men who have sex with men with experience of sexualized drug use in the past year. *BMC Infectious Diseases*, 20(1), 299. <https://doi.org/10.1186/s12879-020-05024-4>
- Wang, Z., Yang, X., Mo, P. K. H., Fang, Y., Ip, T. K. M., & Lau, J. T. F. (2020b). Influence of social media on sexualized drug use and chemsex among Chinese men who have sex with men: Observational prospective cohort study. *Journal of Medical Internet Research*, 22(7), e17894. <https://doi.org/10.2196/17894>
- White Hughto, J. M., Hidalgo, A. P., Bazzi, A. R., Reisner, S. L., & Mimiaga, M. J. (2016). Indicators of HIV-risk resilience among men who have sex with men: A content analysis of online profiles. *Sexual Health*. <https://doi.org/10.1071/SH16023>. Advance online publication. <https://doi.org/10.1071/SH16023>
- Wilson, D. P., Regan, D. G., Heymer, K. J., Jin, F., Prestage, G. P., & Grulich, A. E. (2010). Serosorting may increase the risk of HIV acquisition among men who have sex with men. *Sexually Transmitted Diseases*, 37(1), 13–17. <https://doi.org/10.1097/OLQ.0b013e3181b35549>
- Yang, X., Mo, P. K. H., Ip, M. T. K., & Wang, Z. (2022). Prevalence and predictors of psychoactive drug use among Chinese men who have sex with men: A longitudinal and mediation study. *Journal of Psychoactive Drugs*, 1–10. Advance online publication. <https://doi.org/10.1080/02791072.2022.2144556>
- Zhang, K., Chen, S., Chan, P. S., Fang, Y., Cao, H., Chen, H., Hu, T., Chen, Y., Zhou, X., & Wang, Z. (2022). Changes in HIV testing utilization among Chinese men who have sex with men during the COVID-19 pandemic in Shenzhen, China: An observational prospective cohort study. *Frontiers in Medicine*, 9, 842121. <https://doi.org/10.3389/fmed.2022.842121>
- Zung, W. W. (1971). A rating instrument for anxiety disorders. *Psychosomatics*, 12(6), 371–379. [https://doi.org/10.1016/S0033-3182\(71\)71479-0](https://doi.org/10.1016/S0033-3182(71)71479-0)

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