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Poverty matters: Contextualizing the syndemic condition of psychological factors and newly diagnosed HIV infection in the United States

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INTRODUCTION

In the United States, there were nearly 50,000 new cases of HIV per year in adults between 2006 and 2009.[1] There are notable geographic differences in the distribution of HIV, with the largest burden of HIV in the Southern United States.[2,3] Complex social forces, including socioeconomic factors and gender, are thought to contribute to growing disparities in HIV incidence in the United States.[4] The HIV epidemic in the United States is considered a concentrated epidemic.[5] However, HIV prevalence among Americans living in urban poor areas exceeds 2%, calling into question whether HIV should be considered a generalized epidemic in the setting of poverty.[6] Research has shown that poverty, above other social determinants such as gender, race/ethnicity, and sexual orientation, is the driver of the changing shape of the HIV epidemic today.[6,7] Multiple studies have demonstrated an association between psychological factors, including major depression, substance use, and experiences of violence, and HIV risk behavior.[8–12] These factors are thought to increase HIV risk by fueling HIV risk-taking behaviors, including increased engagement unprotected sex and/or an increase in number of partners or partner concurrency.[13,14] While each risk factor may operate via separate pathways (e.g., through impaired decision making the ability to negotiate condom use), the co-occurrence of multiple psychological factors may further augment HIV risk-taking behavior. The co-occurrence of multiple, potentially interacting, factors has been labeled *syndemics*, and recognizes the crucial role of adverse social structures (e.g., poverty) in facilitating the clustering of health-related problems by person, place, or time.[15] As first proposed Singer in 1994[16], syndemics

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Conflicts of Interest

None to declare.

Author Contributions

CEO designed the study, conducted analyses, interpreted results, and drafted the manuscript. APB designed the study, interpreted results, and drafted the manuscript. SLR designed the study, interpreted results, and drafted the manuscript. All authors critically reviewed and approved the final version of the manuscript.

include both epidemics of disease and of the social conditions that independently and jointly contribute to adverse health. In relation to HIV, this recognizes that social inequality (e.g., poverty) plays a crucial role in the clustering of factors that facilitate HIV vulnerability leading to the heightened potential for transmission and acquisition of HIV infection[15–18]

Facilitated by the upstream impact of social inequalities, this co-occurrence of factors is thought to lead to negative health consequences, including increased vulnerability for HIV infection.[15,18,19] For example, an increasing number of childhood adverse experiences (i.e., abuse or neglect, witnessing or experiencing violent crime, family financial problems) have been shown to have a dose-response relationship with negative health outcomes.[20] With respect to HIV, a syndemic perspective has been readily employed to assess the with disproportionate burden of the epidemic among inner city racial and sexual minority populations (e.g., urban poor populations of color).[16] Although multiple studies have documented the importance of syndemics in HIV risk in key populations, particularly among men who have sex with men (MSM)[13,19,21–23], few studies have explicitly considered the role of syndemics on HIV incidence in the general population. Although it has been well established that the HIV epidemic in the United States disproportionately affects those living in poverty, few studies have considered the role of poverty on the relationship between syndemic factors and HIV incidence.

To better understand how psychological and socio-economic factors affect HIV transmission risk according to syndemic theory in the U.S. general population, and to determine if poverty affects this association, we investigated relationships between major depressive disorder, substance use disorder, alcohol use disorder, and intimate partner violence and self-reported newly-diagnosed HIV infection. In addition, we applied a syndemic model per Singer's original proposed syndemic theory in 1994,[16] and tested whether poverty moderated the association between syndemic psychological factors and HIV infection. We hypothesized that, in the context of poverty, the effect of syndemic conditions on newly-diagnosed HIV infection would be exacerbated.

METHODS

Study Sample

Data from Wave 1 (2001–2002, N=43,093) and Wave 2 (2003–2004, N=34,653) of the National Epidemiologic Survey on Alcohol and Related Disorders (NESARC)[24] were analyzed. The NESARC is a longitudinal, population-based, nationally representative epidemiologic study that investigates the prevalence of mental health conditions in the U.S. general population among adults (over 18 years of age) who are non-institutionalized. Non-Latino African Americans, Latinos, and individuals aged 18–24 years were oversampled; data were adjusted for oversampling, and weighted to represent the U.S. general population based on the 2000 U.S. Census. Individuals interviewed in Wave 1 were re-interviewed in Wave 2. Individuals who were not followed up in Wave 2 were more likely to live in poverty, be Latino, male, younger, less educated, unmarried, living in urban areas, Southern, not have psychiatric disorders, and live in higher cost of living states.[25] Complete methods for the NESARC have been previously reported in detail.[24,26,27]

Measures

Psychological syndemic factors—Potential syndemic factors included a diagnosis of major depressive disorder, substance use disorder (including amphetamines, opioids, sedatives, tranquilizers, cocaine, inhalants, hallucinogens, and/or heroin), and alcohol use disorder in the 12-month period prior to Wave 1. Twelve-month major depressive disorder, substance use disorder, and alcohol use disorder were assessed using the Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV) according to the Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) definitions.[28] Because intimate partner violence (IPV) data was not collected in Wave 1, we included any IPV (physical and/or sexual) in the 12-month period prior to Wave 2 as a syndemic factor. IPV was assessed through 5 questions, including 1) “How often did your spouse/partner push, grab or shove you”; 2) “How often did your spouse/partner slap, kick, bite or hit you”; 3) “How often did your spouse/partner threaten you with a weapon like a knife or gun”; 4) “How often did your spouse/partner cut or bruise you”, 5) “How often did your spouse/partner force you to have sex with him/her”; and 6) “How often did your spouse/partner injure you enough that you had to get medical care”.[29] A response of more than never to any of the 6 questions was coded as having experienced IPV in the previous year. Individuals who reported not having a partner or dating during the year prior to Wave 2 were coded as not experiencing IPV.

Poverty—Living in poverty at Wave 1 was coded using 2001 U.S. Poverty Guidelines, and were based on household income and family size.[25,30] In the 48 continental United States, the poverty level was defined as $(US\$5570 + [\text{number of persons in household}] * US\$3020)$, and individuals reporting a household income below this level were coded as living in poverty. For Alaska and Hawaii, slightly higher figures were used in accordance with the U.S. Poverty Guidelines.[30]

Newly-diagnosed HIV infection—Newly-diagnosed HIV infection in the 12-month period prior to Wave 2 was assessed with 2 questions: 1) If the individual tested positive for HIV in the past year prior to the Wave 2 interview and 2) if a doctor confirmed the diagnosis. An affirmative response to both questions was coded as incident HIV infection. Individuals who reported “unknown” if they had been diagnosed with HIV in the past year were coded as missing (N=226) and not included in the analysis.

Covariates—Several potentially confounding variables were included in all multivariable models. These variables were age, sex (female versus male), sexual identity (coded as identified as a sexual minority or no), race/ethnicity (categorized as White/Caucasian, Black/African American, Latino/a, or Other, due to small numbers of incident HIV infections among Asian and American Indian ethnic groups), urbanicity (coded by metropolitan statistical areas (MSA) including living in the central city, outside central city, or not in an MSA), and educational attainment (coded as greater than high school or high school or less).

Statistical Analysis

Proportions for categorical variables and means and standard deviations for continuous variables were obtained for all variables included in multivariable analyses. Bivariate

associations between each syndemic factor as well as poverty were obtained using a logistic regression model to assess relationships between each factor.

To test the relationship between syndemic factors and newly-diagnosed HIV infection, first a series of multivariable logistic regression models were used to assess the relationship between each syndemic factor individually and newly-diagnosed HIV infection, adjusted for potentially confounding variables described previously. To test whether an increasing number of co-occurring syndemic factors was associated with a proportional increase in odds of newly-diagnosed HIV infection, syndemic factors were added together to create a variable that reflected the number of co-occurring syndemic factors in the period prior to HIV diagnosis. A multivariable logistic regression model was used to assess the relationship between number of syndemic factors and newly-diagnosed HIV infection.

Finally, we tested the effect of poverty on the relationship between the syndemic factors and newly-diagnosed HIV infection. Poverty was hypothesized to be a moderator of the relationship between syndemic factors and newly-diagnosed HIV infection, and as such would affect the strength of the relationship between the two variables.[31] To test if poverty was a modifier of this association, a product term between poverty and syndemic factors was included in a multivariable logistic regression model, allowing for identification of the effect of the syndemic term on newly-diagnosed HIV infection in subgroups living above and below federal poverty guidelines. Secondary analyses restricting the sample to 1) only males and 2) only females were conducted to assess this relationship in males and females separately. All analyses were appropriately survey-weighted and conducted in Stata 13.1 (StataCorp, College Station, TX).

RESULTS

Table 1 presents characteristics of the study sample (N=34,427), stratified by number of concurrent syndemic factors. The overall percentage of individuals reporting newly-diagnosed HIV infection in the previous year was 0.22%, and increased from 0.19% among individuals with no syndemic factors to 5.1% among individuals with 4 concurrent syndemic factors. Individuals living below the federal poverty guidelines in 2001 experienced a greater burden of syndemic factors. Table 2 shows bivariate associations between each syndemic factor. The only relationship that did not reach statistical significance was the relationship between alcohol use disorder and poverty.

Table 3 shows bivariate and multivariable associations between each syndemic factor individually and newly-diagnosed HIV infection, as well bivariate and multivariable models modeling the additive effect of syndemic factors on newly-diagnosed HIV infection. Other than major depressive disorder, all syndemic factors were individually associated with HIV incidence, including substance use disorder (aOR 3.71, 95% CI 3.12 to 4.40), alcohol use disorder (aOR 1.31, 95% CI 1.16 to 1.47), and IPV (aOR 2.30, 95% CI 1.65 to 3.19), adjusting for potentially confounding factors. In the additive syndemic model, every additional syndemic factor was associated with a 47% increase in odds of HIV infection (aOR 1.47, 95% CI 1.30 to 1.65).

Table 4 displays results of a multivariable model assessing modification of the relationship between syndemic factors and newly-diagnosed HIV infection by poverty status. Figure 1 graphically displays regression slopes for the additive effect of syndemic factors on probability of incident HIV infection among individuals living above compared to below poverty guidelines. Among individuals who lived below federal poverty guidelines, every additional syndemic factor was associated with a 96% increase in odds of incident HIV (aOR 1.96, 95% CI 1.57 to 2.44), compared to a 21% increase among individuals living above federal poverty guidelines (aOR 1.21, 95% CI 1.07 to 1.36). In an analysis stratifying by sex, the strongest association between syndemic factors and newly diagnosed HIV infection was among males who lived below the poverty line (aOR 4.15, 95% CI 2.71 to 6.37).

DISCUSSION

Our results indicate a significant association between co-morbid psychological conditions and partner violence and newly-diagnosed HIV infection in the U.S. general population, constituting a syndemic condition of psychological factors and HIV risk. The existence of a syndemic condition between psychological factors and both HIV risk and incident HIV infection has been well established among MSM.[13,19,21,22] Results of studies among MSM have consistently shown that odds of HIV and/or HIV risk are proportional to increasing numbers of syndemic factors.[13,21,32,33] The results of the present study indicate that there may be a similar relationship between syndemic factors and newly-diagnosed HIV infection in the U.S. general population, and that this relationship may be amplified in the setting of poverty.

Here, we found evidence that poverty is a modifier of the relationship between syndemic factors and newly-diagnosed HIV infection. Among females in particular, an increase in the number of syndemic conditions was only associated with HIV in the context of poverty, and among males this relationship was considerably stronger in the context of poverty. Individuals of lower socio-economic status may be more likely to experience a greater number of co-occurring syndemic factors and thus have increased vulnerability to HIV infection. It is well established that the HIV epidemic in the United States is concentrated geographically in areas that are economically disadvantaged and among those living in poverty.[3,36] In the United States, lower socio-economic status has been described as both a risk factor for and a result of psychiatric disorders.[37] Conditions associated with living in poverty, such as crowding, underemployment, financial and other stress, and exposure to violence may increase the risk of one or more psychiatric disorders.[38] Moreover, IPV is differentially distributed and more prevalent in areas of lower socio-economic status, which could be due to chronic stress of poverty and/or gender inequality.[39] Guided by syndemic theory, we recognize the importance of social context by assessing the association between syndemic factors, poverty, and HIV risk. Whereas the clustering of risk factors, or co-occurrence alone, is important, these results demonstrate that social inequality, here defined as poverty, modifies this relationship. These results suggest that poverty potentiates the association between these syndemic factors and HIV infection. For example, stress related to living in poverty could increase risk for psychiatric conditions, or exacerbate responses to syndemic factors in the form of increased HIV risk-taking behavior. Further work

elucidating this pathway specifically will be important to understand how best to design interventions that address the heightened effect of syndemic factors in the setting of poverty.

The results of this study must be considered in the context of several limitations. HIV diagnoses were obtained via self-report, and HIV testing was not done as part of the NESARC study. This could introduce misclassification bias especially in that to be diagnosed with HIV infection, one must be tested for HIV. A differential distribution in access to HIV testing access could therefore bias results. In the United States, there are disparities in access to HIV testing and care services with respect to poverty, urbanicity, and ethnic or racial background.[40] If individuals living below the poverty line or who had more syndemic factors were less likely to have been tested and thus know their result, there may be a downward bias in study results. Similarly, individuals may not wish to disclose HIV status, which could introduce bias. Future work should consider the effect of syndemics on biological assay-confirmed HIV incidence. However, this study represents one of the largest prospective studies that includes measures of newly-diagnosed HIV infection with validated measures of psychiatric disorders, which gives this study the ability to consider not only the effect of syndemic factors but how they are modified by poverty. An additional limitation is that we were unable to control for sexual risk-taking behavior in this study, due to lack of assessment of recent HIV sexual risk behavior prior to the period on which HIV incidence was assessed. In addition, IPV was only assessed among participants who reported being in a relationship in the year prior to Wave 2. It is possible that individuals experienced IPV outside of a relationship, which would not be captured here and thus could introduce misclassification. Poverty is only a single dimension of adverse social context. Although we believe this is a robust measure, it is possible that important dimensions of inequalities (i.e., stigma, security, neighborhood environment) are not captured by this analysis. Finally, given the relatively small number of new HIV diagnoses recorded in this study, we were unable to stratify more finely and assess the relationship between syndemic factors and specific subgroups of the population beyond those living in poverty. Future work should consider the moderating role of poverty on the relationship between syndemic factors and HIV incidence within specific subgroups, such as racial/ethnic minorities, in order to better understand how poverty affects this relationship.

This study provides additional evidence that co-occurring psychological and socio-economic conditions increase vulnerability to new HIV infection among the general population in the United States in a similar fashion as seen in MSM.[13,21,22] Importantly, this effect was considerably stronger among people living below federal poverty guidelines, and particularly among males living in the context of poverty. These results underscore that poverty is a key social determinant of health inequity and a core aspect of syndemic theory. [16] We recommend that future analyses examine the association between co-occurring individual psychological factors and HIV infection explicitly consider and incorporate socio-economic factors, such as poverty.

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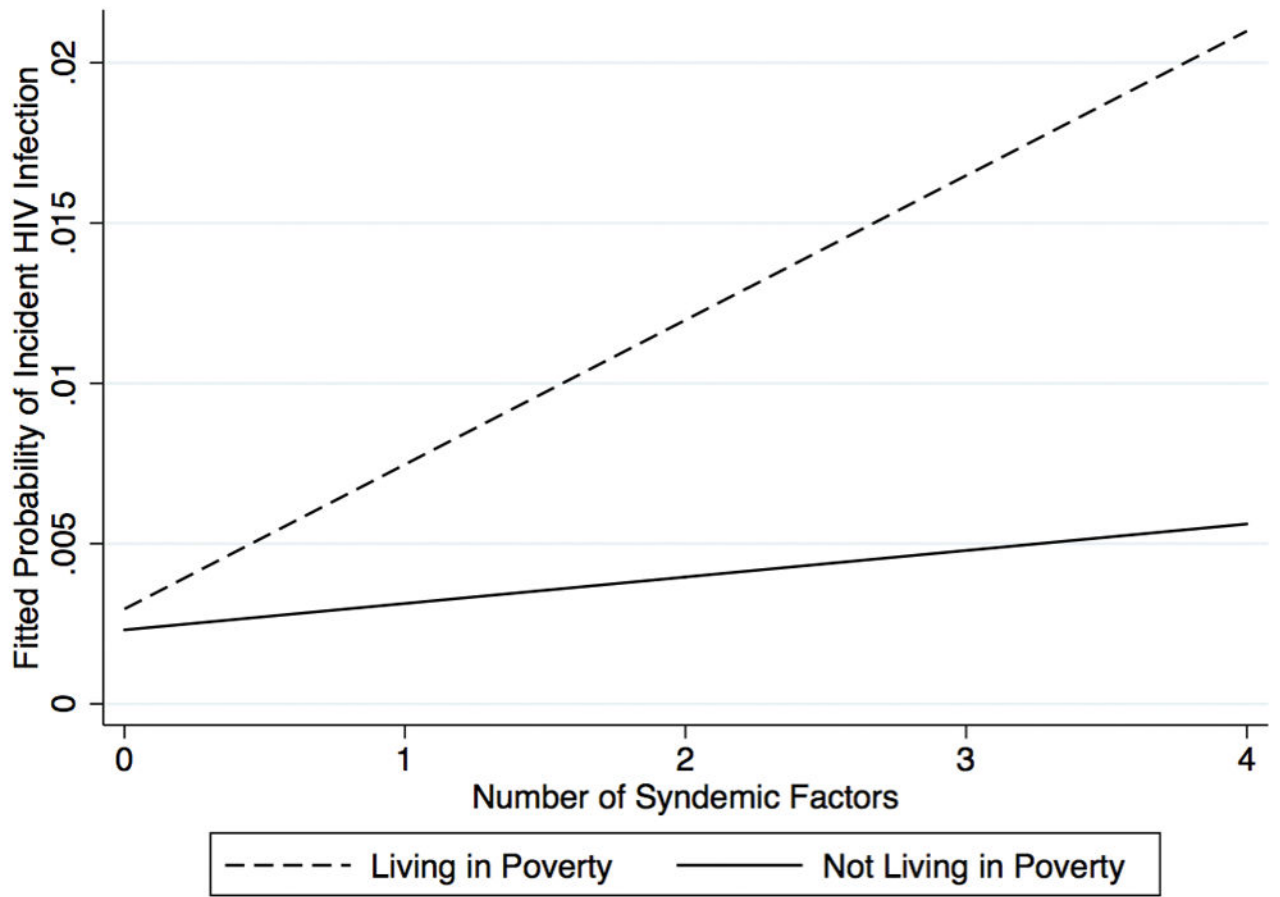


Figure 1.

Table 1

Descriptive characteristics by number of syndemic factors, weighted percent

	Number of Syndemic Factors					Total (N=34,427)
	0 (N=28,149)	1 (N=5,344)	2 (N=794)	3 (N=123)	4 (N=17)	
HIV seroconversion	0.19%	0.24%	0.46%	1.7%	5.1%	0.22%
Age (mean, SD), years	48.0 (18.4)	39.6 (15.1)	33.8 (12.1)	31.0 (10.6)	25.9 (8.3)	46.4 (18.2)
Race/ethnicity						
White/Caucasian	70.9%	71.1%	69.4%	71.4%	78.9%	70.9%
Black/African American	11.1%	11.0%	11.2%	10.0%	13.0%	11.0%
Latino/a	11.5%	12.0%	12.6%	10.5%	1.5%	11.6%
Other	6.6%	5.9%	6.9%	8.1%	6.6%	6.5%
Female sex	53.1%	47.4%	47.4%	41.0%	39.2%	52.1%
Sexual minority identity (gay, lesbian, bisexual)	2.5%	3.6%	5.0%	6.0%	12.4%	2.7%
Urbanicity						
In MSA ¹ – central city	28.5%	30.5%	32.0%	29.4%	39.2%	28.9%
In MSA ¹ – outside central city	51.3%	48.2%	45.9%	44.2%	38.7%	50.6%
Not in MSA ¹	20.3%	21.4%	22.2%	26.3%	22.1%	20.5%
Greater than high school education	59.8%	61.5%	58.2%	50.6%	55.3%	60.0%
Living below federal poverty guidelines	11.4%	14.3%	16.3%	24.3%	29.3%	12.0%

¹ Metropolitan statistical areas (MSA)

Table 2

Associations between each syndemic factor

	Major Depressive Disorder	Substance Use Disorder	Alcohol Use Disorder	Intimate Partner Violence	Poverty
Major Depressive Disorder					
Substance Use Disorder	6.72 (5.66 to 7.99)				
Alcohol Use Disorder	2.26 (2.10 to 2.44)	20.3 (17.7 to 23.3)			
Intimate Partner Violence	2.07 (1.86 to 2.29)	4.93 (4.17 to 5.82)	2.56 (2.37 to 2.77)		
Poverty	1.79 (1.66 to 1.94)	2.01 (1.62 to 2.49)	0.97 (0.88 to 1.07)	1.33 (1.18 to 1.49)	

Bivariate weighted logistic regression model

Table 3

Association between syndemic factors and HIV incidence

	Unadjusted Models ¹		Multivariable Models ²	
	OR (95% CI)	P-value	aOR (95% CI)	P-value
Major depressive disorder	1.44 (1.15 to 1.81)	0.002	1.19 (0.94 to 1.51)	0.15
Substance use disorder	5.79 (4.99 to 6.73)	<0.001	3.71 (3.12 to 4.40)	<0.001
Alcohol use disorder	1.68 (1.47 to 1.92)	<0.001	1.31 (1.16 to 1.47)	<0.001
Intimate partner violence	2.93 (2.22 to 3.86)	<0.001	2.28 (1.64 to 3.18)	<0.001
Additive syndemic factors	1.73 (1.56 to 1.93)	<0.001	1.46 (1.30 to 1.65)	<0.001
Restricted to Women Only				
Major depressive disorder	1.64 (1.29 to 2.10)	<0.001	1.60 (1.22 to 2.09)	0.001
Substance use disorder	**		**	
Alcohol use disorder	1.01 (0.82 to 1.24)	0.95	1.00 (0.78 to 1.27)	0.97
Intimate partner violence	3.81 (2.11 to 6.86)	<0.001	2.32 (1.18 to 4.55)	0.015
Additive syndemic factors	1.62 (1.28 to 2.04)	<0.001	1.47 (1.11 to 1.95)	0.008
Restricted to Men Only				
Major depressive disorder	1.44 (0.89 to 2.33)	0.13	0.93 (0.57 to 1.52)	0.78
Substance use disorder	7.85 (6.52 to 9.44)	<0.001	4.27 (3.35 to 4.45)	<0.001
Alcohol use disorder	1.72 (1.49 to 1.98)	<0.001	1.44 (1.29 to 1.61)	<0.001
Intimate partner violence	2.32 (2.05 to 2.63)	<0.001	2.33 (1.87 to 2.89)	<0.001
Additive syndemic factors	1.76 (1.60 to 1.94)	<0.001	1.49 (1.32 to 1.68)	<0.001

** No women with substance use disorder had a newly diagnosed HIV infection;

¹ Survey-weighted bivariate logistic regression models;

² Survey-weighted multivariable logistic regression models adjusting for age, sex, sexual identity, race/ethnicity, urbanicity, and education

Table 4
Association between syndemic factors and newly diagnosed HIV by poverty status and sex

	Multivariable Models ¹ , Entire Sample		Multivariable Models ² , Women Only		Multivariable Models ³ , Men Only	
	aOR (95% CI)	P-value	aOR (95% CI)	P-value	aOR (95% CI)	P-value
Additive syndemic factors among individuals living below the poverty line	1.96 (1.57 to 2.44)	<0.001	1.64 (1.15 to 2.34)	0.007	4.15 (2.71 to 6.37)	<0.001
Additive syndemic factors among individuals living above the poverty line	1.21 (1.07 to 1.36)	0.002	1.15 (0.86 to 1.54)	0.34	1.15 (1.01 to 1.32)	0.03
		<0.001		0.08		<0.001

¹ Survey-weighted multivariable logistic regression model with main effect terms for syndemic factors and poverty and interaction term for syndemic factors*poverty adjusted for age, sex, sexual identity, race/ethnicity, urbanicity, and education;

² Survey-weighted multivariable logistic regression model with main effect terms for syndemic factors and poverty and interaction term for syndemic factors*poverty adjusted for age, sexual identity, race/ethnicity, urbanicity, and education and restricted only to participants reporting female sex;

³ Survey-weighted multivariable logistic regression model with main effect terms for syndemic factors and poverty and interaction term for syndemic factors*poverty adjusted for age, sexual identity, race/ethnicity, urbanicity, and education and restricted only to participants reporting male sex