



OPEN ACCESS

Characterising a syndemic among black women at risk for HIV: the role of sociostructural inequity and adverse childhood experiences

Kiyomi Tsuyuki ¹, Erica Chan,¹ Marguerite B Lucea,² Andrea Cimino,³ Abby E Rudolph,⁴ Yordanos Tesfai,¹ Jacquelyn C Campbell,³ Christina J Catabay,¹ Jamila K Stockman ¹

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/sextrans-2021-055224>).

¹Department of Medicine, University of California San Diego, La Jolla, California, USA

²Department of Nursing, Towson University, Towson, Maryland, USA

³School of Nursing, Johns Hopkins University, Baltimore, Maryland, USA

⁴Department of Epidemiology and Biostatistics, Temple University College of Public Health, Philadelphia, Pennsylvania, USA

Correspondence to

Dr Kiyomi Tsuyuki, Medicine, University of California San Diego, La Jolla, California, USA; ksuyuki@gmail.com

Received 16 July 2021

Accepted 13 February 2022

Published Online First

20 May 2022

ABSTRACT

Objectives Black women disproportionately experience STIs (including HIV/AIDS), gender-based violence, substance misuse and mental health conditions. Addressing a gap in syndemic research, we characterised comorbidity overlap within the context of sociostructural inequities and adverse childhood experiences (ACEs) among black women in Baltimore, Maryland.

Methods Between 2015 and 2018, black women (n=305) were recruited from STI clinics in Baltimore, Maryland. Among those with complete survey data (n=230), we conducted a latent class analysis to differentiate women based on their profile of the following syndemic comorbidities: STIs, adult sexual victimisation, substance misuse and mental health disorders. We then examined the association between ACEs and syndemic latent class membership.

Results Thirty-three percent of women experienced three to nine ACEs before age 18 years, and 44% reported four to six comorbidities. The two-class latent class solution demonstrated the best fit model, and women were categorised in either class 1 (past-year STI; 59%) or class 2 (syndemic comorbidities; 41%). Women in class 2 were more likely to report unstable housing (10% vs 3%) and identify as bisexual/gay (22% vs 10%) than women in class 1. ACEs were significantly associated with an increased likelihood of class 2 membership.

Conclusions This study reinforces the importance of screening for ACEs and offering trauma-informed, integrated care for black women with syndemic comorbidities. It also highlights the critical nature of tailoring interventions to improve sociostructural equity, preventing and reducing syndemic development.

INTRODUCTION

Black women bear the greatest burden of STIs, including HIV, among women in the USA. In 2018, black women had the highest HIV prevalence (57%)¹ and HIV incidence rate (23.1/100 000) among US women.¹ The national rate of reported cases of chlamydia, gonorrhoea and syphilis among black women was 5.1, 8.4 and 7.0 times the rate of white women, respectively;² increasing the likelihood of transmitting and acquiring HIV.

Black women also bear a substantial burden of gender-based violence (GBV), experiencing intimate partner violence (IPV) at a rate 21% higher than

white women.³ Additionally, nearly 25% of black women report childhood physical or sexual abuse.⁴ Experiencing violence in childhood increases one's risk for experiencing violence in adulthood.⁵ GBV exposure is also associated with an increased risk of developing substance use disorders (SUD), mental health conditions⁶ and engaging in sexual risk behaviours such as being forced into sex or being coerced into unprotected sex by male partners. GBV and comorbidities increase black women's risk for HIV/STIs and impede HIV testing.⁷

These health disparities and their overlap can be understood through the lens of syndemic theory, which links sociostructural inequity to co-occurring and synergistic health epidemics (syndemics) that systematically and disproportionately affect disadvantaged populations.⁸ In particular, we draw from the Substance Abuse, Violence, and HIV/AIDS syndemic to include prevalent epidemics among black women (ie, substance misuse, violence, mental health and STIs). Syndemic theory is helpful to understand the interplay between comorbidities and sociostructural conditions that may increase or attenuate risk for syndemic development, thereby elucidating targets for intervention. Sociostructural inequity overburdens black women,⁹ and this inequity is linked to experiencing more housing instability¹⁰ and poverty. Homelessness and housing instability increase sexual risk behaviors associated with HIV,¹⁰ IPV and syndemic development among men who have sex with men (MSM)¹¹ and transgender women.¹² Understanding syndemics and identifying sociostructural targets for intervention among US black women at risk for HIV is critical, especially given the disparities in key HIV prevention interventions for women, including HIV testing and pre-exposure prophylaxis (PrEP).⁹ Moreover, HIV prevention interventions may be most effective for individuals with syndemic risk.¹³

Despite a substantial body of syndemic literature, and recent efforts to include more studies on racial and ethnic minorities, there is a paucity of studies to understand syndemic theory among cisgender heterosexual black women. Existing syndemic studies focus on people living with HIV or key populations at heightened risk for HIV like persons with SUD, sex workers, MSM and sexual or gender minority women. Syndemic research among black women at risk for HIV is essential given their disproportionate burden of violence³ and STIs,²



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Tsuyuki K, Chan E, Lucea MB, et al. *Sex Transm Infect* 2023;**99**:7–13.

including HIV.¹ Furthermore, comorbidities (e.g., SUD, mental health conditions and violence) are found to contribute differently to syndemic risk depending on racial and ethnic identity, sexual orientation and gender identity.¹⁴

Personal life experiences also influence disease trajectories and intervention effectiveness. The life course perspective highlights the relationship between childhood experiences and adverse health outcomes. Tenants of the life course perspective suggest that lives and social networks are intertwined, social contexts influence life opportunities and challenges, the timing of significant events impacts developmental trajectories and individuals can exercise actions to shape their trajectories.¹⁵ A poignant example of the life-course perspective is the impact of adverse childhood experiences (ACEs)—7–10 types of childhood trauma, abuse and neglect—that results in cumulative lifetime stress.¹⁶ ACEs are associated with long-lasting, negative sexual health consequences that are stronger and more persistent among women than men.^{17,18} Unfortunately, differences by race and ethnicity are unknown because neither Brown's analysis (71% white) nor Hillis' analysis (77% white) stratified their data by race and ethnicity. People who experience 4+ ACEs are at increased risk for substance use disorders, mental health conditions and sexual risk behaviours for STIs.¹⁸

A recent systematic review of HIV risk and syndemic development among black women¹⁹ highlighted that most studies fail to understand nuances by race and ethnicity. In one of the few studies that examined racial differences, black women experienced five times more childhood maltreatment than white women.²⁰ Childhood sexual abuse increased adult risk for lifetime STI acquisition, along with partner concurrency, emotional trauma and lifetime sex trading in a sample of 66% black women.²¹ Among young women who used marijuana, black women were more likely to engage in high-risk sexual behaviours and progress to marijuana use than white women.²² Previous research found that each additional ACE reported among black women was associated with a 49% increased risk of experiencing very early sexual initiation at 11–12 years old.²³ Women (24% Hispanic/non-white sample) with 3+ ACEs (a level of ACE exposure not unusual among women of colour) reported increased HIV risk behaviours. Despite these disparities, limited research has considered the impact of ACEs and syndemic burden among black women at risk for HIV.

The current analysis applies syndemic and life-course theory to understand the overlap of STIs, sexual violence, alcohol and substance use disorder, and mental health conditions among a sample of US black women. Specifically, we aim to: (1) characterise syndemic latent classes and (2) explore the association between ACEs and syndemic class membership. Although underused in syndemic research, latent class analysis (LCA) focuses on the co-occurring aspect of comorbidities as described by syndemic theory.

METHODS

We analysed data from a cross-sectional, retrospective cohort study investigating the association between the built and social environment, sexual assault and HIV risk behaviours among black women in Baltimore, Maryland.

Procedure

Black women (n=305) seeking health services were recruited from two Baltimore City public STI clinics between November 2015 and May 2018. Interested participants were consented and screened for eligibility using the following: self-identified as a

black female between 18 and 44 years old, tested HIV negative via rapid test at enrollment, had sex with a man in the past 6 months and had at least two sexual partners in the past year or had sex with a partner at increased risk for HIV (i.e., used substances, had sex with men, had been to prison, had a concurrent sex partner, had an STI or was HIV positive in the past year). Eligible women consented and completed an audio computer-assisted self-interview survey lasting 60–90 min. Participants were compensated with \$35 (\$10 for screening, \$25 for survey).

Measures

The outcome variable was latent class membership, modelled using the following categorical syndemic comorbidity variables: STI, adult sexual victimisation, substance misuse (ie, harmful drinking and substance misuse) and mental health conditions (ie, symptoms of depression and post-traumatic stress disorder (PTSD)).

Past-year STI was measured using self-report that a doctor diagnosed them with any of the following STIs in the past year: chlamydia, gonorrhoea, trichomoniasis, syphilis, herpes, bacterial vaginosis, hepatitis B and/or hepatitis C in the past year.

Sexual victimisation as an adult was measured as a positive response to one of the following questions: (1) 'Since you turned 18, has a male sex partner: used threats to make you have sex when you did not want to or used force (like hitting, holding down, or using a weapon) to make you have sex?' and (2) 'Since you turned 18, has any other male done any of the following: used threats to make you have sex when you did not want to or used force (like hitting, holding down, or using a weapon) to make you have sex?'

Alcohol use was measured using the Alcohol Use Disorders Test (AUDIT), a 10-item, self-report measure that evaluates alcohol consumption, drinking behaviours and alcohol-related problems during the past year. Items included how much and often alcohol was consumed, how often they were unable to stop drinking and how often they felt guilt after drinking. Responses were measured on a five-point scale ranging from '0: never' to '5: daily or almost daily'. Scores were summed (range: 0–40), and a cut-off score of ≥ 6 was chosen to denote alcohol use disorder ($\alpha=0.863$), as studies suggest that women require a lower AUDIT score cut-off than men.²⁴

Participants were also asked how often (if ever) they used marijuana, crack, cocaine, non-medically prescribed Percocet and/or other prescription drugs in the past 6 months. For each substance, misuse was defined by use ≥ 2 –3 days per week for the past 6 months.

Depression was measured using the Center for Epidemiologic Studies Short Depression scale, a 10-item, self-reported measure of an individual's depressive feelings and behaviours during the past week. Items included being bothered by things, having trouble concentrating, and feeling lonely. Responses ranged from '0: rarely or none of the time (<1 day)' to '3: all of the time (5–7 days)'. Scores were summed (range: 0–30), and a cut-off score of ≥ 10 denoted having symptoms indicative of depression ($\alpha=0.827$).

PTSD symptoms were measured using the National Stressful Events Survey PTSD Short Scale, a nine-item, self-reported measure that determines PTSD symptom severity during the past month. Responses were measured on a five-point scale ranging from 0 'never' to 4 'extremely'. Items were averaged to derive a PTSD symptoms score with higher scores indicating greater PTSD severity (mild=1 to extreme=4).²⁵ Then, we created a

binary cut-off score of ≥ 3 to denote severe/extreme PTSD symptoms ($\alpha=0.931$).

The primary independent variable was the presence of ACEs at or before age 18 years. The original questionnaire measured seven categories of ACEs (emotional, physical and/or sexual abuse, witnessing maternal abuse, household substance misuse, household mental illness and incarcerated household member). It was expanded to include three additional categories (emotional and physical neglect and parental separation/divorce).²⁶ We measured ACEs on the 10-item scale,²⁶ where participants responded 'yes' (1) or 'no' (0) ($\alpha=0.807$). Scores were summed for a total ACE score (range: 0–10).

Other variables included in our analyses were sociodemographic variables (i.e., age, education, employment status, yearly income, number of children and relationship status) and socio-structural variables (i.e., housing instability (defined as living in hotel/motel, transitional housing or on the streets) and sexual minority status).

Analysis

Analyses were conducted using Stata V.15. Listwise deletion was performed to include participants with complete data ($n=230$). Women excluded from the analysis due to missing data reported significantly more housing instability than those included. Descriptive statistics characterised sociodemographic and syndemic comorbidity characteristics (i.e., STIs, sexual violence, harmful drinking, substance misuse, depressive and PTSD symptoms) and ACEs.

We chose LCA because it is an innovative method that is stronger than other approaches (i.e., logistic regression), providing a granular description how syndemic comorbidities vary and covary. LCA is a person-centred (vs variable-centred) technique, which uses maximum likelihood estimation to create classes that are internally homogeneous and externally heterogeneous.²⁷ LCA is also a model-based technique that provides fit statistics to indicate the most appropriate and parsimonious model for the data.²⁸ Lastly, LCA provides conditional probabilities, which provide information of an individual's probability of membership to variables within a particular class.²⁸

LCA was performed to differentiate groups of women based on comorbidity patterns. We chose best-fit LCA models to determine the number of latent classes based on model fit criteria, including Bayesian information criterion, Akaike information criterion, Likelihood ratio (LR) test and Scree-Plots to assess model fit. We then estimated each conditional probability (CP) of each syndemic comorbidity.

Finally, we estimated the association between ACEs (continuous and categorical) and latent class membership. When the

prevalence of the outcome is $>10\%$, the OR does not approximate the relative risk well.²⁹ Because our two latent class solution resulted in a common outcome, we estimated log-binomial regression models. However, the model with the continuous ACE score as the independent variable did not reach convergence. To resolve this, we used a modified Poisson model with robust variance estimation to estimate the relative risk and CIs.²⁹ Adjusted models accounted for age and other sociodemographic and socio-structural variables that significantly differentiated the latent classes (i.e., housing stability and sexual orientation) in the unadjusted models as potential confounders. We conducted a non-parametric trend test, an extension of the Wilcoxon rank-sum test, to test for a dose–response relationship between the number of ACEs reported and the number of syndemic comorbidities.

RESULTS

Of 230 women, the average age was 26.25 years old ($SD=6.32$), 85% had at least a high school education, 61% were employed, 59% had an annual income $< \$10\,000$, 6% did not have stable housing and 68% were single (data found in online supplemental appendix, table A). Nearly 33% experienced three to nine ACEs, with parental separation or divorce (38%), emotional neglect (31%) and household substance misuse (27%) being the most common. The most common syndemic comorbidities were depressive symptoms (46%), at least one STI in the past year (46%), adult sexual violence (40%), misuse of at least one drug in the past 6 months (37%), severe/extreme PTSD (28%) and harmful drinking (23%).

The two-class solution had the best fit (see online supplemental appendix, table B). The CP of each syndemic comorbidity is shown in figure 1. Although women in class 1 had some probability for comorbidities, the majority (59%) had only one morbidity—an STI in the past year. In comparison, nearly half of the women in class 2 (41%) had multiple comorbidities, including an STI in the past year, substance misuse in the past 6 months, depressive symptoms in the past week, severe/extreme PTSD in the past month and adult sexual victimisation. Class 2 women were likely to be harmful drinkers (CP: 0.36), misuse substances (CP: 0.53), have depressive symptoms (CP: 0.85), have severe/extreme PTSD (CP: 0.63), have experienced adult sexual violence (CP: 0.68) and have had at least one STI in the past year (CP: 0.41).

Table 1 placed women in the latent class with the highest probability of membership and compared women by their sociodemographic and sociostructural characteristics, ACEs and syndemic comorbidities using the χ^2 statistic. Compared with class 1 (ie, past-year STI), significantly more women in class 2 (ie, syndemic comorbidities) identified as a sexual minority (22% vs 10%,

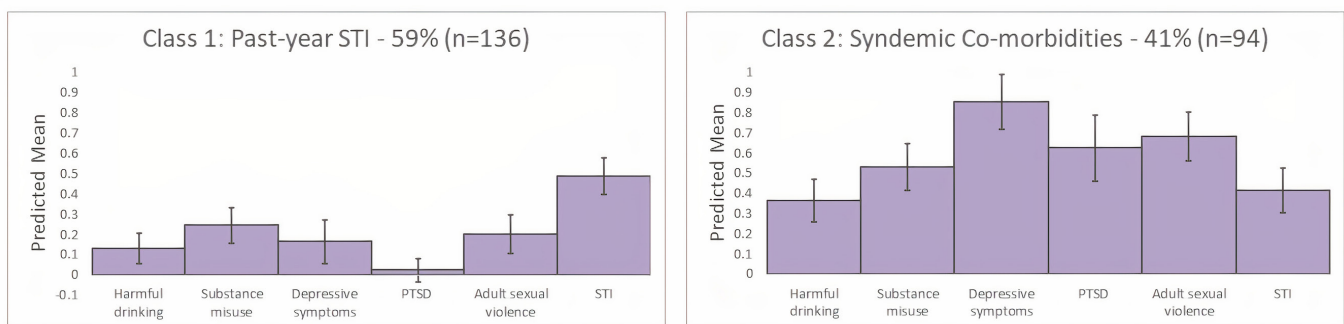


Figure 1 Predicted means of syndemic comorbidities by latent class membership of black women at risk for HIV in Baltimore, Maryland, November 2015–May 2018 ($n=230$).

Table 1 Sociodemographic characteristics, adverse childhood experiences (ACEs) and syndemic comorbidities of black women in Baltimore, Maryland, by latent class membership (n=230)

Variables	Class 1		Class 2	
	Past-year STI		Syndemic comorbidities	
	59% (n=136)		41% (n=94)	
Categorical variables	n	%	n	%
Sociodemographics				
Age (years)				
18-24	65	48	36	38
25-34	59	43	44	47
35-44	12	9	14	15
At least a high school education	117	86	78	83
Currently employed	87	64	54	57
Individual yearly income				
<\$10 000	74	54	61	65
\$10 000–29 999	47	35	27	29
>\$30 000	15	11	6	6
Number of children				
0	69	51	46	49
1–2	49	36	34	36
3 or more	18	13	14	15
Current relationship status				
Single	92	68	65	69
In a relationship	40	29	26	28
Separated/divorced/widowed/other	4	3	3	3
Sociostructural				
Housing instability*	4	3	9	10
Sexual orientation†				
Heterosexual	123	90	73	78
Bisexual or gay	13	10	21	22
ACEs				
0‡	63	46	12	13
1	33	24	15	16
2	15	11	15	16
3 to 9	25	18	52	55
Emotional abuse‡	15	11	37	40
Physical abuse‡	3	2	21	23
Sexual abuse‡	6	4	31	35
Emotional neglect‡	30	22	41	45
Physical neglect‡	15	11	28	31
Witness maternal abuse‡	10	7	23	25
Household substance misuse‡	24	18	37	41
Household mental health problems‡	17	13	32	34
Parental separation or divorced‡	40	30	48	51
Incarcerated household member‡	21	16	30	32
Syndemic comorbidities				
Depressive symptoms (past week)‡	20	15	85	90
STI (≥1 in past year)*	70	51	35	37
Adult sexual victimisation‡	26	19	67	71
Substance misuse (past 6 months)‡	34	25	50	53
Severe/extreme PTSD (past month)‡	2	1	62	66
Harmful drinking (past year)‡	19	14	34	36

Source: November 2015–May 2018.

* P value ≤0.05.

†P value ≤0.01.

‡P value ≤0.001 using the χ^2 statistic.

ACEs, adverse childhood experiences; PTSD, post-traumatic stress disorder; Source, November 2015–May 2018.

respectively), reported housing instability (10% vs 3%, respectively) and indicated a relatively higher ACE score of 3–9 (55% vs 18%, respectively). Women in class 2 reported significantly more of almost all syndemic comorbidities than women in class 1. Women in class 1 were more likely to report a past-year STI.

There was a significant dose–response association with increasing ACE exposure associated with a greater likelihood of class 2 membership (p value <0.001). Figure 2 shows a four-set Venn diagram (at least one STI, mental health issues, adult sexual violence victimisation and substance misuse) that visually captures the syndemic overlap among women in class 2 who had an ACE score of 0–2 versus those with a score of 3–9. The Venn diagram collapses (1) depressive and PTSD symptoms into a broader mental health condition variable and (2) harmful drinking and misuse of at least one drug into a broader substance misuse variable. Every woman in class 2 in the higher ACE score category experienced an overlap of at least two comorbidities. Women with 3–9 ACEs were significantly more likely than women with 0–2 ACEs to experience overlap between STI and mental health issues (24/52 vs 11/42; p value=0.05), STI and sexual violence victimisation (21/52 vs 7/42; p value=0.01), substance misuse and sexual violence victimisation (31/52 vs 16/42; p value=0.04), and mental health issues and sexual violence victimisation (44/52 vs 22/42; p value <0.001).

Table 2 reports Poisson regression models findings. Those with at least one ACE were more likely to be in class 2 in the unadjusted models. Those with two and those with three or more ACEs were significantly more likely to be in class 2 in both unadjusted and adjusted models. The latter demonstrates a statistically significant dose–response association where increased exposure to ACEs increased the relative risk of membership in class 2 (syndemic comorbidities) versus class 1 (past-year STI).

DISCUSSION

This study used LCA to characterise a syndemic in a sample of black women at risk for HIV and examine the associations between ACEs and latent class membership. Our findings show that women were categorised into either a past-year STI latent class (class 1) or a syndemic comorbidities latent class (class 2)—comprising substance misuse, mental health conditions, sexual violence and STIs. Women in class 2 were significantly more likely to report sociostructural inequities (e.g., housing instability and sexual minority status) and ACEs than those in class 1. Our findings have implications for integrated HIV interventions that address sociostructural inequalities and childhood trauma experiences.

Our study adds to research on syndemics among black women at risk for HIV in the USA. Women in class 1 had high levels of past-year STIs, which has important implications given that black women have greater HIV incidence rates and STI prevalence than white women.^{1 2} Women in class 1 also reported some substance misuse, sexual violence and harmful drinking, which likely impede their ability to negotiate safe sexual encounters. However, women in class 2 reported significantly more harmful drinking, substance misuse, depressive symptoms and severe/extreme PTSD symptoms than women in class 1. We found significant interactive synergy between ACE scores and increasing overlap of comorbidities. These comorbidities likely impede women's access and uptake of physical and mental healthcare. For example, one study found that comorbidities, such as IPV and substance use, were barriers to PrEP adoption among black women.⁹ We also found that black bisexual or gay women were at greater risk of comorbidities compared with black

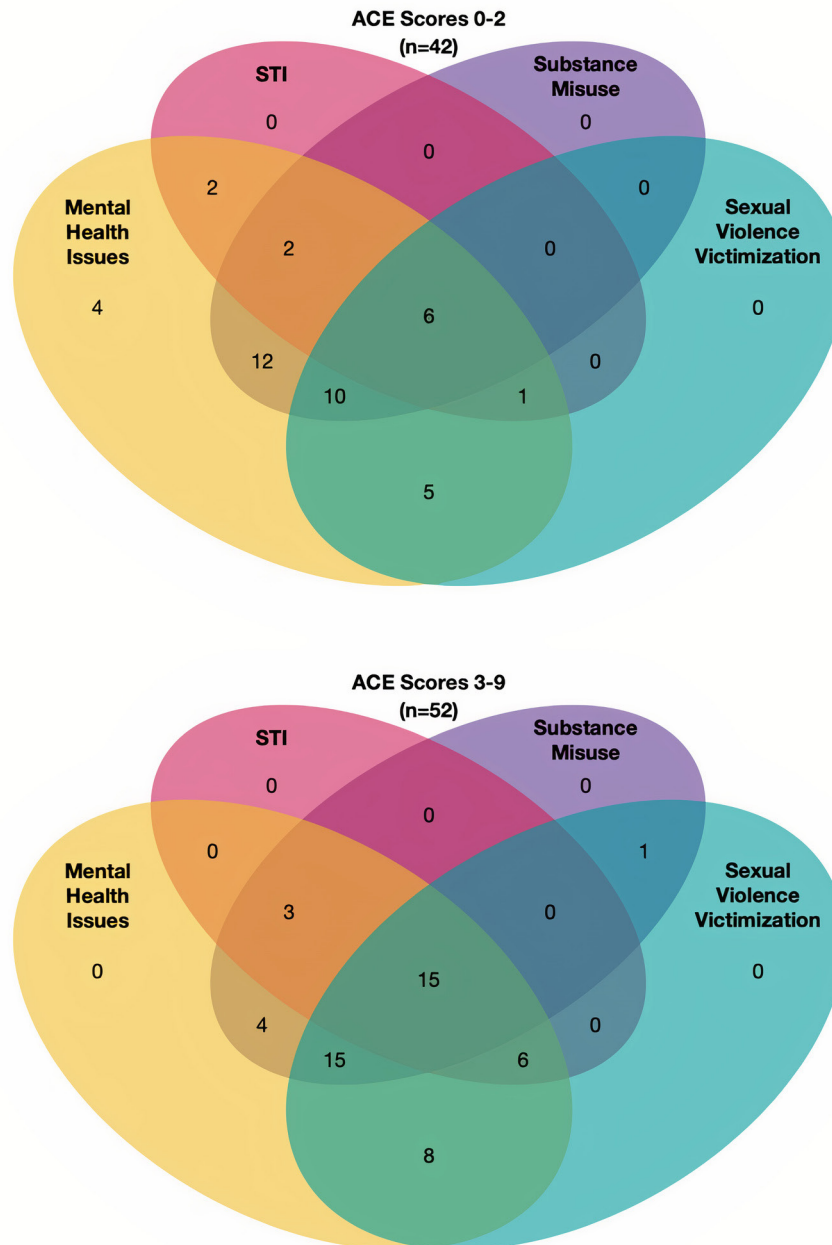


Figure 2 Venn diagram of syndemic comorbidities among class 2 members by ACE score category (n=94). ACE, adverse childhood experience.

heterosexual women, which is consistent with recent research highlighting disparities in smoking, heavy episodic drinking and marijuana use observed among black lesbian/gay and bisexual women compared with their counterparts.³⁰ This noteworthy finding provides support for future research to elucidate the underlying mechanisms and development of tailored interventions accounting for sexual identity and race and ethnicity to reduce the risk of comorbidities in this marginalised population.

Our findings also contribute to literature establishing links between sociostructural factors and overlapping adverse mental health outcomes, substance misuse and HIV risk among cisgender heterosexual and sexual minority black women.^{31 32} When comparing the sociostructural factors associated with class membership, we found class 2 women were more likely to report

sexual minority status and current housing instability, which aligns with syndemic theory. Sociostructural factors, such as poor access to social services, transportation and childcare, were barriers to PrEP adoption among black women.⁹ Our findings are consistent with other studies linking stress experienced by racial, gender and sexual minorities due to stigma, prejudice and discrimination to adverse physical and mental health outcomes.³³ Establishing the connection between the sociostructural context and syndemics is crucial to understanding how these factors influence individual HIV risk and prevention behaviours. Delivery models are needed that consider the multitude of sociostructural factors affecting the health of black women who are at risk for HIV. These findings support holistic HIV prevention measures targeting sociostructural health determinants, such as housing

Table 2 Poisson regression models with robust error variances of syndemic latent class membership on adverse childhood experiences (ACEs) among black women in Baltimore, Maryland, between 2015 and 2018 (n=230)

	Unadjusted models		Adjusted models		Adjusted models	
	Class 2 (syndemic comorbidities) versus class 1 (past-year STI)		Class 2 (syndemic comorbidities) versus class 1 (past-year STI)		Class 2 (syndemic comorbidities) versus class 1 (past-year STI)	
	RR	95% CI	ARR	95% CI	ARR	95% CI
ACEs score	1.19‡	(1.14 to 1.25)	1.18‡	(1.13 to 1.24)	–	
ACEs categories						
0	Ref.		–		Ref.	
1	1.95*	(1.00 to 3.81)	–		1.93	(0.99 to 3.77)
2	3.13‡	(1.66 to 5.88)	–		2.98‡	(1.59 to 5.59)
3–9	4.22‡	(2.45 to 7.26)	–		3.95‡	(2.28 to 6.81)
Housing instability	1.77†	(1.19 to 2.64)	1.31	(0.83 to 2.09)	1.28	(0.85 to 1.93)
Sexual minority	1.66†	(1.20 to 2.29)	1.38*	(1.02 to 1.88)	1.39*	(1.04 to 1.93)
Age	1.02	(0.99 to 1.04)	1.00	(0.98 to 1.03)	1.01	(0.99 to 1.03)

Adjusted models include age, housing stability, and sexual minority status.

Source: November 2015–May 2018.

Comparison category for logistic regression is class 1.

*P value ≤0.05.

†P value ≤0.01.

‡P value ≤0.001.

ACEs, adverse childhood experiences; RR, relative risk; Source, November 2015–May 2018.

instability and sexual minority stigma, to reduce syndemic risk among women.¹³

Another key finding was the significant dose–response association between ACEs and class 2 membership. This finding aligns with the life-course perspective; traumatic childhood events can shape health trajectories later in life. This study adds to the extant literature on ACEs and health by demonstrating a significant association between ACEs and syndemic comorbidities. Findings support incorporating assessments for ACEs and their lingering effects into the trauma-informed care that is both timely and contextually comprehensive.³⁴ Findings also highlight the need for comprehensive interventions to prevent childhood trauma and abuse.³⁵ A recent, integrated intervention addressing current sexual risk behaviours and childhood trauma showed promise in pilot testing, reducing episodes of unprotected sex, alcohol use and likelihood to be in a violent relationship following the intervention.³⁶ The women in class 2 of our study might benefit from similar interventions that attend to sociostructural factors such as housing,¹⁰ sexual or gender minority stigma, and discrimination,³³ or a combination of the two.

Our study had some important limitations. Our sample size was modest for using LCA, but close to the recommended sample size for similar models given our effect size and statistical power.³⁷ Nevertheless, further research with larger sample sizes are needed to account for limited power on associations, such as that with housing instability. Our sample did not include transgender black women, a population at increased risk for the comorbidities under investigation. Understanding the role of sociostructural inequity and ACEs on syndemic comorbidities in this population would facilitate tailored interventions. Given that we only included housing instability and sexual identity as indicators of sociostructural inequity, future research should include a more robust conceptualisation of sociostructural inequity (eg, intersectional stigma and discrimination). Moreover, our retrospective cohort study measured comorbidities using different timeframes (eg, past year alcohol use, drug use in past 6 months and past month PTSD symptoms). Additionally, we did not measure the synergy among comorbidities, a characteristic of syndemics defined by syndemic theory. Our

cross-sectional analysis cannot determine the temporal relationship between ACEs, sociostructural factors and syndemic development. Longitudinal studies with larger sample sizes would allow us to examine the potential causal effects of ACEs on syndemic development among black women. Although we noted an overlap between ACEs and current experiences with violence, we could not determine the added impact of current experiences of violence on ACEs in this study. Furthermore, because women were recruited from STI clinics, the majority of women in both latent classes unsurprisingly reported at least one STI in the past year. Lastly, our study findings may not be generalisable to black women who do not seek care at STI clinics or those from rural environments or other racial and ethnic groups.

In conclusion, our study demonstrates the need for a holistic perspective, especially when working with black women who are usually affected by multiple traumas and stressors. As outlined by syndemic theory, this includes the various risks from different health behaviours and burdens and the often-overlooked social inequities and sociostructural factors outside of black women's control. Our findings also support the need for integrated, trauma-informed interventions specifically designed for black women that address lingering health effects of childhood trauma. Though more research is required to contextualise our findings among black women better, a comprehensive approach that accounts for past trauma and multiple health and social stressors may help reduce the synergistic burden of their interactions.

Handling editor Adam Huw Bourne

Acknowledgements We would like to thank the study participants who generously provided the data for this research. We would also like to thank the Baltimore City Health Department for their support on this project.

Contributors Conceptualisation: KT; formal analysis: KT; funding acquisition and investigation: KT, ANC, JCC and JKS; methodology: KT and AER; supervision: JCC and JKS; validation: KT and AER; writing – original draft: KT, EC, MBL, YT and CJ; writing – review and editing: KT, EC, MBL, ANC, AER, YT, JCC and JKS; Guarantor: KT.

Funding This work was supported by grants from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R01HD077891 – JKS and JCC), the National Institute on Minority Health and Health Disparities (L60MD003701–JKS; L60MD011184–KT) and the National Institute of Alcohol Abuse and Alcoholism (K01AA025009–KT). We also acknowledge support by the

Key messages

- ⇒ Adverse childhood experiences (ACEs) and syndemic comorbidities were highly prevalent among black women.
- ⇒ Sociostructural barriers to health, such as unstable housing and identifying as bisexual or gay, were significantly associated with membership in the syndemic latent class.
- ⇒ Reporting ACEs were significantly associated with an increased likelihood of membership in the syndemic latent class.
- ⇒ Findings suggest the need for an integrated and trauma-informed approach to address social inequity and lingering health effects of childhood trauma.

San Diego Center for AIDS Research (Grant #P30AI036214) and the Johns Hopkins Center for AIDS Research (Grant #1P30AI094189- A. Cimino), which is supported by the following institutes and centres: NIAID, NCI, NICHD, NHLBI, NIDA, NIA, NIGMS, NIDDK and NIMHD.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Johns Hopkins University IRB and the University of California, San Diego IRB the ESSENCE Project (#130681). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data may be available on request.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Kiyomi Tsuyuki <http://orcid.org/0000-0002-9141-1395>

Jamila K Stockman <http://orcid.org/0000-0003-1909-6965>

REFERENCES

- 1 Centers for Disease Control and Prevention. *Hiv surveillance report, 2018 (Preliminary)*, 2019.
- 2 Centers for Disease Control and Prevention. Sexually transmitted disease surveillance 2017, 2018. Available: https://www.cdc.gov/std/stats17/2017-STD-Surveillance-Report_CDC-clearance-9.10.18.pdf
- 3 Smith SG, Basile KC, Gilbert LK. *National intimate partner and sexual violence survey (NISVS): 2010-2012 state report*, 2017.
- 4 Anne Lown E, Nayak MB, Korcha RA, et al. Child physical and sexual abuse: a comprehensive look at alcohol consumption patterns, consequences, and dependence from the National alcohol survey. *Alcoholism: Clinical and Experimental Research* 2011;35:317–25.
- 5 Niolon PH, Kearns M, Dills J. *Preventing intimate partner violence across the lifespan: a technical package of programs, policies, and practices*, GNCI/PaC, editor. Atlanta: Centers for Disease Control and Prevention, 2017.
- 6 Walsh K, Keyes KM, Koenen KC, et al. Lifetime prevalence of gender-based violence in US women: associations with mood/anxiety and substance use disorders. *J Psychiatr Res* 2015;62:7–13.
- 7 Tsuyuki K, Cimino AN, Holliday CN, et al. Physiological changes from violence-induced stress and trauma enhance HIV susceptibility among women. *Curr HIV/AIDS Rep* 2019;16:57–65.
- 8 Singer M, Clair S. Syndemics and public health: reconceptualizing disease in bio-social context. *Med Anthropol Q* 2003;17:423–41.
- 9 Nydegger LA, Dickson-Gomez J, Ko TK. Structural and syndemic barriers to PreP adoption among black women at high risk for HIV: a qualitative exploration. *Cult Health Sex* 2021;23:659–73.
- 10 Dickson-Gomez J, McAuliffe T, Quinn K. The effects of housing status, stability and the social contexts of housing on drug and sexual risk behaviors. *AIDS Behav* 2017;21:2079–92.
- 11 Singer M. AIDS and the health crisis of the U.S. urban poor; the perspective of critical medical anthropology. *Soc Sci Med* 1994;39:931–48.
- 12 Fletcher JB, Kisler KA, Reback CJ. Housing status and HIV risk behaviors among transgender women in Los Angeles. *Arch Sex Behav* 2014;43:1651–61.
- 13 Pitpitan EV, Strathdee SA, Semple SJ, et al. Buffering syndemic effects in a sexual risk-reduction intervention for male clients of female sex workers: results from a randomized controlled trial. *Am J Public Health* 2015;105:1866–71.
- 14 Tsuyuki K, Pitpitan EV, Levi-Minzi MA. Substance use disorders, violence, mental health, and HIV: differentiating a syndemic factor by gender and sexuality 2017;21:2270–82.
- 15 Elder GH, Johnson MK, Crosnoe R. The emergence and development of life course theory. In: *Handbook of the life course*. Springer, 2003: 3–19.
- 16 Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The adverse childhood experiences (ACE) study. *Am J Prev Med* 1998;14:245–58.
- 17 Brown MJ, Masho SW, Perera RA, et al. Sex and sexual orientation disparities in adverse childhood experiences and early age at sexual debut in the United States: results from a nationally representative sample. *Child Abuse Negl* 2015;46:89–102.
- 18 Hillis SD, Anda RF, Felitti VJ, et al. Adverse childhood experiences and sexual risk behaviors in women: a retrospective cohort study. *Fam Plann Perspect* 2001;33:206–11.
- 19 Taggart T, Milburn NG, Nyhan K, et al. Utilizing a life course approach to examine HIV risk for black adolescent girls and young adult women in the United States: a systematic review of recent literature. *Ethn Dis* 2020;30:277–86.
- 20 Cunradi CB, Caetano R, JJofv S. Socioeconomic predictors of intimate partner violence among white, black and Hispanic couples in the United States 2002;17:377–89.
- 21 Leblanc NM, Alexander K, Carter S, et al. The effects of trauma, violence, and stress on sexual health outcomes among female clinic clients in a small northeastern U.S. urban center. *Womens Health Rep* 2020;1:132–42.
- 22 Volkow ND, Baler RD, Compton WM, et al. Adverse health effects of marijuana use. *New England Journal of Medicine* 2014;370:2219–27.
- 23 Tsuyuki K, Al-Alusi NA, Campbell JC, et al. Adverse childhood experiences (ACEs) are associated with forced and very early sexual initiation among black women accessing publicly funded STD clinics in Baltimore, MD. *PLoS One* 2019;14:e0216279.
- 24 de Meneses-Gaya C, Zuardi AW, Loureiro SR, et al. Alcohol use disorders identification test (audit): an updated systematic review of psychometric properties. *Psychol Neurosci* 2009;2:83–97.
- 25 Kilpatrick D, Resnick H, Friedman M. *National stressful events survey PTSD short scale (NSESS-PTSD)*, 2013.
- 26 Dube SR, Anda RF, Felitti VJ, et al. Exposure to abuse, neglect, and household dysfunction among adults who witnessed intimate partner violence as children: implications for health and social services. *Violence Vict* 2002;17:3–17.
- 27 Berlin KS, Williams NA, Parra GR. An introduction to latent variable mixture modeling (Part 1): overview and cross-sectional latent class and latent profile analyses. *J Pediatr Psychol* 2014;39:174–87.
- 28 Vermunt JK, Magidson J. Latent class cluster analysis. *Applied latent class analysis* 2002;11:89–106.
- 29 Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702–6.
- 30 Schuler MS, Prince DM, Breslau J, et al. Substance use disparities at the intersection of sexual identity and Race/Ethnicity: results from the 2015-2018 national survey on drug use and health. *LGBT Health* 2020;7:283–91.
- 31 Hotton AL, Garofalo R, Kuhns LM, et al. Substance use as a mediator of the relationship between life stress and sexual risk among young transgender women. *AIDS Educ Prev* 2013;25:62–71.
- 32 Voisin DR, Hotton AL, Schneider JA, et al. The relationship between life stressors and drug and sexual behaviors among a population-based sample of young black men who have sex with men in Chicago. *AIDS Care* 2017;29:545–51.
- 33 Logie CH, Lacombe-Duncan A, Poteat T, et al. Syndemic factors mediate the relationship between sexual stigma and depression among sexual minority women and gender minorities. *Womens Health Issues* 2017;27:592–9.
- 34 Sharps PW, Njie-Carr VP, Alexander K. The Syndemic interaction of intimate partner violence, sexually transmitted infections, and HIV infection among African American women: best practices and strategies. *Journal of Aggression, Maltreatment & Trauma* 2019:1–17.
- 35 Centers for Disease Control and Prevention. Preventing adverse childhood experiences: Leveraging the best available evidence, 2019. Available: <https://www.cdc.gov/violenceprevention/pdf/preventingACES.pdf>
- 36 Senn TE, Braksmajer A, Urban MA, et al. Pilot test of an integrated sexual risk reduction intervention for women with a history of childhood sexual abuse. *AIDS Behav* 2017;21:3247–59.
- 37 Dziak JJ, Lanza ST, Tan X. Effect size, statistical power and sample size requirements for the bootstrap likelihood ratio test in latent class analysis. *Struct Equ Modeling* 2014;21:534–52.