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### Authors

Jain, Jennifer P

Hill, Miranda

Gamarel, Kristi E

et al.

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## Socio-Ecological Barriers to Viral Suppression among Transgender Women Living with HIV in San Francisco and Los Angeles, California

Jennifer P. Jain<sup>1</sup>, Miranda Hill<sup>2</sup>, Kristi E. Gamarel<sup>3</sup>, Glenn-Milo Santos<sup>1</sup>, Mallory O. Johnson<sup>2</sup>, Torsten B. Neilands<sup>2</sup>, Samantha E. Dilworth<sup>2</sup>, Cathy J. Reback<sup>4,5</sup>, Jae Sevelius<sup>2,6</sup>

<sup>1</sup>Department of Community Health Systems, University of California, San Francisco

<sup>2</sup>Department of Medicine, University of California, San Francisco

<sup>3</sup>Department of Health Behavior and Health Education, University of Michigan School of Public Health

<sup>4</sup>Friends Research Institute, Los Angeles, California

<sup>5</sup>Center for HIV Identification, Prevention and Treatment Services, University of California, Los Angeles

<sup>6</sup>Department of Psychiatry, Columbia University

### Abstract

Troubling disparities in viral suppression persist among transgender (trans) women living with HIV in the US. We utilized baseline data from a randomized controlled trial of a behavioral intervention among trans women living with HIV in San Francisco and Los Angeles, to identify the socio-ecological correlates of biologically confirmed viral suppression (<200 HIV-1 RNA copies/mL). Among 253 participants, the mean age was 43 (SD=11), 46% identified as Black or African American and 35% were virally non-suppressed. In adjusted Poisson regression models, the following barriers to viral suppression were identified: injection drug use (adjusted risk ratio

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Corresponding Author: Jennifer P. Jain, PhD, MPH, 2 Koret Way, San Francisco, California 94143, Telephone: 415-476-1435, Jennifer.Jain@ucsf.edu.

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#### DECLARATIONS

**Conflicts of interest/competing interests:** The authors declare no conflicts of interest or completing interests.

**Ethics approval:** The study protocol was approved by the institutional review boards at the University of California, San Francisco and the University of California, Los Angeles.

**Consent to participate:** All participants provided written informed consent at study baseline.

**Consent for publication:** All participants provided written informed consent at study baseline which included the consent to publish their deidentified data.

**Availability of data and material:** Due to the sensitive nature of the data collected and the vulnerable nature of our study participants, data are available upon request. Formal data requests may be sent to the UCSF Committee on Enterprise Information and Analytics (contact via [datasharing@ucsf.edu](mailto:datasharing@ucsf.edu)). In addition, the principal investigator Dr. Jae Sevelius will happily assist with any efforts to replicate our study findings for researchers who meet criteria for data access.

**Code availability:** The code used for the statistical analyses presented in this manuscript are also available upon request. The corresponding author, Dr. Jennifer P. Jain will gladly facilitate access to her code for those who meet the criteria for code access.

[aRR]=0.78, 95% CI=0.65–0.93,  $Z=-2.64$ ,  $p=0.008$ ), methamphetamine use (aRR=0.65, 95% CI=0.51–0.83,  $Z=-3.45$ ,  $p=0.001$ ), amphetamine use (aRR=0.62, 95% CI=0.44–0.87,  $Z=-2.75$ ,  $p=0.006$ ), homelessness (aRR= 0.79, 95% CI=0.63–0.98,  $Z=-2.06$ ,  $p=0.039$ ), and sex work (aRR=0.60, 95% CI=0.41–0.86,  $Z=-2.77$ ,  $p=0.009$ ). These findings underscore the importance of interventions that address the socio-ecological barriers to viral suppression among trans women in urban settings.

## RESUMEN

Persisten disparidades preocupantes en la supresión viral entre las mujeres transgénero (trans) que viven con el VIH en los EE. UU. Utilizamos datos de referencia de un ensayo controlado aleatorizado de una intervención conductual entre mujeres trans que viven con el VIH en San Francisco y Los Ángeles, para identificar los correlatos socioecológicos de la supresión viral confirmada biológicamente (<200 copias/ml de ARN del VIH-1). Entre 253 participantes, la edad media fue de 43 años (DE = 11), el 46 % se identificó como negro o afroamericano y el 35 % no tenía supresión viral. En modelos de regresión de Poisson ajustados, se identificaron las siguientes barreras para la supresión viral: uso de drogas inyectables (razón de riesgo ajustada [aRR] = 0,78, IC del 95 % = 0,65–0,93,  $Z = -2,64$ ,  $p = 0,008$ ), uso de metanfetamina (aRR = 0,65, IC 95%=0,51–0,83,  $Z=-3,45$ ,  $p=0,001$ ), consumo de anfetaminas (aRR=0,62, IC 95%=0,44–0,87,  $Z=-2,75$ ,  $p=0,006$ ), falta de vivienda (aRR= 0,79, IC 95%=0,63–0,98,  $Z=-2,06$ ,  $p=0,039$ ), y trabajo sexual (aRR=0,60, IC 95%=0,41–0,86,  $Z=-2,77$ ,  $p=0,009$ ). Estos hallazgos subrayan la importancia de las intervenciones que abordan las barreras socioecológicas para la supresión viral entre las mujeres trans en entornos urbanos.

## INTRODUCTION

Globally, transgender (trans) women have some of the highest HIV prevalence estimates and worse HIV prevention and treatment outcomes among priority populations (1,2). The HIV care continuum is a framework that examines the stages of medical care that people living with HIV should go through in order to achieve the ultimate goal of sustained viral suppression (3). Achieving sustained viral suppression is essential to preventing the onward transmission of HIV and reducing morbidity and mortality among people living with HIV (4,5). In the United States (US), rates of viral suppression have been shown to be lower among trans women living with HIV compared to other people living with HIV, at approximately 50% compared to 61%, respectively (6,7). Thus, more research is needed to identify and confirm the barriers to attaining viral suppression among trans women in the US in order to inform the adaptation, development and implementation of comprehensive interventions.

Trans women living with HIV, particularly those who identify as women of color, experience interlocking systems of oppression rooted in racism, cissexism and HIV-related stigma that function as critical barriers to engagement in HIV treatment and care (8–10). Stigma, defined as a social process of labeling, stereotyping, and othering as a form of social control, manifests across multiple socio-ecological levels (e.g., individual/behavioral, interpersonal/social and structural) (9). At the structural level, stigma often operates by limiting and constraining resources including access to economic opportunities and healthcare (9). For

example, many trans women living with HIV experience high rates of unemployment, poverty, unstable housing and limited access to gender affirming healthcare services (8,11–14). Further, economic marginalization is associated with entry into sex work, and HIV prevalence among trans women who practice sex work is nearly twice as high compared to trans women who do not practice sex work (27% vs. 14%, respectively) (15–17).

At the interpersonal level, many trans women report experiencing interpersonal stigma, which includes daily experiences of discrimination, physical and sexual assault, harassment and misgendering (i.e., referring/relating to a person, or describing a person in a way that is inconsistent with their affirmed gender identity) (9,18). We know from prior research that social gender affirmation and healthcare empowerment together mediate the negative association between discrimination and viral suppression among trans women living with HIV (19). Moreover, social gender affirmation alone has shown to be predictive of perfect adherence to ART and viral suppression, further supporting the need for gender-affirming HIV care among trans women living with HIV (17,19).

Such forms of structural and interpersonal stigma also lead to problematic substance use and poor mental health conditions including, depression among trans women living with HIV (20). Substance use and depression are associated with suboptimal adherence to ART, viral non-suppression and overall delayed advancement along the HIV care continuum (21–23). Altogether, there is a mounting body of evidence suggesting that multiple levels of risk influence HIV treatment and care outcomes among trans women. However, few studies have used a socio-ecological framework to examine how a combination of multilevel factors influence viral suppression among trans women. In addition, most studies examining HIV treatment and care outcomes have been among cisgender women resulting in significant knowledge gaps among trans women (24,25). Therefore, there is a need for more research informed by multilevel frameworks to identify the barriers and facilitators to viral suppression among trans women in the US (26,27).

To advance our knowledge in this area, we studied trans women living with HIV in San Francisco and Los Angeles, California (CA), to estimate the impact of socio-ecological barriers and facilitators on viral suppression. Given documented associations between homelessness, sex work, stigma, substance use and poor HIV treatment and care outcomes, we were interested in examining whether these associations held true in this sample (23,26–32). In addition, prior research conducted by our team found that social gender affirmation measured via the Transgender Women’s Importance of Pronouns Scale demonstrated predictive validity with viral suppression, therefore we were interested in examining whether higher scores on this scale were significantly associated with viral suppression in a multivariable analysis. We hypothesized that homelessness, sex work, stigma and substance use would be negatively associated with viral suppression and that social gender affirmation would be positively associated with viral suppression. As such, findings from this research may help inform the development of multilevel interventions designed to optimize HIV treatment and intervention among trans women in CA and other similar settings.

## METHODS

### Theoretical Framework.

Due to the increasing recognition that multiple levels of risk influence engagement in HIV treatment and care, we utilized the Social-Ecological Model (SEM) to guide our research (Figure 1) (33,34). The SEM is a widely accepted theoretical framework that considers how micro, meso and macro level factors shape risk and resilience (33,35). Specifically, the SEM recognizes the impact of individual/behavioral, interpersonal/social, and structural level influences on human health and behavior. The SEM is a particularly relevant framework for understanding the HIV care needs of trans women given the individual (e.g., substance use), social (e.g., misgendering) and structural (e.g., economic marginalization) level barriers to engagement in HIV treatment and care this group experiences (13). Using the SEM to examine how multiple levels of risk impact viral suppression, may help identify leverage points for multilevel interventions that address the social and structural factors which shape individual level risk in order to optimize HIV prevention and treatment (36,37).

### Participants and Procedures.

Baseline data were drawn from a randomized controlled trial (RCT) of a behavioral intervention entitled *Healthy Divas* which has been described fully elsewhere (38). Between 2016 and 2019, trans women living with HIV in San Francisco and Los Angeles, CA were enrolled into *Healthy Divas*, which aimed to promote HIV care engagement by providing culturally tailored information, peer support and skill building activities to help participants accomplish their healthcare goals pertaining to HIV treatment. All study activities took place in community-based settings separate from clinical care sites, to minimize confounding with clinic attendance. In San Francisco, the field site was located in the Tenderloin District and in Los Angeles the field site was located on the border between Hollywood and West Hollywood.

Participants were recruited through passive recruitment methods (e.g., flyers), active recruitment methods (e.g., presentations at community-based organizations), and word of mouth. Participants were eligible if they were at least 18 years of age; assigned male sex at birth but did not currently identify as male; English- or Spanish-speaking; HIV-positive confirmed via antibody testing; and reported suboptimal engagement in HIV care, as indicated by one or more of the following: (a) not on ART; (b) if on ART, reported less than perfect adherence on a validated adherence rating scale; or (c) reported no HIV primary care appointments in the prior 6 months. Potential participants were deemed ineligible if they exhibited evidence of severe cognitive impairment or active psychosis, as determined by the Project Director in consultation with the Principal Investigator, a licensed clinical psychologist. Baseline procedures were facilitated by trained research assistants. Eligible participants completed a baseline survey using an audio computer-assisted self-interviewing (ACASI) system in a private setting at each site and had their blood drawn to confirm HIV viral load. Participants received \$30 for completing all baseline study activities. This study was approved by the University of California, San Francisco Institutional Review Board and the Western Institutional Review Board.

## Measures

**Viral Suppression.**—Our primary outcome of interest was a binary measure of viral suppression defined as having <200 HIV-1 RNA copies/mL (yes/no). Viral suppression was based on HIV-RNA tests performed at baseline and the <200-level cutoff was used to define viral suppression based on recommendations set forth by the AIDS Clinical Trials Group (39).

**Individual and Behavioral Level Factors.**—We assessed several individual-level factors that are associated with viral suppression. Participants were asked their age in years, race/ethnicity (Black or African American, Latina, other), and gender identity (Male, Female, Transgender Male/Trans man/FTM, Transgender Female/Trans woman/MTF, Genderqueer, Additional category, Refuse to answer). Participants self-reported whether they were currently on ART (yes/no) and the total number of years they have been on ART. To measure adherence to ART, we created a dichotomous measure of an ART adherence rate of  $\geq 85\%$  (yes/no) in the past month, using responses from the visual analogue scale which ranged from 0–100% (40). Depression was measured using the 4-item Center for Epidemiologic Studies Depression Scale (CESD) (41), and a score of 4 or greater was used to indicate symptoms consistent with clinical depression (yes/no). We also measured psychological gender affirmation among trans women, using a 5-item scale developed by our team where scores range from 5–25 ( $\alpha=0.82$ ) (42).

Participants were asked whether they had ever injected drugs (yes/no), and whether or not they used any of the following drugs in the past three months (yes/no): methamphetamine, amphetamines, cocaine, crack cocaine, inhalants, opiates, hallucinogens, phencyclidine/PCP, sedatives, ketamine, gamma hydroxybutyrate (GHB), ecstasy, and marijuana. A measure of polysubstance use in the past three months (yes/no), was defined as reporting the use of three or more of any of the aforementioned drugs. We also assessed substance use disorder severity (none, mild, moderate or severe) based on criteria set forth by the DSM-5.

**Interpersonal/Social Level Factors.**—Social gender affirmation was measured using the Transgender Women’s Importance of Pronouns Scale ( $\alpha=0.87$ ) (43). Using a five-point Likert scale ranging from “not at all important” to “extremely important,” participants responded to the following four items: “*How important is it to you that: (1) your family members call you ‘she’ when talking about you?(2) your friends call you ‘she’ when talking about you (3) health care providers call you ‘she’ when talking about you? and (4) you have a driver’s license or ID that says you are female?*” Scores were created by calculating the mean of the four responses; higher scores indicate higher subjective levels of the importance correct pronoun usage.

We also assessed how often one experienced anti-trans interpersonal stigma using a measure that was adapted from Landrine and colleagues Racism Scale (44,45). Using Likert scale responses ranging from “never” to “all of the time,” participants recorded how often they experienced anti-trans stigma. All scores were summed to create total scores ranging from 0–55 with higher scores representing more experiences of anti-trans stigma ( $\alpha=0.93$ ). HIV stigma was measured using 12 of 13 items from Sowell’s Scale, including subscales

on distancing, blaming and discrimination ( $\alpha=0.92$ ) (46). Using a 4-point Likert scale where responses ranged from “not at all” to “often”, participants recorded how often they experienced HIV stigma. Example items include: “*I avoided getting treatment because someone might find out about my illness*” and “*I feared my family would reject me if they learned about my illness.*” All scores were summed to create total scores ranging from 0–36, with higher scores representing higher levels of HIV stigma.

**Structural Level Factors.**—Participants were asked about their level of education (less than high school, high school graduate, and technical degree or some college), average monthly income (\$0-\$500, \$501-\$1,000, \$1,001 or more), having health insurance (yes/no) and having seen an HIV care provider in the past six months (yes/no). We also measured having a history of incarceration (yes/no) and experiencing homelessness in the past six months (yes/no). Lastly, a binary variable of sex work in the past six months (yes/no) was created from the following question: “*In the past six months what were your sources of income and financial support (employed full-time job, employed part-time, employed sometimes, general assistance, disability, unemployment benefits, social security insurance, sex for pay (prostitution), spouse/partner provides income, other family members or friends provide income, selling drugs, alimony or child support, scamming or stealing, other)?*”

### Statistical Analyses

We used baseline data from the *Healthy Divas* RCT and compared virally suppressed trans women living with HIV and virally unsuppressed trans women living with HIV with respect to several socio-ecological variables. For dichotomous variables, Chi-square tests were used and for continuous variables t-tests or Wilcoxon’s Rank Sum tests were used for normally and non-normally distributed variables, respectively (Table 1).

Modified Poisson regression with robust variance estimation was then used to estimate the crude and adjusted relative risk of viral suppression by various socio-ecological factors that were identified as primary exposures of interest. Modified Poisson regression is recommended when modeling changes in prevalent outcomes (e.g., >10%) (47,48) because it helps generate more conservative point estimates and precise (e.g., smaller) confidence intervals compared to logistic regression (49). Each primary effect measure that was significantly (i.e.,  $p<0.05$ ) associated with viral suppression at the bivariate level was examined further in adjusted regression models. Adjusted models controlled for the following potential confounders that varied significantly by viral suppression status: study site (San Francisco vs. Los Angeles), age in years, having seen an HIV care provider in the past six months and being on ART at baseline. The impact of each primary effect measure on viral suppression was modeled separately. This was done to avoid committing a table two fallacy which occurs when controlled direct effects from secondary covariates are presented as total effects (50,51). In this analysis we present total effect estimates for each primary exposure after holding the aforementioned confounders constant (Table 2). The analysis sample consisted of the 253 participants for whom we had viral load data, less one participant who was missing retention information and thus excluded from the multivariable models.  $P$ -values are two-sided, and significance was set at  $p<0.05$ . All analyses were performed using Stata 16.1.

## RESULTS

Participant characteristics overall and by viral suppression status are presented in Table 1. A total of 253 trans women living with HIV (98 from San Francisco, 155 from Los Angeles) were included in this study, of whom 65% were virally suppressed (71 in San Francisco, 94 in Los Angeles). The mean age was 43 (standard deviation [SD]=11), and the majority identified as persons of color such that 45% identified as Black or African American, 33% identified as Latinx/a, 15% identified as other and 7% identified as White. Over two-thirds (67%) were on ART at baseline, the overall median number of years since initiating ART was 11 (interquartile range [IQR]=4–18); and 60% self-reported an ART adherence rate of 85%. In terms of mental health, 49% had symptoms consistent with clinical depression and 50% reported symptoms consistent with a severe substance use disorder. Regarding substance use, 48% reported ever injecting drugs, 35% reported methamphetamine use in the past three months, 20% reported amphetamine use in the past three months, and 23% reported polysubstance use in the past three months.

In terms of interpersonal level factors, overall median scores for HIV stigma (scores range from 0–36), experiences of anti-trans stigma (scores range from 0–55) and social gender affirmation (scores range from 5–27) were 11 (IQR=4–18), 19 (IQR=10–29) and 21 (IQR=16–25), respectively. Regarding structural level factors, 40% reported attaining a high school level education, 44% reported earning between \$0–500 on a monthly basis, 86% reported having health insurance, 82% reporting seeing an HIV care provider in the past six months, 76% reported a history of incarceration, 41% reported homelessness in the past six months, and 17% reported practicing sex work as a source of income in the past six months.

Comparisons of trans women who were and were not virally suppressed at baseline suggested that the two groups differ with respect to several socio-ecological factors (see Table 1). Regarding individual and behavioral level factors, virally unsuppressed trans women were significantly younger on average (40 vs. 44,  $t(251)=2.53$ ,  $p=0.01$ ) and more likely to report injection drug use ever (59% vs. 42%,  $\chi^2(1)=6.86$ ,  $p<0.01$ ); using methamphetamine (53% vs. 25%,  $\chi^2(1)=19.66$ ,  $p<0.01$ ); using amphetamines (33% vs. 13%,  $\chi^2(1)=13.72$ ,  $p<0.01$ ); and engaging in polysubstance use (31% vs. 18%,  $\chi^2(1)=5.13$ ,  $p=0.02$ ) in the past three months, and less likely to be on ART (51% vs. 76%,  $\chi^2(1)=15.78$ ,  $p<0.01$ ) compared to those who were virally suppressed. In terms of interpersonal level factors, trans women who were virally suppressed had significantly higher median scores on the social gender affirmation scale compared to those who were virally unsuppressed (21 vs. 18,  $Z=-2.56$ ,  $p=0.01$ ). Regarding structural level factors, trans women who were virally unsuppressed were significantly less likely to have seen an HIV care provider in the past six months (74% vs. 87%,  $\chi^2(1)=6.31$ ,  $p=0.01$ ), more likely to report experiencing homelessness (56% vs. 33%,  $\chi^2(1)=11.84$ ,  $p<0.01$ ), and more likely to report practicing sex work as a source of income in the past six months (30% vs. 11%,  $\chi^2(1)=13.87$ ,  $p<0.01$ ), compared those who were virally suppressed.

In unadjusted analyses the following factors were associated with viral suppression; ever injecting drugs (RR=0.78, 95% CI=0.65–0.94,  $Z=-2.55$ ,  $p=0.01$ ), using methamphetamine in the past three months (RR=0.62, 95% CI=0.49–0.79,  $Z=-3.83$ ,  $p<0.001$ ), using



amphetamines in the past three months (RR=0.60, 95% CI=0.43–0.84,  $Z=-2.96$ ,  $p=0.03$ ), polysubstance in the past three months (RR=0.76, 95% CI=0.58–0.99,  $Z=-2.00$ ,  $p=0.04$ ), greater importance of social gender affirmation via correct pronoun usage (RR=1.01, 95% CI=1.002–1.03,  $Z=2.21$ ,  $p=0.02$ ), homelessness in the past six months (RR=0.71, 95% CI=0.58–0.87,  $Z=-3.18$ ,  $p=0.001$ ), and engaging in sex work for income in the past six months (RR=0.58, 95% CI=0.40–0.83,  $Z=-2.90$ ,  $p=0.004$ ).

In the adjusted models everything except social gender affirmation and polysubstance use remained significantly and negatively associated with viral suppression as follows: ever injecting drugs (aRR=0.78, 95% CI=0.65–0.93,  $Z=-2.64$ ,  $p=0.008$ ); methamphetamine use (aRR=0.62, 95% CI=0.44–0.87,  $Z=-3.45$ ,  $p=0.001$ ), amphetamine use (aRR=0.62, 95% CI=0.44–0.87,  $Z=-2.75$ ,  $p=0.006$ ), homelessness (aRR=0.79, 95% CI=0.63–0.98,  $Z=-2.06$ ,  $p=0.039$ ); and sex work (aRR=0.60, 95% CI=0.41–0.86,  $Z=-2.77$ ,  $p=0.009$ ) (Table 2).

## DISCUSSION

This study identified multiple socio-ecological barriers to viral suppression among trans women living with HIV in San Francisco and Los Angeles, CA. We found that recent homelessness and sex work as a source of income were significant structural level barriers to attaining viral suppression. We also found that substance use related factors were enduring individual/behavioral level barriers to viral suppression. Specifically, ever injecting drugs, and stimulant use (i.e., methamphetamine use and amphetamine use) were negatively associated with viral suppression among participants in our study. These findings may have salient implications for multilevel interventions that seek to optimize HIV treatment and intervention among trans women living with HIV in urban centers.

Consistent with our main hypothesis, we found a strong association between recent homelessness and having a lower likelihood of being virally suppressed at baseline. Homelessness is a well-established barrier to engagement in care among people living with HIV in the US. For example, a study among young trans women in the US found that those who were unstably housed had a higher probability of having detectable HIV viral load (52). Another study among women living with HIV in San Francisco, found that the odds of unsuppressed viral load increased significantly for every 10 nights spent sleeping on the streets, in a shelter, or in a single room occupancy hotel (28). Similarly, research among female sex workers living with HIV in Vancouver, Canada, found that homelessness was negatively correlated with undetectable viral load (31). Our study extends upon this literature by showing that homelessness is a persistent structural barrier to attaining and/or maintaining viral suppression among trans women in San Francisco and Los Angeles, CA.

The association between sex work as a source of income and having a significantly lower likelihood of being virally suppressed at baseline was anticipated as it maps onto prior work showing high rates of viral non-suppression among trans women and other women who engage in sex work (15,53–58). Importantly, entry into sex work is often fueled by economic marginalization, tends to be more prevalent among trans women of color and overlaps with substance use and incarceration (54,59–61). Consistent with these previous findings, the majority of those who reported sex work as a source of income in our study were

homeless, had a history of incarceration, were living with a severe substance use disorder and identified as a person of color (data not shown). This finding can also be interpreted in the context of the ongoing criminalization of sex work and HIV, where extra penalties are imposed on persons living with HIV who engage in sex work (62–65). For example, while sex work is a misdemeanor for HIV-negative sex workers, it is considered a felony for people living with HIV (65). Altogether, our results add to the literature by showing that sex work is negatively associated with viral suppression among racially diverse trans women living with HIV who experience cooccurring homelessness, substance use and incarceration.

As hypothesized, drug use including, recent injection drug use and stimulant use predominated as individual/behavioral level barriers to viral suppression among the trans women in our study. Drug use has been linked to suboptimal engagement in care, viral non-suppression and delayed advancement along the HIV care continuum among people living with HIV in different settings (22). Interestingly, those who engaged in drug use had a significantly higher odds of reporting sex work as a source of income (data not shown), suggesting that drug use occurring within the context of sex work may partially explain why sex work is negatively associated with viral suppression in this study. Regardless of the mechanism, drug use and sex work appear to overlap and negatively impact viral suppression among trans women in our study. Future analyses leveraging longitudinal data should explore drug use as mediator between sex work and viral non-suppression among trans women living with HIV to better understand causal mechanisms.

### Limitations.

Our study should be interpreted in the context of certain limitations. This was a cross-sectional study which precludes our ability to draw causal inferences. Future analyses are planned to leverage longitudinal data from the *Healthy Divas* trial to identify the time varying predictors of viral suppression and explore mediating mechanisms (e.g., drug use). We sought to address potential confounding by controlling for relevant factors; however, it is possible that residual or unmeasured confounding affected our results. The relatively small sample size (N=253) precluded our ability to stratify by study site. However, it should be noted that all final regression models controlled for study site. Both study sites were located in urban areas in San Francisco and Los Angeles therefore our findings may not generalize to trans women living in rural areas. Participants were recruited into the study using non-probability sampling methods which limits the generalizability of our findings to trans women living with HIV outside of this study. This study was limited to trans women who reported suboptimal engagement in HIV care, therefore our findings may not be applicable to trans women who are well engaged in care.

We did not assess other aspects of gender affirmation, including medical (e.g., prescribed hormones), legal (e.g., name and identity marker changes on legal documents), and psychological (e.g., internalized affirmation) which is an important area for future research. The measures used in this study did not directly capture bias in healthcare settings towards trans women, therefore we cannot draw conclusions on the importance of gender affirming HIV care. However, given the mounting evidence base that supports the importance of gender affirming healthcare (19,66), future studies should continue to examine the impact

of bias towards trans women on HIV treatment and care outcomes and assess the efficacy of gender affirming HIV care. Finally, we relied upon self-reported data on several sensitive behaviors (e.g., substance use and sexual risks) which are subject to social desirability bias and underreporting.

## CONCLUSIONS

Despite these limitations, this study underscores several enduring barriers to viral suppression that span across multiple socio-ecological levels among trans women living with HIV. Based on our findings, we recommend implementing structural level interventions that increase access to affordable housing and economic opportunities. We also advocate for the decriminalization of sex work, HIV and substance use, in order to create safer sex work and drug use environments and facilitate access to health and social services among trans women living with HIV (67,68). Further, integrating harm reduction-based substance use treatment services into HIV care settings may improve engagement in care among trans women who use drugs. Taken together, addressing the socio-ecological barriers to viral suppression through the delivery of comprehensive multilevel interventions may optimize HIV treatment and intervention among trans women living with HIV in urban centers throughout the US.

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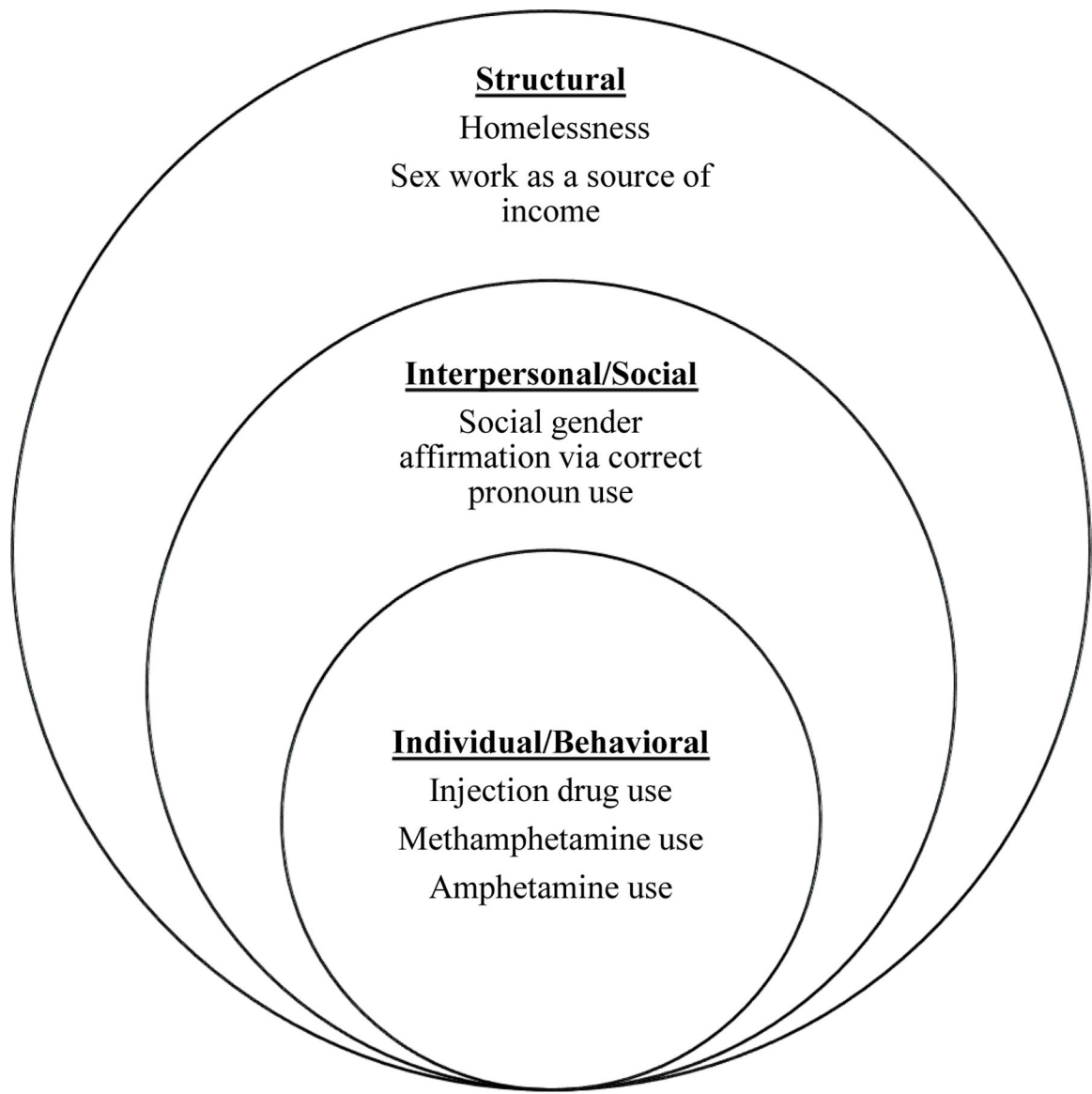
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**Figure 1.** Socio-ecological factors associated with viral suppression among trans women living with HIV in San Francisco and Los Angeles, CA (N=253), that were significant or marginally significant in adjusted modified Poisson regression models.



Table 1.

Baseline characteristics of transgender women living with HIV in California, who are and are not virally suppressed (N=253)

Socio-ecological domain and variable	Overall (N=253)	Virally Suppressed (<200 copies/mL) n=165	Virally Unsuppressed (≥200 copies/mL) n=88	X <sup>2</sup> (DF)	P-value
<i>Study site</i>					
San Francisco (SF), CA	98 (39%)	71 (43%)	27 (31%)		
Los Angeles (LA), CA	155 (61%)	94 (57%)	61 (69%)	3.68 (1)	0.06
<b>Individual and behavioral level factors</b>					
Mean age (SD)	43 (11)	44 (11)	40 (10)	-2.53 (251)*	0.01
<i>Race-ethnicity</i>					
Black or African American	115 (45%)	73 (44%)	42 (48%)		
White	18 (7%)	13 (8%)	5 (6%)		
Latina	83 (33%)	57 (35%)	26 (29%)		
Other	37 (15%)	22 (13%)	15 (17%)		
Currently on antiretroviral therapy (ART)	170 (67%)	125 (76%)	45 (51%)	1.52 (3)	0.67
Median number of years since ART initiation (IQR)	11 (4, 18)	12 (5, 20)	10 (3, 14)	15.78 (1)	<0.01
Optimal adherence to ART (≥85%)	152 (60%)	101 (61%)	51 (58%)	-1.80*	0.07
<i>Substance use</i>					
Injection drug use ever	121 (48%)	69 (42%)	52 (59%)	6.86 (1)	<0.01
Methamphetamine use in the past three months	89 (35%)	42 (25%)	47 (53%)	19.66 (1)	<0.01
Amphetamine use in the past three months	51 (20%)	22 (13%)	29 (33%)	13.72 (1)	<0.01
Cocaine use in the past three months	22 (9%)	11 (7%)	11 (13%)	2.45 (1)	0.11
Crack cocaine use in the past three months	22 (9%)	15 (9%)	7 (8%)	0.09 (1)	0.76
Inhalant use (e.g., popper use) in the past three months	21 (8%)	14 (8%)	7 (8%)	0.02 (1)	0.88
Opiate use in the past three months	15 (6%)	9 (5%)	6 (7%)	0.19 (1)	0.66
Hallucinogen use (e.g., LSD) in the past three months	10 (4%)	6 (4%)	4 (5%)	0.12 (1)	0.72
Phencyclidine/PCP (e.g., angel dust) in the past three months	10 (4%)	5 (3%)	5 (6%)	1.06 (1)	0.30
Sedative use (e.g., benzodiazepines) in the past three months	13 (5%)	8 (5%)	5 (6%)	0.08 (1)	0.77
Ketamine use in the past three months	4 (2%)	2 (1%)	2 (2%)	0.41 (1)	0.51
Gamma Hydroxybutyrate (GHB) use in the past three months	14 (6%)	7 (4%)	7 (8%)	1.51 (1)	0.21
Ecstasy use in the past three months	12 (5%)	7 (4%)	5 (6%)	0.26 (1)	0.60
Marijuana use in the past three months	119 (47%)	71 (43%)	48 (55%)	3.05 (1)	0.80

Socio-ecological domain and variable	Overall (N=253)	Virally Suppressed (<200 copies/mL) n=165	Virally Unsuppressed (≥200 copies/mL) n=88	X <sup>2</sup> (DF)	P-value
Polysubstance use (i.e., the use of three or more drugs) in the past three months	57 (23%)	30 (18%)	27 (31%)	5.13 (1)	0.02
<i>Substance use disorder severity based on DSM criteria</i>					
None	43 (23%)	29 (25%)	14 (18%)		
Mild	31 (16%)	23 (20%)	8 (10%)		
Moderate	21 (11%)	12 (11%)	9 (12%)		
Severe	96 (50%)	50 (44%)	46 (60%)	6.14 (3)	0.10
<i>Psychological factors</i>					
Median trans women's psychological gender affirmation score (IQR), $\alpha=0.82$ , score range 5–25	17 (14,20)	17 (14,20)	18 (14.5, 20)	0.53*	0.59
At risk of clinical depression (score >4 on the 4-item CESD)	124 (49%)	81 (49%)	43 (49%)	0.001 (1)	0.97
<b>Interpersonal and social level factors</b>					
Median HIV stigma score (IQR), $\alpha=0.92$ , score range 0–36	11 (4, 18)	12 (4, 18)	11 (4, 20)	-0.004*	0.99
Experiences of transphobia in the past three months (IQR), $\alpha=0.93$ , score range 0–55	19 (10, 29)	19 (9, 30)	18 (10, 26)	-0.868	0.38
Median trans women's importance of correct pronoun usage score (IQR), $\alpha=0.87$ , score range 5–27	21 (16, 25)	21 (17, 25)	18 (13, 23)	-2.56*	0.01
<b>Structural level factors</b>					
<i>Education</i>					
Less than high school	68 (27%)	38 (23%)	30 (34%)		
High school graduate	101 (40%)	67 (41%)	34 (39%)		
Technical degree, some college or college degree	84 (33%)	60 (36%)	24 (27%)	4.09 (2)	0.12
<i>Income in the past month</i>					
\$0–500	111 (44%)	66 (40%)	45 (51%)		
\$501–1,000	98 (39%)	68 (41%)	30 (34%)		
\$1,001 or more	44 (17%)	31 (19%)	13 (15%)	2.90 (2)	0.23
<i>Has health insurance</i>					
Seen an HIV care provider in the past six months	217 (86%)	145 (88%)	72 (82%)	1.72 (1)	0.18
Ever been incarcerated	207 (82%)	142 (87%)	65 (74%)	6.31 (1)	0.01
Experienced homelessness in the past six months	193 (76%)	121 (73%)	72 (82%)	2.28 (1)	0.13
Engaged in sex work in the past six months	104 (41%)	55 (33%)	49 (56%)	11.84 (1)	<0.01
	44 (17%)	18 (11%)	26 (30%)	13.87 (1)	<0.01

Notes:

Some percentages are based on denominators smaller than the N listed in the column heading; this is due to missing data.

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Abbreviations; SD, standard deviation; IQR, interquartile range; CI, confidence interval

Differences in continuous measures were assessed using *t*-tests or Wilcoxon rank sum tests depending on distributional assumptions. For *t*-tests the *t*-statistic and degrees of freedom are reported and for Wilcoxon rank sum tests the *z*-statistic is reported. These values are denoted with an asterisk.\*

**Table 2.**

Poisson regression models examining the socio-ecological factors associated with viral suppression among transgender women living with HIV in California (N=253)

Socio-ecological domain and primary effect measure	Unadjusted Risk Ratio (95% CI)	Z	P-value	Adjusted Risk Ratio (95% CI) Models 1–7	Z	P-value
<b>Individual and behavioral level factors</b>						
Injection drug use ever	0.78 (0.65–0.94)	-2.55	0.011	0.78 (0.65–0.93)	-2.64	0.008
Methamphetamine use <sup>~</sup>	0.62 (0.49–0.79)	-3.83	0.000	0.65 (0.51–0.83)	-3.45	0.001
Amphetamine (e.g., Crank, Speed, Adderall) use <sup>~</sup>	0.60 (0.43–0.84)	-2.96	0.003	0.62 (0.44–0.87)	-2.75	0.006
Polysubstance use (i.e., three or more drugs) <sup>~</sup>	0.76 (0.58–0.99)	-2.00	0.046	0.77 (0.59–1.01)	-1.88	0.060
<b>Interpersonal and social level factors</b>						
Importance of correct pronoun use/social gender affirmation	1.01 (1.00–1.03)	2.21	0.027	1.01 (0.99–1.03)	1.75	0.079
<b>Structural level factors</b>						
Experienced homelessness <sup>^</sup>	0.71 (0.58–0.87)	-3.18	0.001	0.79 (0.63–0.98)	-2.06	0.039
Engaged in sex work <sup>^</sup>	0.58 (0.40–0.83)	-2.90	0.004	0.60 (0.41–0.86)	-2.77	0.009

Notes:

All adjusted models controlled for study site (San Francisco versus Los Angeles), age in years, race/ethnicity, having seen and HIV care provider in the past six months and currently being on anti-retroviral therapy at baseline

Abbreviations: CI, confidence interval; and RR, risk ratio

<sup>~</sup> past three months

<sup>^</sup> past six months

- Model 1\_Total effect of injection drug use in the past three months on viral suppression
- Model 2\_Total effect of methamphetamine use in the past three months on viral suppression
- Model 3\_Total effect of amphetamine use in the past three months on viral suppression
- Model 4\_Total effect of polysubstance use in the past three months on viral suppression
- Model 5\_Total effect of importance of correct pronoun usage on viral suppression
- Model 6\_Total effect of homelessness in the past six months on viral suppression
- Model 7\_Total effect of sex work in the past six months on viral suppression