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Permalink

https://escholarship.org/uc/item/0v49071w

Journal

Drug and Alcohol Review, 39(2)

ISSN

0959-5236

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Publication Date

2020-02-01

DOI

10.1111/dar.13026

Peer reviewed

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Author manuscript

Drug Alcohol Rev. Author manuscript; available in PMC 2021 March 29.

Published in final edited form as:

Drug Alcohol Rev. 2020 February ; 39(2): 116–127. doi:10.1111/dar.13026.

Investigating possible syndemic relationships between structural and drug use factors, sexual HIV transmission and viral load among men of colour who have sex with men in Los Angeles County

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Abstract

Introduction and Aims: Past research investigating syndemic factors and HIV-related outcomes has overlooked the impact of structural conditions on behaviours linked with HIV transmission and disease progression. In the context of prevalent substance use among our sample, we explored whether four structural conditions indicative of social marginalisation and previously correlated with increased risk for HIV infection demonstrated syndemic (additive/synergistic) effects on: a) HIV viral suppression, and b) self-reported involvement in sexual HIV transmission behaviours among a prospective cohort mostly comprising men of colour who have sex with men (MCSM; i.e., Latino/Hispanic and African American/black men) in Los Angeles County.

Design and Methods: Data were collected between August 2014 and March 2017. The structural conditions of interest were: current unemployment, recent (≤6 months) incarceration history, 'unstable' accommodation (past month), and remote (>6 months) contact with healthcare providers. Generalised estimating equations assessed possible additive effects of experiencing multiple structural conditions, and possible synergistic effects on the HIV-related outcomes.

Results: Of 428 participants, nearly half (49%) were HIV-positive at baseline. Involvement in sexual HIV transmission risk behaviours varied over follow-up (22–30%). Reporting ≥2 structural

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syndemic conditions was significantly associated with reporting sexual HIV transmission risk behaviours among HIV-negative participants, and having a detectable viral load among HIV-positive participants. Frequent methamphetamine use was consistently associated with the HIV-related outcomes across the final multivariate models.

Discussion and Conclusions: When developing initiatives to address HIV transmission among marginalised sub-populations including MCSM, we must holistically consider systemic and structural issues (e.g., unemployment and homelessness), especially in the context of prevalent substance use.

Keywords

prospective cohort study; methamphetamine; HIV infections; unemployment; homeless persons; men who have sex with men

INTRODUCTION

HIV transmission in Los Angeles County (LAC) continues to occur, disproportionately, among men of colour who have sex with men (MCSM; defined for this study as African-American/black and/or Hispanic/Latino men) [1]. In 2016 (some of the most recent figures available), the rate of new HIV diagnoses among males in LAC was highest for African Americans at 122.4 per 100,000, and 42.8 per 100,000 for Latino/Hispanic males, compared to 26.6 per 100,000 Caucasian males during the same year [2]. The overall rate of new HIV diagnoses in LAC remains just under 2,000 per year [2].

Identifying and combating factors that explain discrepancies across races and ethnicities linked to HIV transmission among MSM generally could help to reduce HIV incidence and prevalence in LAC and nationwide. In this context, numerous studies have investigated the contribution of syndemic factors – two or more synergistic or additive conditions that interact to adversely impact disease trajectories [3, 4] – on HIV transmission among MSM. This research has focused primarily on psychosocial and drug use syndemic conditions such as polysubstance use, depression, childhood sex abuse and partner violence [e.g., 5, 6, 7]. The findings of such studies have provided valuable indications of the cumulative and interconnected links between these factors and HIV, and their co-occurrence with transmission behaviours. At minimum, these studies have underscored the need to recognise and address the contributions of diverse syndemic variables for MSM living with, or at risk of, HIV.

Although research underpinned by syndemics theory in the HIV field has typically investigated interrelationships between psychosocial and substance use factors and HIV-associated outcomes, this does not negate the application of syndemics theory to investigations of the cumulative impacts of structural or systemic conditions on HIV transmission and disease progression [8]. Yet, this research gap exists and it is problematic, given studies which have shown strong links between different structural factors and HIV-related outcomes, including those indicative of broader social disadvantage and marginalisation. For example, Aidala et al.'s [9] systematic review of evidence on associations between housing status and health outcomes among people living with HIV

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indicated that unstable or insecure accommodation had a significant impact on numerous HIV outcomes including appropriate medical care, sustained viral suppression, adherence to antiretroviral therapy, and risk of forward transmission. Other studies have highlighted the adverse impacts of system-level and structural factors such as unemployment and incarceration on HIV-related outcomes among both HIV-positive and HIV-negative people [10–12]. It is crucial that we consider these conditions in the context of other factors prevalent among MSM and known to impact HIV transmission and disease progression, such as psychostimulant use [13, 14].

Importantly, there is also a paucity of research in the extant literature on syndemic factors that specifically impact ethnic and racial groups – including the aforementioned structural conditions of homelessness, unemployment and incarceration, in addition to limited healthcare access and provision [15] – who also experience disproportionately higher rates of HIV infection (e.g., African American MSM), and the exploration of associations between such exposures and HIV outcomes. This possibly mitigates our abilities to identify key opportunities to disrupt HIV transmission and disease progression among specific at-risk groups and across diverse contexts via existing socio-structural systems.

Our research sought to address these gaps. Specifically, we explored whether certain structural conditions indicative of social marginalisation demonstrated syndemic effects on a) HIV viral suppression and b) involvement in reported sexual HIV transmission behaviours among a prospective cohort of predominantly MCSM with high rates of substance use in LAC. We expected that these structural conditions would show additive effects on HIV disease progression (i.e., viral suppression) and levels of reported sexual HIV transmission behaviours among this group.

METHODS

The methodology of our ongoing prospective cohort study (‘mSTUDY’) has been described in detail elsewhere [16, 17]. Briefly, it is a National Institute of Drug Abuse-funded program with the overall objective of measuring factors linking substance use with dynamics of HIV transmission and progression (e.g., immune system function) among MCSM in LAC. Participants visit one of two Hollywood-based study sites every six months for completion of a behavioural survey, collection of biological samples (e.g., blood) for laboratory testing, and a physical examination. There is no intervention or treatment component to the mSTUDY.

The current study included data on 428 men enrolled in the study between August 2014 and March 2017.

Sample

Participants were recruited via targeted and convenience sampling measures (e.g., advertising via social media and online dating applications relevant to MSM such as Grindr). Eligible participants were aged between 18 and 45 years (the upper limit was chosen due to the relatively low incidence of HIV infections among males aged >45 years compared to younger age groups [18], in addition to a lower prevalence of drug use among older MSM),

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were born male and identified as male. HIV-negative participants were required to report ≥1 episode of unprotected anal intercourse with a male in the six months pre- recruitment. HIV status was confirmed by serologic testing; HIV-positive participants have their HIV-disease status confirmed via laboratory analyses.

Questionnaire design & administration

The structured behavioural survey is undertaken via computer-assisted self-interview and collects information across domains including: participant sociodemographics, substance use, sexual behaviours, lifestyle conditions (e.g., accommodation, social involvement), HIV testing and treatment history, and utilisation of drug treatment and health and support services.

Measures

Sexual HIV transmission risk behaviours (binary; yes/no) were assessed using participants' responses regarding their last anal sex partners and in terms of time of disclosure of their partners' HIV status (i.e., whether participants had knowledge of their last partners' HIV status prior to sex). Specifically, for HIV-negative participants, sexual HIV transmission risk behaviours were defined as reporting last engaging in anal sex with an individual whose HIV status was unknown, or whose HIV status was disclosed only following sex without a condom. These participants also reported no use of pre- or post-exposure prophylaxis (PrEP or PEP, respectively) in the past six months.

For HIV-positive participants, sexual HIV transmission risk behaviours were defined as having a *detectable viral load* (DVL; ≥20 HIV RNA copies/mL assessed via laboratory confirmation) and last engaging in anal sex with an individual whose HIV status was unknown, or whose HIV status was disclosed only following sex without a condom.

The frequency of involvement in sexual HIV transmission risk behaviours for each participant was not captured given that 'risk' details were only collected for their last penetrative sex event.

Injecting drug use was not investigated as a mode of HIV transmission or indicator of HIV transmission risk in this study, largely as this was a behaviour practiced by a small minority of the sample.

Syndemic conditions: Four structural syndemic conditions indicative of current or recent social disadvantage or marginalisation were assessed due to research also demonstrating links with HIV transmission and disease progression [e.g., 10, 12, 19]: current unemployment (i.e., no self-reported casual, part- or full-time employment at the time of interview); incarcerated within the previous six months (i.e., in a jail, prison or detention facility for more than 24 hours); residing in 'unstable' accommodation during the past month [i.e., in a foster or group home, rooming, boarding or halfway house, shelter/welfare hotel, or in a public location (e.g., the street, a vacant lot, abandoned building, park or car)]; and, reporting that their last contact with a healthcare provider (HCP; doctor, nurse or 'other') was more than six months prior to interview. The longer time/recall periods for the incarceration and healthcare utilisation variables were primarily due to the limits of the

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questions in the survey; however, research has shown that lifetime incarceration and remote or limited engagement with the service system can result in adverse HIV outcomes, including involvement in sexual HIV transmission risk behaviours and especially among people of colour [15, 20–23].

Design & statistical analysis

Data collected over the first 18 months of follow-up visits were used in analyses (i.e., baseline and up to three follow-up visits). Descriptive statistics were calculated to characterise the study sample. Bivariate analyses (i.e., the Mantel-Haenszel Chi-square and Fisher's exact tests for categorical variables, the Wilcoxon signed-rank test for examining associations between continuous/non-parametric variables and dichotomous categorical variables) explored associations between exposures and outcomes of interest (i.e., HIV viral load and involvement in sexual HIV transmission risk behaviours) at a cross-sectional level using baseline data.

Our investigation of potential associations between structural syndemic conditions and HIV-related outcomes reflected the analysis approach utilised by Stall et al.'s [7] examination of co-occurring psychosocial health issues and vulnerability to HIV/AIDS among urban MSM. A logistic regression process was used with generalised estimating equations (GEE) due to the longitudinal nature of the data (i.e., to account for correlation across repeated visits). Participants reporting a race other than Hispanic/Latino/Spanish, African American/black or Caucasian/white were excluded from the analyses (n=36; Table 1).

Firstly, to assess the possible additive effects of experiencing multiple indicators of social disadvantage/marginalisation, the number of specified syndemic conditions was summed for participants at each time-point (i.e., ranging from zero to four) and included in a GEE analysis with sexual HIV transmission risk behaviours as the dependent variable, controlling for age, race and last partner type (i.e., main/regular partner, friend/acquaintance, or one-time/unknown/'trade' partner).

Secondly, we constructed multivariate GEE models (using an exchangeable correlation structure due to the underlying assumption that outcomes from the same subject are correlated over follow-up) to explore associations between exposures and outcomes over the follow-up period and generate profiles of participants classified as experiencing high levels of social disadvantage/marginalisation (i.e., a greater number of syndemic conditions). The same GEE model was conducted alternating each of the syndemic conditions and involvement in sexual HIV transmission risk behaviours as the dependent variable, and controlling for age, HIV status, race, key drug use variables significant at a bivariate level, and last partner type. Observations with missing data were excluded from the GEE models.

All data analyses were conducted using Stata Version 13 (Statacorp LP, Texas, USA) with a significance level of $p<0.05$. All reported percentages are rounded to the nearest whole number. All available data were included in the analyses; i.e., analyses were not restricted to only those participants who had completed all four follow-up visits.

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The study protocol was approved by the Institutional Review Board at the University of California, Los Angeles. All participants provided informed consent prior to data collection.

RESULTS

Sample characteristics

Four hundred and twenty-eight study participants provided data across 1,009 observations (see Box 1. Note that these numbers do not represent total follow-up rates; due to ongoing recruitment, not every participant had completed – or was due for – each follow-up visit). Laboratory analyses confirmed that close to half (49%) of all participants were HIV-positive at baseline.

The sociodemographic characteristics of the cohort at baseline, stratified by HIV status, are shown in Table 1. At baseline, the mean age of the sample was 31 years (range: 18–46) and the majority of participants were classified as MCSM; the most common race participants most identified with was African American/black (43%), with just over one-third reporting that they most identified as Hispanic, Latino and/or Spanish, and 14% as Caucasian/white. ‘Other’ race types included Native American, ‘indigenous’ and ‘mixed’. Compared to HIV-negative participants, significantly more of those who were HIV-positive were older, reported recent incarceration, and were born in a country other than the United States. Fewer HIV-positive participants were employed at baseline. Any use of alcohol and cannabis in the past six months was reported by significantly more HIV-negative participants at baseline, whereas significantly more HIV-positive participants reported any use of crystal methamphetamine and amyl nitrite/’popper’ in the past six months.

Sexual HIV transmission risk behaviours

The percentages of all participants reporting involvement in sexual HIV transmission risk behaviours at each time-point were: 25% at baseline (visit 0), 22% at visit 1 (approximately six months post-baseline), 30% at visit 2, and 26% at visit 3 (approx. 18 months). There were minimal differences in the percentages of participants engaging in such behaviours by HIV status (Figure 1).

The percentages of HIV-positive participants with a DVL at each time-point reflected a similar pattern (Figure 1); a maximum of 71% of HIV-positive participants recorded a DVL at visit 0/baseline, dropping to 60% at visit 1.

Notably, despite most (83–90%) of the HIV-positive participants reporting that they were prescribed antiretroviral therapy at each time-point, the majority of this group also recorded a DVL over the course of the study.

Around one-quarter (26%) of HIV-negative participants reported using PEP or PrEP in the last six months. A smaller percentage – 18% – were currently prescribed either anti-HIV medication at their baseline interview (38 participants were prescribed PrEP and one was prescribed PEP).

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Multivariate analyses: Number of syndemic conditions reported vs. key outcomes

Table 2 shows that, when controlling for participant age and race and last partner type, reporting a greater number (i.e., two or more) of structural syndemic conditions was significantly associated with reporting sexual HIV transmission risk behaviours among HIV-negative respondents [two conditions: adjusted odds ratio (AOR) = 1.15, 95% confidence interval (CI) = 1.02–1.30; ≥3 conditions: AOR = 1.19, 95% CI: 1.03–1.37), and having a DVL among the HIV-positive group (vs. not having a DVL) (two conditions: AOR = 1.26, 95% CI = 1.11–1.42; ≥3 conditions: 1.29, 95% CI = 1.09–1.52). Among HIV-positive respondents, reporting two structural conditions was significantly associated with reporting involvement in sexual HIV transmission risk behaviours with their last anal sex partner, compared to reporting no conditions (AOR = 1.13, 95% CI = 1.00–1.27).

Multivariate analyses: Sexual HIV transmission risk behaviours

In the multivariate GEE models examining predictors of self-reported involvement in sexual HIV transmission behaviours with participants' last anal sex partner among all participants (Table 3), of the structural syndemic factors considered, only reporting of more remote (>6 months) contact with any healthcare provider was independently associated with this outcome when it was the dependent variable (AOR = 1.09, 95% CI = 1.01–1.17). This relationship held when remote contact with a healthcare provider was considered as the dependent variable (AOR = 1.08, 95% CI = 1.02–1.16). Frequent (i.e., weekly or more) use of both crystal methamphetamine and crack cocaine was also independently associated with involvement in sexual HIV transmission risk behaviours (crystal: AOR = 1.15, 95% CI = 1.05–1.25; crack: AOR = 1.29, 95% CI = 1.07–1.55), in addition to last having sex with a one-time, unknown or trade partner (AOR = 1.22, 95% CI = 1.14–1.31). Compared to identifying as African American/black, identifying as Latino/Hispanic was associated with significantly lower odds of reporting involvement in sexual HIV transmission risk behaviours (AOR = 0.92, 95% CI = 0.86–1.00) and of being incarcerated in the last six months (AOR = 0.96, 95% CI = 0.92–1.00).

Notably, frequent methamphetamine use was the factor most consistently associated with the dependent variable across all the final models, excluding recent incarceration and more distant contact with any healthcare provider.

Multivariate analyses: HIV-positive respondents (DVL)

As shown in Table 4, two factors were independently associated with having a DVL among HIV-positive participants: frequent crystal methamphetamine use (AOR = 1.17, 95% CI = 1.03–1.30), and current unemployment (AOR = 1.21, 95% CI = 1.09–1.34). Reflecting the findings in Table 3 and highlighting considerable levels of disadvantage among this group, across these models, significant associations were observed for residing in some form of unstable accommodation in the previous month and recent incarceration, in addition to residing in unstable accommodation and current unemployment.

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DISCUSSION

Our findings from the mSTUDY cohort show support for applying the concept of syndemic theory using structural or systemic conditions to investigate possible impacts on HIV-related outcomes. Previous syndemics research on HIV has typically focused on co-occurring psychosocial and substance use conditions among MSM, indicating that the cumulative effect of factors including poor mental health, drug use, partner violence and childhood sex abuse can adversely impact HIV outcomes [5–7]. Our study did point to an additive effect in that experiencing more structural syndemic conditions was associated with significantly higher odds of both HIV-negative and HIV-positive participants engaging in sexual HIV transmission risk behaviours with their last anal sex partner, and of HIV-positive participants having a DVL. This underscores the value of simultaneously considering multiple structural and other systemic issues – such as unemployment, homelessness and engagement with the healthcare system – when developing and implementing initiatives to address HIV transmission among marginalised MCSM, especially in the context of problematic substance use.

Despite the apparent additive effect, our final GEE models provided only limited indications of independent associations between the structural syndemic factors we considered and these outcomes when controlling for age, race, key drug use variables and last partner type. Remote contact with healthcare providers predicted involvement in sexual HIV transmission risk behaviours among all participants, and unemployment predicted DVL among the HIV-positive group. Although these findings indicate that the interplay between this specific set of factors did not directly impact the HIV outcomes among our sample, as noted above, they reflect previous syndemics research by indicating that HIV-related consequences can be significantly and negatively influenced with the experience of multiple factors. Our findings do raise questions regarding how we interpret and understand published HIV prevention reports for MCSM that measure either a single or no structural determinants when assessing HIV-relevant outcomes; they provide evidence to show that, although no specific factor links to negative health effects or behaviours, they effectively stratify subpopulations by severity linked to experiencing more than one factor.

Our findings further highlight the detrimental impacts that experiencing structural indicators of social disadvantage and marginalisation can have on marginalised sub-groups, such as MCSM. This was demonstrated, for example, by the finding across multiple GEE models that current unemployment was significantly associated with residing in unstable accommodation during the previous month (and vice versa). This reflects previous research [24, 25] and, crucially, indicates that more effort is needed to address issues of homelessness and unemployment among LAC-based MCSM. Such initiatives could have wide-reaching benefits beyond this population; for example, numerous studies conducted in North America and internationally [e.g., 26, 27, 28] have provided evidence of considerable cost offsets resulting from the implementation of initiatives to reduce homelessness.

Corresponding with lower rates of HIV diagnoses among adolescent and adult Latino and Hispanic men in LAC compared to African American men [1, 29], identifying as Latino and/or Hispanic was associated with significantly lower odds of participants reporting

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involvement in sexual HIV transmission risk behaviours with their last anal sex partners. Identifying as Latino and/or Hispanic was also associated with lower odds of recent incarceration (compared to being African American/black). However, race was not significantly associated with any other outcomes, suggesting that experience of the structural disparities investigated in this research is an important contributor to involvement in sexual HIV transmission risk behaviours among MCSM generally. Further analyses did not indicate significant differences in the distribution of the four structural conditions according to race (data not shown). Regardless, it is important to note the continuing inequality among people of colour across issues including incarceration, homelessness and unemployment in the United States and the urgent need to address institutionalised racism and inequality.

The links between crystal methamphetamine – and, to a lesser extent, crack cocaine – consumption, HIV-associated outcomes and structural indicators of disadvantage in our analyses show how highly damaging regular use of these drugs can be among MCSM across multiple domains. In particular, despite HIV-negative participants using the drug at significantly lower levels compared to HIV-positive participants, crystal methamphetamine was significantly associated with an increased likelihood of reporting sexual HIV transmission risk behaviours among the HIV-negative group (data not shown). Given substantial previous research demonstrating links between methamphetamine use and HIV incidence [e.g., 30, 31, 32], this suggests that such individuals are at great risk of contracting HIV. Multi-faceted initiatives encompassing prevention, harm reduction and treatment approaches are urgently required to prevent and reduce methamphetamine use and associated outcomes – including the transmission of blood-borne viruses such as HIV – among MCSM in LAC. This includes combating barriers to harm reduction or formal treatments for crack- and methamphetamine-using MCSM. One practical example could be to enhance access to sterile injecting equipment among people who inject drugs in LAC, given previous research indicating inadequate syringe exchange program coverage in the region [33]. The dissemination of ‘safe’ stimulant smoking kits could also facilitate less risky use patterns and referrals to appropriate professional support among sub-populations such as MCSM [34, 35].

Notably, reported involvement in sexual HIV transmission risk behaviours was independently associated with more distant contact with any healthcare provider, despite nearly 80% and 65% of HIV-negative and HIV-positive participants, respectively, having some form of health insurance at baseline. Further analyses showed that this finding was not dictated by age or any particular race (data not shown), suggesting that additional barriers are preventing such men from accessing appropriate professional support. This is problematic and possibly indicates that HIV-negative and HIV-positive MSM who are most at-risk of contracting and transmitting the virus, respectively, are not engaged with the healthcare system. This finding accords with previous research which has demonstrated that people living with HIV in the United States who are more socially disadvantaged, including MCSM, often get tested later and experience limited access to quality healthcare [19]. This means there are fewer opportunities for monitoring HIV status (including viral load), early detection of HIV, and for the provision of HIV education and prevention initiatives targeted to this group. Indeed, given high rates of DVLs among HIV-positive mSTUDY participants, regardless of antiretroviral use, and that only a minority of HIV-negative participants

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reported PEP and/or PrEP use, our findings further indicated a strong need for such initiatives targeting MCSM in LAC.

Limitations

The targeted and convenience sampling methods used for recruiting participants mean that the sample might not be representative of MCSM in LAC or elsewhere in the United States. Participant attrition is a limitation intrinsic to longitudinal studies such as ours and is a source of sampling bias and threat to statistical power. It is possible that involvement in the study served as a de facto intervention which impacted participants' involvement in predictors and outcomes of interest (e.g., substance use, sexual HIV transmission risk behaviours) over the follow-up period. The self-report process for the behavioural survey means that the data were possibly subject to recall and social desirability biases; however, the latter may have been mitigated somewhat by the computer-assisted self-interview data collection process for the behavioural survey. Given that our investigation of sexual HIV transmission risk behaviours relied on event level data (i.e., participants' last occasion of anal sex) as opposed to an estimate of occasions of anal sex over a specific time period, such as the last six months, it is possible that the specific event recalled was not representative of such risk behaviours overall. Last occasion of anal sex is a standard metric among MCSM [36], but it is possible we underestimated the likelihood of risk in this group. The differences in effect sizes associated with experiencing greater numbers of structural syndemic factors are positive yet could be considered incremental; analyses of further follow-up data will provide additional insight to this issue over time. Lastly, the relatively small numbers of participants reporting recent incarceration may have precluded the identification of significant associations with the HIV-related outcomes.

CONCLUSION

Our findings provide a sharp analysis into subpopulations vulnerable to diverse syndemics and suggest that health and social conditions may be generally enhanced for HIV-positive MCSM who are virally suppressed. Specifically, experiencing a greater number of structural syndemic conditions associated with social disadvantage and marginalisation was associated with self-reported involvement in sexual HIV transmission risk behaviours among HIV-negative and HIV-positive participants, and having a DVL among HIV-positive participants. Holistically addressing such issues among MCSM, in addition to problematic drug use patterns, could impact levels of involvement in sexual HIV transmission risk behaviours – and DVL – among this and other marginalised groups.

ACKNOWLEDGEMENTS

We are grateful to the participants for generously contributing their time to this study. The names of specific colleagues have been excluded to allow blinded review.

CONFLICT OF INTEREST

This work was supported by the National Institute on Drug Abuse grant U01DA036267, the mSTUDY (PIs: Gorbach, Shoptaw); the UCLA Postdoctoral Fellowship Training Program in Global HIV Prevention Research grant T32MH080634 (PIs: Currier, Gorbach); and the Center for HIV Identification, Prevention, and Treatment Services NIMH grant PS30 MH058107 (PI: Shoptaw). B Quinn was supported by a Postdoctoral Fulbright

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Scholarship at the time of writing. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

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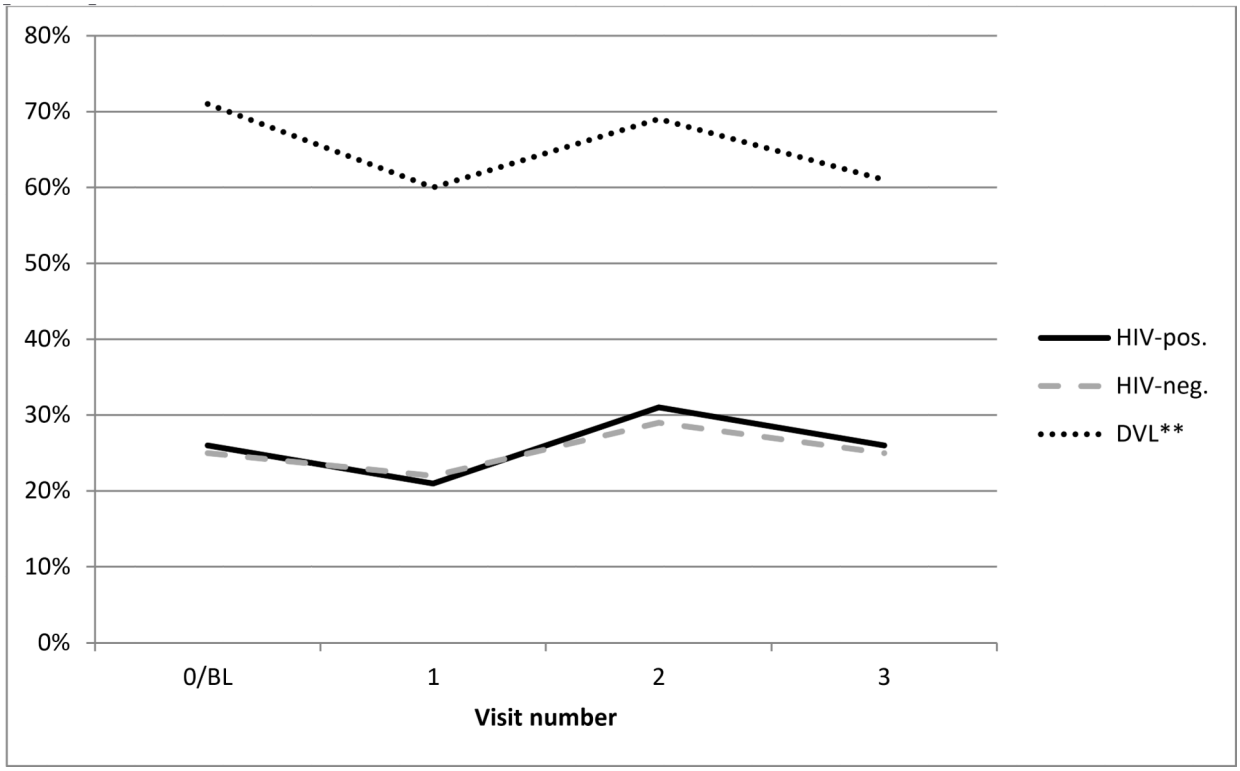

Figure 1:

Percentages at each time-point of: 1) HIV-positive & HIV-negative participants (with available data) reporting sexual HIV transmission risk behaviours, & 2) HIV-positive participants with a DVL*

*Refer to Box 1 for the total numbers of participants interviewed at each time-point at the time of writing

**Detectable viral load (among HIV-positive participants)

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Table 1:

mSTUDY sample (N=428) characteristics and drug use by HIV status at baseline, n (%)

	TOTAL N=428	HIV+ n=209	HIV- n=219	*p*
Age (yrs.), median (range)[a]	31 (18–46)	34 (18–45)	28 (18–46)	**0.000**
Yrs. education completed[b]	13 (0–22)	12 (0–22)	13.5 (0–22)	**0.017**
Race most identified with				
African American/black	186 (43)	86 (41)	100 (46)	
Hispanic/Latino/Spanish	147 (34)	76 (36)	71 (32)	
White	59 (14)	32 (15)	27 (12)	
Other	36 (9)	15 (7)	21 (10)	0.491
Country of birth				
USA	347 (81)	158 (76)	189 (86)	
Mexico	35 (8)	24 (11)	11 (5)	
Central America	19 (4)	9 (4)	10 (5)	
Other	27 (6)	18 (9)	9 (4)	**0.015**
'Unstable' housing[a]	106 (25)	52 (25)	54 (25)	0.957
Unemployed[c,d]	n=417[d] 229 (55)	n=202 122 (60)	n=215 107 (50)	**0.029**
Incarcerated last 6 mths[a]	30 (7)	16 (8)	15 (6)	**0.618**
>6mths since last HCP contact	81 (19)	14 (7)	67 (31)	**0.000**
No health insurance	56 (13)	8 (4)	48 (22)	**0.000**
Prescribed antiretroviral therapy for HIV	181 (42)	181 (87)	-	-
DRUG USE (any last six months; y/n)				
Alcohol	338 (79)	156 (75)	182 (83)	**0.032**
Crystal methamphetamine	187 (44)	119 (57)	68 (31)	**0.000**
Ecstasy	76 (18)	40 (19)	36 (16)	0.465
Erectile dysfunction drugs	75 (18)	42 (20)	33 (15)	0.171
Cocaine				
Powder	94 (22)	41 (20)	53 (24)	0.252
Crack	34 (8)	19 (9)	15 (7)	0.391
Other party drugs[e]	75 (18)	44 (21)	31 (14)	0.061
Marijuana	249 (58)	109 (52)	140 (64)	**0.014**
Prescription drugs[f]	72 (17)	33 (16)	39 (18)	0.577
Amyl nitrite ('poppers')	156 (36)	86 (41)	70 (32)	**0.048**
Heroin	16 (4)	6 (3)	10 (5)	0.355

[a] Missing data for one respondent

[b] Missing data for six respondents (outliers included 114 & 42)

[c] Excludes data for 11 respondents who refused to answer

[d] Full-or part-time employment

[e] Includes gamma hydroxybutyrate (GHB), ketamine (‘Special K’), psilocybin (‘magic mushrooms’), lysergic acid diethylamide (LSD/‘acid’)

[f] E.g., OxyContin, Vicodin, Valium, Xanax

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Table 2:

Independent associations between number of self-reported structural syndemic conditions and: 1) involvement in sexual HIV transmission risk behaviours among mSTUDY participants; and, 2) DVL, controlling for age and race

	1) Sexual HIV transmission risk behaviours								2) DVL			
	HIV-negative participants				HIV-positive participants				HIV-positive participants			
	OR	95% CI	aOR[a]	95% CI	OR	95% CI	aOR[b]	95% CI	OR	95% CI	aOR[c]	95% CI
Num. structural syndemic conditions												
0	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-
1	1.09	0.99–1.21	1.06	0.95–1.17	1.05	0.95–1.18	1.07	0.96–1.20	1.05	0.94–1.18	1.09	0.97–1.23
2	**1.17**	**1.05–1.31**	**1.15**	**1.02–1.30**	1.12	1.00–1.25	**1.13**	**1.00–1.27**	**1.22**	**1.09–1.37**	**1.26**	**1.11–1.42**
3 or 4	**1.26**	**1.11–1.44**	**1.19**	**1.03–1.37**	1.10	0.95–1.28	1.13	0.97–1.31	**1.24**	**1.06–1.45**	**1.29**	**1.09–1.52**
Aged 31+years (vs. <31)	1.00	0.91–1.10	0.96	0.87–1.06	1.05	0.95–1.16	1.05	0.95–1.16	1.03	0.92–1.15	1.00	0.89–1.11
Race												
African American/black	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-
White	0.96	0.87–1.07	0.97	0.85–1.11	1.02	0.91–1.15	1.02	0.89–1.16	0.97	0.85–1.10	0.96	0.84–1.11
Hispanic/Latino	**0.89**	**0.80–0.99**	0.90	0.81–1.00	0.97	0.88–1.08	0.96	0.86–1.06	0.95	0.85–1.07	0.99	0.88–1.11
Last partner type												
Main/regular	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-
Friend/acquaintance	1.07	0.95–1.16	1.03	0.94–1.14	1.08	0.99–1.25	1.10	0.99–1.22	0.94	0.87–1.08	0.95	0.85–1.06
One-time/unknown/trade partner	**1.22**	**1.07–1.32**	**1.19**	**1.08–1.31**	1.20	1.10–1.35	**1.26**	**1.14–1.39**	0.97	0.88–1.05	0.94	0.85–1.04

[a] 417 observations across 201 participants

[b] 420 observations across 197 participants

[c] 431 observations across 200 participants

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Table 3:

Intersecting sociodemographic, drug use, sexual risk and structural factors among mSTUDY cohort participants (n=388) over time (final multivariate GEE models comprised 821 observations; 188 observations were not included in the models due to missing data)

	AOR (95% CI)				
Predictors	**Sexual HIV transmission risk behavs**	**Incarcerated last 6 mths**	**Currently unemployed**	**Unstable accom. last mth**	**>6mths since last HCP contact**
Aged 31+years (vs. <31)	1.00 (0.93–1.07)	1.00 (0.97–1.05)	1.04 (0.96–1.13)	1.03 (0.97–1.10)	**0.91 (0.85–0.97)** **
HIV-positive (vs. HIV-neg.)	1.01 (0.94–1.09)	0.99 (0.95–1.03)	1.09 (1.00–1.20)	0.97 (0.90–1.04)	**0.79 (0.74–0.85)** ***
Race					
African American/black	Ref	Ref	Ref	Ref	Ref
Latino/Hispanic	**0.92 (0.86–1.00)** *	**0.96 (0.92–1.00)** *	0.94 (0.86–1.03)	0.96 (0.89–1.02)	0.99 (0.93–1.06)
White	1.00 (0.91–1.10)	0.99 (0.94–1.04)	0.95 (0.85–1.06)	1.01 (0.93–1.10)	0.93 (0.86–1.01)
Sexual HIV transmission risk behavs	N/A	1.00 (0.96–1.05)	1.03 (0.96–1.10)	1.00 (0.94–1.06)	**1.08 (1.02–1.16)** *
Crystal use freq. last 6 mths					
None	Ref	Ref	Ref	Ref	Ref
≥weekly	**1.15 (1.05–1.25)** **	1.04 (0.99–1.09)	**1.14 (1.04–1.26)** **	**1.14 (1.05–1.23)** **	0.99 (0.92–1.08)
≤monthly	1.04 (0.96–1.13)	1.03 (0.98–1.08)	**1.11 (1.03–1.21)** **	1.05 (0.98–1.13)	1.02 (0.95–1.10)
Crack use freq. last 6 mths					
None	Ref	Ref	Ref	Ref	Ref
≥weekly	**1.29 (1.07–1.55)** **	**1.20 (1.07–1.33)** **	1.14 (0.93–1.39)	0.99 (0.83–1.17)	0.84 (0.71–1.00)
≤monthly	0.96 (0.83–1.12)	**1.14 (1.04–1.24)** **	1.16 (1.00–1.35)	0.96 (0.84–1.10)	1.04 (0.90–1.20)
Last partner type					
Main/regular	Ref	Ref	Ref	Ref	Ref
Friend/acquaintance	1.06 (0.98–1.14)	1.00 (0.96–1.04)	0.99 (0.93–1.07)	0.99 (0.93–1.06)	1.04 (0.97–1.12)
One-time/unknown/trade partner	**1.22 (1.14–1.31)** ***	1.02 (0.98–1.06)	1.03 (0.96–1.10)	1.03 (0.96–1.09)	1.02 (0.96–1.09)
Incarc. last 6 mths	1.01 (0.90–1.13)	N/A	1.08 (0.96–1.20)	**1.12 (1.01–1.24)** *	0.94 (0.85–1.05)
Unemployed	1.04 (0.98–1.11)	1.03 (0.99–1.06)	N/A	**1.12 (1.05–1.18)** ***	1.03 (0.97–1.09)
Unstable accom.	1.00 (0.93–1.08)	**1.07 (1.02–1.12)** **	**1.14 (1.06–1.23)** **	N/A	1.03 (0.96–1.11)
>6mths since last HCP contact	**1.09 (1.01–1.17)** *	0.98 (0.93–1.02)	1.00 (0.93–1.07)	1.03 (0.96–1.10)	N/A

Drug Alcohol Rev. Author manuscript; available in PMC 2021 March 29.

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* Sig. at $p<0.05$

** Sig. at $p<0.01$

*** Sig. at $p<0.001$

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Table 4:

Intersecting sociodemographic, drug use, sexual risk and structural factors and DVL among HIV-positive mSTUDY cohort participants (n=196) over time (final multivariate GEE models comprised 418 observations; 67 observations with missing data were excluded from the models)

	AOR (95% CI)				
Predictors	**DVL**	**Incarcerated last 6 mths**	**Currently unemployed**	**Unstable accom. last month**	**>6mths since last HCP contact**
Age (years)	1.00 (0.89–1.12)	1.01 (0.95–1.08)	1.08 (0.95–1.22)	1.04 (0.94–1.15)	**0.92 (0.86–0.99)** *
Race					
African American/black	Ref	Ref	Ref	Ref	Ref
Latino/Hispanic	0.95 (0.85–1.07)	0.97 (0.91–1.03)	0.91 (0.80–1.04)	0.98 (0.89–1.09)	0.96 (0.89–1.03)
White	0.94 (0.81–1.09)	0.98 (0.91–1.07)	1.00 (0.86–1.17)	1.00 (0.88–1.13)	0.95 (0.87–1.04)
DVL	N/A	0.98 (0.93–1.03)	**1.19 (1.10–1.29)** ***	0.99 (0.91–1.07)	1.06 (0.99–1.12)
Crystal use freq. last 6 mths					
None	Ref	Ref	Ref	Ref	Ref
≥weekly	**1.17 (1.03–1.30)** *	1.04 (0.97–1.11)	1.08 (0.97–1.20)	1.06 (0.96–1.17)	1.01 (0.94–1.09)
≤monthly	1.01 (0.91–1.13)	1.01 (0.95–1.08)	1.10 (0.99–1.21)	0.98 (0.89–1.08)	0.98 (0.91–1.06)
Crack use freq. last 6 mths					
None	Ref	Ref	Ref	Ref	Ref
≥weekly	1.01 (0.73–1.42)	0.88 (0.73–1.07)	1.13 (0.83–1.54)	1.04 (0.79–1.38)	0.89 (0.72–1.11)
≤monthly	1.23 (0.99–1.53)	**1.18 (1.04–1.33)** **	1.03 (0.85–1.25)	0.89 (0.74–1.06)	0.90 (0.78–1.04)
Last partner type					
Main/regular	Ref	Ref	Ref	Ref	Ref
Friend/acquaintance	0.97 (0.87–1.08)	0.99 (0.93–1.06)	0.93 (0.85–1.02)	1.02 (0.93–1.11)	0.98 (0.91–1.06)
One-time/unknown/trade partner	0.96 (0.87–1.07)	0.99 (0.93–1.05)	**0.89 (0.82–0.98)** *	1.04 (0.95–1.13)	1.04 (0.97–1.11)
Incarc. last 6 mths	0.94 (0.80–1.11)	N/A	1.10 (0.96–1.27)	**1.21 (1.06–1.39)** **	0.91 (0.81–1.01)
Unemployed	**1.21 (1.09–1.34)** ***	1.06 (1.00–1.12)	N/A	**1.13 (1.04–1.23)** **	1.02 (0.96–1.09)
Unstable accom.	0.98 (0.88–1.11)	**1.10 (1.04–1.19)** **	**1.15 (1.04–1.28)** **	N/A	1.00 (0.92–1.08)
>6mths since last HCP contact	1.12 (0.97–1.28)	0.93 (0.86–1.01)	1.00 (0.88–1.11)	1.01 (0.90–1.13)	N/A

*Sig. at p<0.05

**Sig. at p<0.01

*** Sig. at p<0.001

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