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Assessing the Risk of Sexually Transmitted Infections among Men who have Sex with Men in San Francisco during COVID-19: A Socio-ecological Analysis

Christopher Justin Hernandez^{1,2}, Dillon Trujillo^{2,3}, Moranda Tate², Glenda Baguso², Jerry Quintana², Katherine C. McNaughten², Jennifer P. Jain⁴, Glenn-Milo Santos⁴, Sean Arayasirikul², Willi McFarland^{2,5}, Erin C. Wilson^{2,5}

¹David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

²Center for Public Health Research, Department of Public Health, San Francisco, USA

³Department of Community Health Sciences, UCLA School, of Public Health, Los Angeles, USA

⁴Department of Community Health Systems, University, of California, San Francisco, USA

⁵Department of Epidemiology and Biostatistics, University, of California, San Francisco, USA

Abstract

Background: Men who have sex with men (MSM) are disproportionately affected by sexually transmitted infections, a disparity that has only worsened in recent years. During the COVID-19 pandemic, an overall increasing trend remained.

Methods: We utilized data from the MSM cycle of the National HIV Behavioral Surveillance (NHBS) study in San Francisco, California, conducted from June 2021 through December 2021, to identify socio-ecological disruptions during the COVID-19 pandemic that were associated with sexually transmitted infections.

Results: In total, 505 participants were surveyed, and approximately 24% of the participants reported having been diagnosed with an STI infection within the past 12 months. In the adjusted Poisson regression models, socio-ecologic factors that were independently associated with STI infection included barriers to STI testing due to COVID-19 (aRR 1.62, 95% CI 1.18–2.23), sex with partners part of small social circles/pods (aRR 2.41, 95% CI 1.41–4.12), sex with partners whose risk for COVID-19 was not known (aRR 3.53, 95% CI 2.05–6.06), and an increase or relapse in recreational substance use (aRR 2.01, 95% CI 1.49–2.72).

Conclusions: These findings indicate the importance of enacting comprehensive policies that not only address an ongoing global pandemic but also consider its potential effects on other public health epidemics, such as sexually transmitted infections among men who have sex with men.

✉ Christopher Justin Hernandez, christopherhernandez@mednet.ucla.edu.

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Keywords

Men who have sex with men; STD risk; Socio-ecological risk; COVID-19 pandemic

Introduction

On March 4th, 2020, a state of emergency was declared in California in response to the COVID-19 pandemic, beginning what would become a multi-year cycle of tightening, loosening, and modifying policies aimed at reducing the burden of COVID-19 [1]. Through these policies, as well as individual concern of becoming infected with the novel virus, the pandemic significantly impacted healthcare by limiting in-person healthcare visits, redirecting resources to COVID-19 related efforts, and contributing to a rise in healthcare worker burnout and attrition [2–4]. The pandemic also affected access for sexual health services, including services for sexually transmitted infections (STIs) [5].

Although a significant number of STIs are asymptomatic in nature, guidelines to test and treat only those experiencing symptoms were encouraged [6]. Additionally, policies that were enacted to curb a COVID-19 surge diverted resources from STI and HIV screening and treatment centers [7]. For example, a retrospective study among an open cohort of Kaiser Permanente of Southern California members found substantial decreases in testing and diagnoses of STIs during the COVID-19 pandemic compared to the three years prior, likely explained by reductions in asymptomatic screening [8]. Furthermore, some healthcare facilities became less available. For example, centers such as the Berkeley Free Clinic in Berkeley, California, which offers free STI screening and treatment, closed for remote and in-person services for a significant period [9]. With many healthcare centers resorting to online video visits, those without access to privacy, stable internet connection, adequate technology, or the ability to access and return samples, were unlikely to receive necessary testing [10, 11]. These policies likely impacted STI treatment access and the forward transmission of STIs, which may have accelerated with less treatment engagement.

Men who have Sex with Men (MSM) are a population that is disproportionately affected by STIs, which could cause direct health impacts or increase the risk for HIV infection [12, 13]. However, little is known about how STI risk, or the risk of acquiring STIs through sexual behaviors with multiple partners, with suboptimal levels of barrier or biomedical protection, or through event-driven substance use that affects adherence to protection, changed for MSM, if at all, during the COVID-19 pandemic [14]. Prior to the pandemic, STI rates were on the uptrend in the United States. Syphilis infection cases among MSM increased 11.2%, from 16,155 to 17,968 between the years of 2016 and 2020 [15]. At the start of the COVID-19 pandemic, between March through April 2020, STI rates decreased likely due to a combination of fewer people being screened and fewer interactions between MSM, but rates began to increase again by the end of the year [16–18]. San Francisco, saw a similar pattern unfold. According to the San Francisco Department of Health there was a 34% increase in syphilis, 16% increase in gonorrhea, and 12% increase in chlamydia between 2016 and 2019, but a 17% decrease in syphilis, 39% decrease in chlamydia, and 26% decrease in gonorrhea between 2019 and 2020 [19]. There was also a sharp decrease

in STI screening rates at the start of March 2020, which were still at pre-pandemic levels over a year later in August 2021, indicating that the decreases seen in San Francisco could in part be explained by insufficient screening [19]. Despite what should have been an apparent drop in STI rates, the Centers for Disease Control (CDC) reported that incidence among MSM increased, disproportionately affecting minority communities, the reasons for which, are multifaceted, complex, but not fully elucidated [20].

For MSM, COVID-19 has affected healthcare through a reduction in access to services such as HIV and STI testing, HIV care needs, and access to other services, which could have led to missed diagnoses and a higher risk for onward transmission [21, 22]. Sexual networks were also altered, with a study in San Francisco finding that some MSM became abstinent during this period, while others had no changes or even reported increases in the number of sexual partners [23]. Some of the practices employed to reduce COVID-19 risk included being part of small social circles, which were endorsed by some local governments; however, how these attempts to mitigate the acquisition of a respiratory infection affected STI risk is not well understood [24]. Furthermore, prolonged COVID-19 shelter-in-place policies increased mental distress and substance use during the COVID-19 pandemic, which in turn may have increased STI risk [25–28]. Untangling the impact of factors affecting STI risk among MSM during the COVID-19 pandemic may help inform the development of interventions to reduce STIs among MSM. Moreover, identifying MSM at risk for STIs can help inform targeting of novel biomedical interventions, including doxycycline post-exposure prophylaxis (DoxyPEP), which may reduce the need for in-person clinic visits and has demonstrated efficacy in reducing bacterial STIs [29].

The Socio-Ecological Model (SEM) is a framework that is designed to examine how multilevel factors affect the health and behaviors of individuals [30]. It posits that motivations are influenced not just by internal drivers or perceptions, which are mediated by factors such as mental health, substance use, or personal belief systems, but by the context of an individual's surroundings, such as policies, culture, economic situation, access to healthcare, as well as the nature of interpersonal relationships. In regards STI risk among MSM, the SEM model is a useful framework to examine how risk-taking behaviors unfold to explain the higher rates of STIs among this population [31, 32]. Further, the SEM model can pinpoint areas to intervene at any of these levels which may have salient implications for STI risk mitigation. To reduce these gaps in research, we assessed and analyzed data capturing behaviors of MSM during the peak of the COVID-19 pandemic to examine COVID-related structural, interpersonal, and individual risk and/or protective factors for STI risk during this period [30]. Findings from this study may help inform policies to reduce STIs among MSM in the context of a pandemic.

Methods

This study utilized secondary data from the MSM cycle of the National HIV Behavioral Surveillance (NHBS) study in San Francisco, conducted from June 2021 through December 2021. NHBS is a CDC led collaboration of health jurisdictions across the US which samples MSM, as well as people who inject drugs and high-risk heterosexuals on a 3-year cycle [33]. NHBS historically utilized time location sampling at physical venues to obtain relatively

large quasi-probability samples of MSM. However, in response to the COVID-19 pandemic, study recruitment was conducted by intercepting potential participants in virtual venues such as dating apps and through advertisements on social media sites targeting persons with interests in LGBT topics. The use of online venues for sampling MSM was intended to be analogous to the use of physical venue for the usual cycles of NHBS for MSM. A pre-survey formative research phase was conducted using in-depth interviews with community stakeholders and leaders to gather information on popular dating apps and social media sites used by MSM in San Francisco. Based on findings from this formative phase, the study identified a comprehensive list of apps used by MSM. Randomly selected app-day time slots were used to conduct recruitment activities. Potential participants were sent a brief introductory message to assess their interest in participating in this study. Interested participants called the study phone line to be assessed for eligibility based on the following inclusion criteria: being 18 years or older, identifying as a cisgender man, reporting a male sexual partner in their lifetime, and residing in San Francisco, California. Eligible participants scheduled an online study visit, provided verbal consent, and completed the virtual interviewer-administered survey on zoom or through phone call. The participants were offered the opportunity to be tested for HIV using an at-home OraQuick HIV testing kit, which were mailed to the participants. HIV test results and STI specimens were either mailed back to the study site or dropped in person.

Participants were asked about their demographic information, such as age in years, race/ethnicity, highest level of education, and access to healthcare in the past 12 months. Most questions referenced the previous 12-month period, or June 2020–Dec 2020, at a time when healthcare systems were still impacted by the pandemic and shelter-in-place ordinances were still in place to mitigate COVID-19 risk. In addition, participants were asked about sexual and substance use risk behaviors, such as “Within the past 12 months, how many sexual partners have you had?”; and “How often have you used (substance class) in the past 12 months?” The substance classes evaluated included methamphetamine, powdered cocaine, painkillers, heroin, ecstasy, and poppers. The PrEP questions included participants who had taken PrEP in the past 12 months (yes/no). The participants were asked to self-report their HIV status. Participants received \$75 to complete the survey.

To assess STI diagnoses, participants were asked “In the past 12 months, had a doctor or other healthcare provider told you that you had [gonorrhea, chlamydia, syphilis] (yes/no)? The outcome of interest for this study was derived from this question and was any self-reported STI diagnosis in the past 12 months (yes/no), including gonorrhea, chlamydia, or syphilis. We excluded from this outcome variable any viral STIs that were asked about, including HIV, Herpes Simplex Virus, or Hepatitis C infection.

To measure exposures of interest, we were guided by the SEM (see Fig. 1) and asked participants several questions related to how the pandemic may have caused disruptions in access to care, sexual behaviors, substance use, and depression. Due to small sample sizes that could not allow for ordinal analysis, all responses were dichotomized as follows:

A) Structural disruptions due to Covid-19

Question: Did you experience any difficulties obtaining PrEP medications due to the COVID-19 pandemic?

–Answers dichotomized to 0 = No or did not attempt to obtain PrEP; 1 = Yes

Question: Did you experience any difficulties obtaining an HIV test due to the COVID-19 pandemic?

–Answers dichotomized to 0 = No or did not attempt to obtain an HIV test, 1 = Yes

Question: Did you experience any difficulties obtaining a STI test due to the COVID-19 pandemic?

–Answers dichotomized to 0 = No or did not attempt to obtain an STI test; 1 = Yes

Question: Did you skip an HIV healthcare visit due to the COVID-19 pandemic?

–Answers dichotomized to 0 = No, 1 = Yes

Question: Did you miss any HIV medication doses due to the COVID-19 pandemic?

–Answers dichotomized to 0 = No, 1 = Yes

B) Interpersonal/Social disruptions due to Covid-19

Question: How did the COVID-19 pandemic affect your sexual behavior? (Choose one of the following).

- I did not have sex during the COVID-19 pandemic.

- I only had sex with partners who were part of a small circle or pod of people who stuck to COVID-19 preventative measures, like masking, distancing, handwashing, avoiding crowds, etc.

- I had sex with casual partners whose risk for COVID-19 I did not know.

- I only had sex with a partner or partners living in my house.

C) Individual/Behavioral disruptions due to Covid-19

Question: Did your drug use (not including alcohol) increase, decrease, or stay the same during the COVID-19 pandemic?

–Answers dichotomized to 0 = no change or decreased, 1 = Increased or Relapsed

Question: Did your alcohol use increase, decrease, or stay the same during the COVID-19 pandemic?

–Answers dichotomized to 0 = no change or decreased, 1 = Increased or Relapsed

Question: Have your levels of depression increased, decreased, or not changed due to the COVID-19 pandemic?

—Answers dichotomized to 0 = decreased or no change, 1 = Increased

Statistical Analysis: Descriptive statistics (i.e. proportions) were used to summarize demographic characteristics, behaviors, and access to HIV care and PrEP. We determined whether there were statistically significant differences in sociodemographic factors between those with an STI diagnosis using t-tests for continuous variables and chi-square statistic or Fisher's exact test for categorical variables, depending on whether all values in the 4×4 table were $n > 5$ (Chi-square) or if any one value was $n \leq 5$ (Fisher's exact test) (Table 1).

Since the prevalence of our outcome of interest, being diagnosed with an STI in the past 12 months, was greater than the rare-disease assumption of less than 10%, a logistic regression would not have been an appropriate statistical method for analysis and so we used bivariate Poisson regressions with a robust error variance to estimate the risk ratio of STI infection by demographic and risk subgroups [34]. This method also has the added benefit of providing a more conservative point estimate and a narrower 95% confidence interval [35]. To further investigate the effect of each individual factor and avoid the Table 2 fallacy, an analytical error that occurs when the impacts of multiple factors are derived from a single multivariable model especially when there is more than one exposure of interest, we built a multivariable Poisson regression with a robust error variance model for each exposure while controlling for age, race/ethnicity and HIV status [36].

The exposures whose association with STI risk were measured were divided into two groups. In the first exposure group, we examined established risk behaviors for STI infection (PrEP use, multiple sexual partners, substance use) that were significant at the bivariate level to determine if their impact on STI risk changed during the COVID-19 pandemic in the multivariable model (Table 2). In the second exposure group, we focused on the association between disruptions to socioecological factors and STI risk (Table 3). A sensitivity analysis for the impact of the COVID-19 pandemic on SEM factors was conducted among the participants who reported an STI test in the past 12 months. All analyses were conducted using STATA version 17 (College Station, TX, USA).

Results

Participant Characteristics

A total of 505 participants were recruited for the study. The median age was 41 years, with interquartile ranges (IQR) of 32 and 54. Most participants held higher education degrees, with 41% holding a bachelor's degree and 33% holding a post-graduate degree; 20.4% had some college or associate degrees, and 6% held a high school diploma or lower. Most participants in this study were white (54%), 5% were Black or African American, 14% were Asian or Pacific Islander, 21% were Hispanic or Latino, and 6% were mixed or other races.

STI Infections and Risk Factors

Among all participants, 71.9% reported getting STI tests in the past 12 months. Additionally, approximately 33.1% of participants who received an STI test reported having been diagnosed with an STI infection in the past 12 months. The most common STI reported was gonorrhea (17%), followed by chlamydia (14%) and syphilis (6%). Among all participants, most (59%) reported engaging in any condomless anal intercourse in the previous year, and among those not living with HIV, 65% reported taking PrEP in the past 12 months. The most commonly used recreational substance was marijuana (64%), followed by inhaled nitrites/poppers (45%), cocaine (25%), ecstasy (24%) and methamphetamine (13%).

SEM Structural Disruptions, Interpersonal Disruptions, Individual Disruptions due to Covid-19

One-fifth (19%) of the participants reported barriers to STI testing related to the Covid-19 pandemic. Among those not living with HIV, 19% had barriers to accessing HIV screening and 6% had barriers to PrEP. Among those living with HIV, 10% had barriers to HIV medication adherence, and 37% had barriers to accessing HIV healthcare visits. The reported interpersonal disruptions due to COVID-19 included 26% of participants stating that they had not engaged in sexual behaviors, 36% reported having sex with partners in small social circles or pods, 18% had sex with partners whose risk for COVID-19 was not known, and 19% reported having sex with partners living in the same household. Individual impacts included an increase in depression (56%), alcohol use (27%), and recreational substance use (27%).

Multivariable Analyses

Several behaviors were associated with having an STI in the past 12 months, including PrEP use in the past 12 months (adjusted risk ratio [aRR] 4.70, 95% CI 2.31–9.53), two or more sexual partners (aRR 4.56, 95% CI 1.71–9.53), and any condomless anal intercourse during the last sexual encounter (aRR 1.76, 95% CI 1.19–2.58).

Substance use in the past 12 months was also independently associated with having an STI in the past year as follows: marijuana use (aRR 1.61, 95% CI 1.11–2.35), methamphetamine use (aRR 2.64, 95% CI 1.93–3.61), cocaine use (aRR 1.85, 95% CI 1.33–2.56), ecstasy use (aRR 2.02, 95% CI 1.49–2.75), and inhaled nitrites/poppers use (aRR 2.45, 95% CI 1.72–3.48).

SEM factors due to COVID that were independently associated with STI infection in the past 12 months included barriers to STI testing due to COVID-19 (aRR 1.62, 95% CI 1.18–2.23), sex with partners of small social circles/pods (aRR 2.41, 95% CI 1.41–4.12), sex with partners whose risk for COVID-19 was not known (aRR 3.53, 95% CI 2.05–6.06), and an increase or relapse in recreational substance use (aRR 2.01, 95% CI 1.49–2.72). In the sensitivity analysis focusing on the 363 MSM who reported receiving an STI test in the past 12 months, the SEM factors that were independently associated with STI infection were consistent; STI testing due to COVID-19 (aRR 1.39, 95% CI 1.03–1.88), sex with partners of small social circles/pods (aRR 1.84, 95% CI 1.12–3.02), sex with partners whose risk

for COVID-19 was not known (aRR 2.46, 95% CI 1.48–4.06), and an increase or relapse in recreational substance use (aRR 1.64, 95% CI 1.22–2.20).

Discussion

In our study of MSM in San Francisco during the COVID-19 pandemic, we found that structural factors related to the Covid-19 pandemic presented serious barriers to accessing sexual health services for MSM in San Francisco. Nearly one-quarter of the participants reported having had an STI infection within the previous 12-month period. The prevalence of self-reported syphilis was consistent with a similar study prior to Dec 2019, and gonorrhea and chlamydia were slightly higher in this study [37]. We found that barriers to STI testing, changes in sexual networks, and an increase or relapse in recreational substance use due to COVID-19 were independently associated with having an STI infection. Furthermore, we found that risk factors associated with STI infection prior to the COVID-19 pandemic still held in this study, including factors such as PrEP use, number of sexual partners, and the use of recreational substances, indicating that the COVID-19 pandemic did not significantly alter the behavioral risk profile of MSM in San Francisco. Risk may have been modified so that some MSM had their risk increased while it decreased for others, as nearly a quarter of MSM reported not having any sexual relationships during the social distancing period. Finally, even among those who reported no sexual behavior, STI infections were still reported, which could be explained by changes in behavior after vaccination or waning of COVID-19 cases.

MSM who encountered barriers to STI testing likely had an increased self-perceived risk of STI. That is, MSM were motivated to undergo STI testing because they engaged in sexual practices or may have experienced some of the symptoms of STIs. Without adequate testing and treatment, there is an increased risk of forward transmission of STIs and the risk of long-term sequelae of these infections, such as neurosyphilis, prostatitis, or epididymo-orchitis [38, 39]. Public health officials should not assume that STI risk will decrease during a pandemic and should prioritize making at-home test kits and treatment affordable, timely, and accessible from over the counter.

A promising new tool for the reduction of STI incidence is DoxyPEP, which can be incorporated into future pandemic planning responses that do not require in-person STI clinic visits [29]. Our findings may help identify efforts to increase uptake and expand roll-out of DoxyPEP, such as MSM who use substances and have condomless sex with multiple partners, who were observed to have increased risk of STI diagnoses.

We also found that sexual behavior was not significantly modified during the pandemic and that public health recommendations for creating small social circles were not protective against STI risk among MSM. Sexual relationships with partners whose risk for COVID was unknown and sexual relationships with people in small social circles or pods were independently associated with STI infection. The finding that sexual relationships with people whose risk for COVID-19 is unknown could represent a lack of change in risk-taking during this period as well as a reversal in behavioral changes due to fatigue induced by strictly adhering to social distancing policies. In addition, social circles and pods were

regarded as important measures to reduce COVID-19 infection risk and were encouraged by public health officials [40]. Regardless of how the risk for COVID-19 was modified by this approach, STI risk was not lowered. This suggests that we need to strengthen our understanding of what constitutes safe social pods and how to strengthen their intended boundaries, such as encouraging STI testing among pod members, as they did not reduce the STI infection risk in this study.

In this study, an increase or relapse in recreational substance use among MSM was associated with STI infection. A 2020 report among the general population found that 13% of US adults reported starting or increasing substance use to cope with stress or emotions related to COVID-19, and these effects likely disproportionately affected MSM communities who were already facing a multitude of challenges specific to minorities [25, 41]. MSM in San Francisco may have used substances to cope with social isolation associated with distancing policies that were enacted or due to the stressors associated with the COVID-19 pandemic. Substance use presents its own set of problems, such as overdose risk or other direct harm; however, with reference to STI risk, previous studies have shown a strong correlation between recreational substance use and STI infection [28, 42, 43]. When STI infections are on the rise, the resurgence of substance use during a pandemic can compromise efforts to reduce STI infections and further place MSM at risk for infection. In the event of future pandemics, policies should be informed that indefinite isolation orders without any form of social or emotional support can result in fatigue and an increase in maladaptive coping strategies, including those that increase the risk of STI.

Limitations

Our study has some limitations, as it is a cross-sectional study that limits our ability to determine longitudinal individual-level risk modifications by policies aimed at reducing COVID-19 infections. The representativeness of MSM in this study is also unclear, as recruitment was conducted online due to the COVID-19 pandemic. As a secondary analysis of a study of HIV risk, questions pertaining to STIs were not framed to assess risk during the height of the pandemic; therefore, there may not be a complete overlap between questions regarding disruptions due to COVID-19 and whether they were diagnosed with an STI in the past 12 months. Similarly, because no time variables were collected, we were unable to control for those periods of time that had a greater effect than others. Along these lines, the COVID-19 pandemic unfolded in unpredictable ways that could result in recall bias from participants, as some questions may have alluded to specific timepoints during the pandemic that were more memorable than others. The sample includes only people using the Internet to find MSM partners and is self-selected in ways that cannot be controlled. Thus, our results may not be generalizable to the MSM population in San Francisco or to MSM in other cities. This is especially pertinent to the fact that over 75% of the sample was older than 32 years, which is not catching the younger age groups that are typically more at risk for STI infections. Additionally, the outcome of STI diagnosis was based on self-reported results (i.e. the study did not conduct STI screening). Moreover, data collection occurred during a period when STI screening services were likely impacted. Hence, misclassification bias may have occurred and it's likely that those with asymptomatic STIs were not captured

in this outcome measure. Therefore, our findings should be interpreted with caution, with these limitations in mind.

Conclusions

Despite these limitations, this study indicates that multiple structural, interpersonal, and individual factors because of the COVID-19 pandemic was associated with increased STI risk. Based on our findings, we recommend that future pandemic mitigation strategies balance efforts to minimize these multi-level disruptions in sexual health services for MSM and which can help to reduce STIs. These findings suggest that, in the setting of future pandemics, public health policies could prioritize comprehensive STI prevention strategies, testing, and treatment, including strategies that can be completed remotely or at home.

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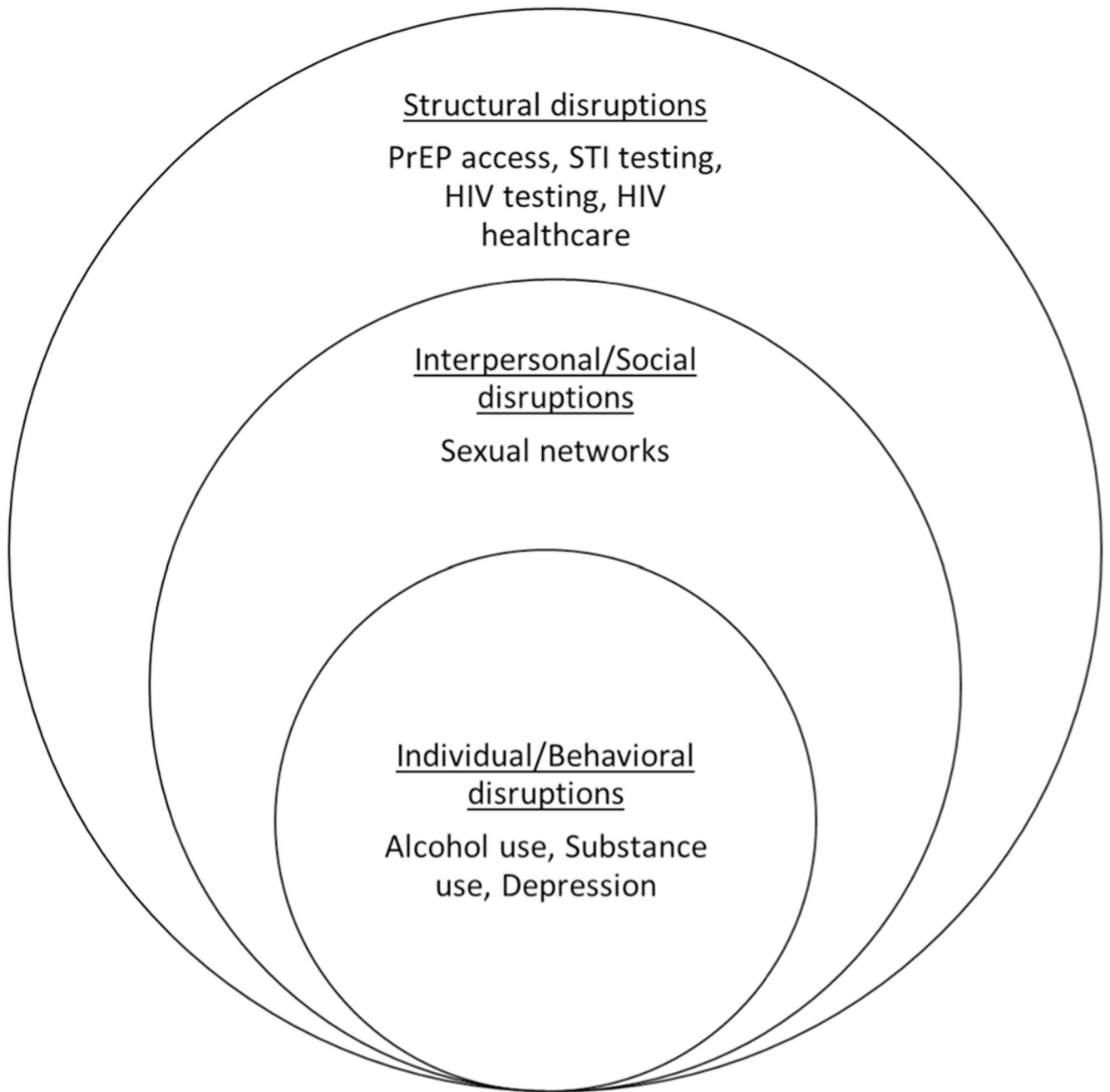


Fig. 1.
Socio-ecological disruptions due to Covid-19 pandemic that were explicitly asked to MSM participants in this study

Sociodemographic, behavioral, and clinical characteristics of Men who have Sex with Men in San Francisco with and without any STI diagnosis in San Francisco, CA 2021 ($n = 505$)

Table 1

Sociodemographic characteristics	Total, $n = 505$ (100%)	No STI diagnosis $n = 385$ (76.2%)	STI diagnosis $n = 120$ (23.8%)	T-test, χ^2 , or Fisher's exact ^a , p-value
<i>Age</i>				
Median age in years (interquartile range = IQR)	41 (32, 54)	42 (32, 55)	36 (28.5, 44)	T (3.93), 0.001
<i>Education</i>				
High School or lower	31 (6.1)	26 (83.9)	5 (16.3)	Fisher's = 0.171
Some College or Associates	103 (20.4)	79 (76.7)	24 (23.3)	
Bachelors	207 (41.0)	148 (71.5)	59 (28.5)	
Post-Graduate studies	164 (32.5)	132 (80.5)	32 (19.5)	
<i>Race/ethnicity</i>				
White	273 (54.4)	207 (75.8)	66 (24.2)	Fisher's = 0.929
Black/African American	26 (5.2)	19 (73.1)	7 (26.9)	
Asian/Pacific Islander	70 (13.9)	54 (77.1)	16 (22.9)	
Hispanic/Latino	105 (20.9)	82 (78.1)	23 (21.9)	
Mixed/Other	28 (5.6)	20 (71.4)	8 (28.6)	
<i>Sexually transmitted infections in the past 12 months</i>				
Syphilis	28 (6.0)	–	–	–
Gonorrhea	87 (17.2)	–	–	–
Chlamydia	69 (13.7)	–	–	–
<i>Sexual behaviors in the past 12 months</i>				
Insertive condomless anal sex during last sexual event	192 (38.0)	136 (70.8)	56 (29.2)	$\chi^2 = 5.0$, 0.025
Receptive condomless anal sex during last sexual event	172 (34.1)	113 (65.7)	59 (34.3)	$\chi^2 = 16.0$, 0.001
Any condomless anal intercourse during last sexual event	300 (59.4)	209 (69.7)	91 (30.3)	$\chi^2 = 17.6$, 0.001
Multiple sexual partners	82 (16.2)	81 (98.8)	1 (1.2)	Fisher's = 0.001
0–1	423 (83.8)	304 (71.9)	119 (28.1)	
2 +				
<i>HIV status</i>				
Negative	409 (81.0)	320 (78.2)	89 (21.7)	$\chi^2 = 4.76$, 0.029

Sociodemographic characteristics	Total, n = 505 (100%)	No STI diagnosis n = 385 (76.2%)	STI diagnosis n = 120 (23.8%)	T-test, χ^2 , or Fisher's exact ^a , p-value
Positive	96 (19.0)	65 (67.7)	31 (32.3)	
<i>Pre-Exposure Prophylaxis (PrEP) use</i> 2				
PrEP use past 12 months	264 (64.5)	183 (69.3)	81 (30.7)	$\chi^2 = 34.8, 0.001$
<i>Substance use in the past 12 months</i>				
Marijuana	324 (64.2)	233 (71.9)	91 (28.1)	$\chi^2 = 9.33, 0.002$
Methamphetamine	65 (12.9)	31 (47.7)	34 (52.3)	$\chi^2 = 33.6, 0.001$
Cocaine	125 (24.8)	78 (62.4)	47 (37.6)	$\chi^2 = 17.6, 0.001$
Ecstasy	123 (24.4)	72 (58.5)	51 (41.6)	$\chi^2 = 28.1, 0.001$
Inhaled nitrates/"poppers"	229 (45.4)	145 (63.3)	84 (36.8)	$\chi^2 = 38.6, 0.001$
<i>Structural disruptions due to COVID-19</i>				
Barriers to STI testing	98 (19.4)	61 (62.2)	37 (37.8)	$\chi^2 = 13.1, 0.001$
Barriers to HIV screening ^b	75 (18.3)	54 (72.0)	21 (28.0)	$\chi^2 = 2.10, 0.147$
Barriers to HIV medication adherence ³	10 (10.4)	6 (60.0)	4 (40.0)	Fisher's = 0.411
Barriers to HIV healthcare visit ^c	35 (36.5)	24 (68.6)	11 (31.4)	$\chi^2 = 0.02, 0.891$
Barriers to PrEP use ^b	24 (5.9)	15 (62.5)	9 (37.5)	$\chi^2 = 3.71, 0.054$
<i>Interpersonal disruptions due to COVID-19</i>				
No sexual behavior during pandemic	132 (26.1)	118 (89.4)	14 (10.6)	$\chi^2 = 44.1, 0.001$
Sex with partners part of small social circles/pods	184 (36.4)	131 (71.2)	53 (28.8)	
Sex with partners whose risk for COVID-19 was unknown	92 (18.2)	51 (55.4)	41 (44.6)	
Sex with partner/s living within same household	97 (19.2)	85 (87.6)	12 (12.4)	
<i>Individual/behavioral disruptions due to COVID-19</i>				
Increase in depression	284 (56.2)	209 (73.6)	75 (26.4)	$\chi^2 = 2.51, 0.113$
Increase/relapse in alcohol use	134 (26.5)	98 (73.1)	36 (26.9)	$\chi^2 = 0.97, 0.325$
Increase/relapse in recreational substance use	137 (27.1)	81 (59.1)	56 (40.9)	$\chi^2 = 30.4, 0.001$

The leftmost column describes the sociodemographic, behavioral, and clinical characteristics of Men who have Sex with Men in San Francisco, CA in 2021 (n = 505). The center two columns include characteristics stratified into those diagnosed and not diagnosed with an STI in the past 12 months. The rightmost column shows statistical differences in characteristics between those who were and were not diagnosed with an STI in the past 12 months

^aThe chi-square test was used if all values in the 4×4 table were $n > 5$. Fisher's exact test was used if any value was ≤ 5 .

^bAmong those whose HIV status is negative (n = 409)

(96) Among those whose HIV status is positive (n = 96)
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Table 2

Bivariate and adjusted risk ratio of being diagnosed with any STI in the past 12 months and risk behaviors associations with STI infection controlling for age, race, education, and HIV infection among MSM in San Francisco, CA (n = 505)

Established associations with STI infection ^a	RR (95% CI), p value	aRR (95% CI), p-value
PrEP use in the past 12 months ^b	5.56 (2.77–11.18), 0.001	4.70 (2.31–9.53), 0.001
Multiple sexual partners	Reference	Reference
0–1	4.80 (1.81–12.78), 0.002	4.56 (1.71–12.18), 0.001
2 +		
Any condomless anal intercourse	2.14 (1.47–3.13), 0.001	1.76 (1.19–2.58), 0.004
Marijuana	1.75 (1.20–2.55), 0.003	1.61 (1.11–2.35), 0.012
Methamphetamine	2.68 (1.98–3.61), 0.001	2.64 (1.93–3.61), 0.001
Cocaine	1.96 (1.44–2.66), 0.001	1.85 (1.33–2.56), 0.001
Ecstasy	2.30 (1.70–3.10), 0.001	2.02 (1.49–2.75), 0.001
Inhaled nitrites/poppers	2.81 (1.98–3.99), 0.001	2.45 (1.72–3.48), 0.001

^a STI infection is defined as self-reported syphilis, chlamydia, or gonorrhea infection in the past 12 months

^b Among those not living with HIV, (n = 409)

Table 3

Bivariate and adjusted risk ratio of being diagnosed with any STI in the past 12 months and socio-ecological factors due to COVID, controlling for age, race, education, and HIV infection among MSM in San Francisco, CA (n = 505)

SEM factors associated with STI infection ^a	RR (95% CI), p value	aRR (95% CI), p-value
<i>Structural disruptions due to COVID-19</i>		
Barriers to STI testing	1.85 (1.35–2.55), 0.001	1.62 (1.18–2.23), 0.001
Barriers to HIV testing ^b	1.38 (0.90–2.09), 0.138	1.20 (0.80–1.81), 0.379
Barriers to PrEP use ^b	1.80 (1.04–3.14), 0.036	1.53 (0.87–2.67), 0.140
Barriers to HIV medication adherence ^c	1.27 (0.56–2.91), 0.565	1.37 (0.55–3.46), 0.498
Barriers to HIV healthcare visit ^c	0.93 (0.50–1.70), 0.808	1.06 (0.58–1.91), 0.859
<i>Interpersonal disruptions due to COVID-19</i>		
No sexual behavior during pandemic	Reference	Reference
Sex with partners part of small social circles/pods	2.72 (1.57–4.69), 0.001	2.41 (1.41–4.12), 0.001
Sex with partners whose risk for COVID-19 was unknown	4.20 (2.43–7.25), 0.001	3.53 (2.05–6.06), 0.001
Sex with partner/s living within same household	1.17 (0.56–2.41), 0.678	0.99 (0.47–2.03), 0.970
<i>Individual/behavioral disruptions due to COVID-19</i>		
Increase in Depression	1.30 (0.94–1.80), 0.117	1.13 (0.82–1.55), 0.447
Increase/relapse in alcohol use	1.19 (0.85–1.67), 0.320	1.16 (0.83–1.61), 0.386
Increase/relapse in recreational substance use	2.35 (1.74–3.17), 0.001	2.01 (1.49–2.72), 0.001

^a Any STI is defined as self-reported syphilis, chlamydia, or gonorrhea infection in the past 12 months

^b Among those not living with HIV, (n = 409)

^c Among those living with HIV (n = 96)