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Social Stability and HIV Risk Behavior: Evaluating the Role of Accumulated Vulnerability

Danielle German · Carl A. Latkin

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Abstract This study evaluated a cumulative and syndromic relationship among commonly co-occurring vulnerabilites (homelessness, incarceration, low-income, residential transition) in association with HIV-related risk behaviors among 635 low-income women in Baltimore. Analysis included descriptive statistics, logistic regression, latent class analysis and latent class regression. Both methods of assessing multidimensional instability showed significant associations with risk indicators. Risk of multiple partners, sex exchange, and drug use decreased significantly with each additional domain. Higher stability class membership (77%) was associated with decreased likelihood of multiple partners, exchange partners, recent drug use, and recent STI. Multidimensional social vulnerabilities were cumulatively and synergistically linked to HIV risk behavior. Independent instability measures may miss important contextual determinants of risk. Social stability offers a useful framework to understand the synergy of social vulnerabilities that shape sexual risk behavior. Social policies and programs aiming to enhance housing and overall social stability are likely to be beneficial for HIV prevention.

Keywords Social stability · HIV risk behavior · Vulnerability · Housing · Latent class analysis

Introduction

A growing body of literature advocates that long term HIV prevention efficacy requires understanding the social factors underlying HIV transmission patterns and implementation of environmental and structural interventions to address the context in which risk behaviors occur [1–4]. Despite indications that social vulnerabilities tend to co-occur, few studies have sought to understand ways in which patterns of social vulnerability contribute to HIV risk. Social stability is an understudied construct that offers a useful framework for understanding co-occurrence of social vulnerabilities as they operate on an individual level. In the present study, social stability refers to the range of life structure and reliable routine that is the product of steady social circumstances within a defined range of domains, such as housing, employment and relationships. Social stability is protective against further situational hazards and helps maintain connections with social resources and societal expectations. The current study evaluates the likelihood that co-occurrence among a set of social stability characteristics is associated with increased sexual risk for HIV.

More than 25 years into the HIV epidemic, the Baltimore area had the second highest number of AIDS case reports of any metropolitan area in the United States [5]. As HIV incidence among injection drug users (IDUs) in Baltimore has decreased over time [6], heterosexual transmission has become the dominant mode of transmission. Close to 90% of HIV and AIDS cases in Baltimore City are among African–Americans [7], whose risk for HIV is framed by societal disadvantage, including economic oppression, racial discrimination, high rates of incarceration, residential segregation, and limited healthcare access [8, 9]. Researchers increasingly urge that attention to racial disparities must also focus on the associated social and economic divisions that create disparate health-related vulnerability [10, 11], while recognizing the intricate relationship among racial differences, gender dynamics, and experiences of stress [12].

D. German (✉) · C. A. Latkin
Department of Health, Behavior and Society, Johns Hopkins Bloomberg School of Public Health, 2213 McElderry St., 2nd Floor, Baltimore, MD 21215, USA
e-mail: dgerman@jhsph.edu

Researchers have documented a paradigm shift within HIV prevention in which HIV risk behavior has become framed within a context of socially structured vulnerability [4]. In such a paradigm, the context in which HIV-related behaviors occur is a critical behavioral determinant [13–15]. Attention has increasingly turned to understanding the complex web of social factors that persistently interact with HIV risk behaviors. A key theme in the HIV literature is the link between social disadvantage and AIDS vulnerability [4, 16, 17].

Structural vulnerabilities for HIV have been described as a "nexus of risk," whereby interactions between diverse social disadvantages facilitate HIV risk behaviors [14, 17]. Research points to a common set of social disadvantages, including economic hardship, homelessness, unemployment, drug use, lack of social support, and incarceration experiences, that simultaneously affect those most at risk and form the context within which HIV risk behaviors occur. Despite the common clustering of these factors in studies of HIV determinants [18–20], few have studied the interplay of social circumstances as indicative of underlying constructs. Considering each dimension independently masks any additive effect or interactive patterns among the factors that may exacerbate the effect of any one dimension on its own. The synergistic interaction of multiple diseases that co-occur as a product of social conditions has been referred to as a "syndemic" [21, 22]. A similar synergistic interaction may also occur within the circumstances of individual-level social structures, yet research is lacking on the ways in which the combination of these factors produces vulnerability to HIV.

The construct of social stability, first developed in addiction literature to characterize variation among alcoholics entering treatment [23, 24], offers a useful framework to understand the synergy of social factors which form the context for HIV risk behavior among urban populations. Operationalization and construct measurement of social stability has varied extensively, making it difficult to compare across studies. A synthesis of existing literature and theory on social stability points to the following as central characteristics of social stability: housing, employment, income, lack of incarceration, residential stability, and having a steady partner [25]. Stability has been discussed as the central determinant of well-being among women receiving welfare [26]. In contrast, social instability has been described as the most challenging barrier to providing healthcare services among injection drug users [27].

Although specific domains of social stability have been shown to predict HIV risk behavior, no study has evaluated the association between HIV risk and the construct of social stability. There are a variety of pathways through which the combined effect of social stability may impact HIV risk behaviors. Some have posited that instability produces a context of constrained rationality, in which health-promoting decision making cannot be disentangled from one's daily environmental stressors and the reality of limited options [26]. Within impoverished communities, HIV is but one of many social issues and often does not command immediate attention [28]. Stressors compete for priority, shape perceptions of future opportunities, and contribute to on-going hopelessness and psychological distress, all of which may function as barriers to sustained risk reduction. Risk in this context may also be the result of deliberate consideration of the implications of risk behavior in comparison to that of continued unstable circumstances.

In addition to assessing the relationships between individual social stability indicators and HIV risks, this study investigates two primary theories of the ways in which the co-occurrence of stability indicators may influence any certain outcome. In most studies of social stability to date, the measure has been assessed with a cumulative scale such that a specific weight is assigned to each stability indicator and the score is summed and analyzed either as a continuous scale or based on severity categories according to the sample distribution. The former approach suggests that it is the accumulation of instability that has most relevance, similar to literature on accumulated stressors [29]. However, it also improbably assumes the impact is incremental, such that stability in any three domains is equally better than two, which in turn is equally better than only one. This study investigates the theory of accumulation using an ordinal rather than continuous measure of stability, in order to assess how probability of risk changes along a continuum without assuming equal increments between intervals.

The latter approach posits a syndromic association among stability characteristics, such that categories of severity can be determined based on the extent of instability in one's life. Prior assessment of social stability severity has been based on investigator determined categories, largely reflecting specific accumulation levels, e.g. the commonly cited Straus-Bacon measure in which a value of three or better on a four-item cumulative scale is considered fairly good [23]. Others have determined severity based on sample distribution along a continuum, e.g. an index measure determined through correspondence analysis and categorized by dividing the respondents into three similarly sized groups indicating high, medium or low stability [30]. This study determines sub-groups of social stability and the extent to which they vary according to risk using latent class analysis (LCA), which identifies sub-groups within a population based on sentinel patterns of co-occurrence among characteristics hypothesized as indicators of a latent, or unobservable, construct. In contrast to investigator-determined categories, LCA involves a series of diagnostic criteria that help to determine the

appropriate number of groups within a study sample. Additionally, LCA involves structural equation models that simultaneously measure the associations among indicators and the relationship with covariates, thus reducing measurement error and enabling assessment of the extent to which any particular outcome varies across data-identified sub-groups.

The current study evaluates the association between a set of social stability indicators and HIV risk and uses two statistical approaches to evaluate the extent to which a multidimensional indicator of social stability is associated with HIV risk factors among a sample of primarily African–American low-income Baltimore City women at risk for HIV.

Methods

Study Population

Study participants were females ($n = 635$) who completed a baseline survey for the CHAT project, a randomized HIV intervention among women at sexual risk for HIV and their social network members in Baltimore, Maryland. Cross-sectional data collection took place over 2 years beginning September 2005. Index participant recruitment occurred through outreach and advertisement in public gathering places, communities with high levels of drug use and sex exchange, a local free newspaper and word-of-mouth. Prior to participation, index participants were screened for eligibility, including: female, age 18–55, current Baltimore City resident, no injection drug use in the past 6 months, reported heterosexual activity in the past 6 months and any of the following in the prior 6 months: sex with more than one person; sexual partner with sexual risk (e.g.. injection drug use, crack use, pay for commercial sex, sex with other men); STI diagnosis in the past 6 months; or used non-injection cocaine or heroin in the past 6 months. Network member inclusion was based on the intervention design to encourage HIV prevention conversations within social networks. Index participants recruited eligible network members, who were Baltimore City residents, aged 18 years or more, and were either sex partners, injection drug users, or someone the index was willing to talk with about HIV and STIs.

Data Collection

Data were collected at a community research site by trained interviewers who administered the survey using computer-assisted-personal-interview (CAPI) and audio-computer-assisted self-interviewing (ACASI) software. Questions related to HIV risk behavior and other sensitive topics were self-administered. Study participants received $35 for completion of the baseline visit. All study protocols were approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board prior to implementation.

Measures

Social Stability

Dichotomous social stability indicator variables were derived from existing social stability measures in order to measure recent extent of life structure as well as constancy in common domains of uncertainty and vulnerability among urban populations. Housing status is a common social stability indicator [23, 30–33]. Homelessness is characterized by uncertainty [34] and social and economic challenges [35]. Additionally, frequent housing changes make it difficult to maintain place attachment, social ties, and resource networks. Residential mobility may be an indication of uncertain economic and social resources and is common among populations experiencing homelessness [36, 37]. In some social stability measures [23, 38–40], residential transition is included as an independent life experience linked to stress, disruption, and uncertainty that may reflect or exacerbate instability in other domains [41–43]. A variety of social stability definitions include criminal justice measures [27, 30, 38], as experiences of arrest and incarceration may create disruption in otherwise stable circumstances and introduce barriers to housing, employment, economic gain and social resources. Indicators of economic uncertainty are often included in measures of social instability and disadvantage [27, 30, 33, 38, 44]. Income level accounts for the variety of income sources among the population. Lack of sufficient income is often closely intertwined with uncertain and changing circumstances and has been linked to a broad range of social and health consequences and often co-occurs with other social stability indicators [45]. Employment is a common social stability indicator, but high levels of unemployment and covariation with each of the other indicators precluded its inclusion. Indications of steady partnership are also common social stability criteria, but were not included here to avoid differential measurement with sexual risk measures.

The final items were operationalized to reflect higher stability in housing, incarceration, residential mobility, and income level during the prior 6 month period. Stability in the housing domain was assessed with a negative response to the question: "Have you been homeless in the past 6 months?" Incarceration was assessed by asking "During the past 6 months, have you been in a jail, prison or correctional facility?" with stability defined as having no incarceration experiences. Stability in the income domain

was defined based on the median response to the following question: "In the past 30 days, how much money did you get altogether from all sources including wages?". The higher stability group had income greater than $500. Stability in the residential mobility domain was defined as no residential moves and assessed with the question: "In the past 6 months, how many times have you moved?" Bivariate statistics and latent class analysis showed the selected items to be inter-related as expected, but not duplicative [25].

HIV-Related Variables

Risk variables were those theorized to increase likelihood of exposure to HIV and those commonly associated with social vulnerability. These included sexual risk behavior indicators of multiple sexual partners and sexual exchange partners, STI diagnosis in the past three-months, and cocaine or heroin use in the past 6 months. Sexual behaviors were assessed for the past 90 days to enhance recall. Number of male partners was assessed by asking how many different people the respondent had any type of sex with in the past 90 days. Based on the data distribution, this variable was coded to indicate having one or no partners versus multiple partners. A dichotomous indicator of sexual exchange was based on reported number of "exchange partners" in the past 90 days, with exchange partner defined for the respondent as "someone you have sex with in exchange for food, money, shelter or drugs". Recent STI history was assessed by asking whether respondents had ever been told by doctor or healthcare provider that they had syphilis, gonorrhea, chlamydia, trichomonas, herpes, genital warts or pelvic inflammatory disease. For each positive response, participants were asked when they were last told about the diagnosis. A summary variable was created to indicate any STI diagnosis in the past three-months. Drug use was assessed as a dichotomous variable measuring of any use of heroin, cocaine or crack in the past 6 months.

Demographic Characteristics

Age and education were included in multivariate models as control variables. Education was coded to indicate high school completion. Age was dichotomized around the sample mean of 41 to stratify the sample into older and younger age groups.

Data Analysis

Independent relationships between stability indicators and each HIV-related risk were explored with logistic regression models using Generalized Estimating Equations (GEE) to account for clustered data [46]. Each indicator was first regressed on each risk outcome, adjusting only for age and education. Then the same models were also adjusted for each other stability indicator to assess the effect of covariance. Stability indicators were tallied to create a four-point cumulative index. Logistic regression models using GEE were used to assess the association between cumulative stability score and each risk outcome, adjusting for age and education.

Latent class analysis was conducted to identify subgroups of participants based on their reported combination of stability indicators. To identify the number of subgroups (or classes), a series of models were fit with increasing class numbers until the model that best fit the data was identified. Substantive evaluation and model fit statistics, including the Bayesian Information Criteria (BIC), Akaike's Information Criteria (AIC) and sample size adjusted BIC, were used to evaluate model fit. All models accounted for clustered data and missing data was imputed using the missing data function of Mplus. Latent class regression was used to assess the association between latent class membership and each HIV risk. Analysis included bivariate and adjusted models. Mplus version 5 was used for latent variable models and Stata version 10.0 was used for exploratory statistics and regression models.

Results

Table 1 shows sample characteristics. Study participants were primarily African–American (96%), with a mean age of 41. About half completed high school and about two-thirds reported any use of cocaine, crack or heroin in the past 6 months. There was a moderate level of sexual risk behavior among the sample. Forty-five percent reported multiple partners and about a third reported any sexual exchange partners. Diagnosis of an STI was relatively rare (6%). Prevalence of social stability characteristics varied. One-third reported any homelessness and a slightly higher proportion (38%) reported any residential moves. About half of the participants (48%) reported income greater than $500 per month and only 15% reported any incarceration.

Latent Class Analysis

Table 2 shows the LCA model fit statistics, estimated class prevalence, and conditional probability of stability characteristics within each class. Likelihood ratio tests and information criteria indicated poor fit for the model with only one latent class. Model fit statistics between the 2-class and 3-class model indicated that the 2-class model was a better fit to the observed data, based on lower values for the AIC, BIC, sample size adjusted BIC, and some

Table 1 Sample characteristics among female CHAT participants, Baltimore, MD ($n = 635$)

Characteristic	*n* (%)
Age	
≤42 years	296 (46.6)
>42 years	339 (53.4)
Education	
≤11 years	329 (52.1)
>11 years	303 (47.9)
Race/ethnicity	
African–American	610 (96.1)
Other	25 (3.9)
Cocaine, crack, heroin in past 6 months	
No	210 (33.1)
Yes	425 (66.9)
Number of sex partners in past 90 days	
0–1	350 (55.1)
2 or more	285 (44.9)
Sex exchange in the past 90 days	
No	406 (63.9)
Yes	229 (36.1)
STI diagnosis in past 3 months	
No	595 (93.7)
Yes	40 (6.3)
Homelessness in past 6 months	
No	447 (70.4)
Yes	188 (29.6)
Incarceration in past 6 months	
No	541 (85.1)
Yes	94 (14.9)
Monthly income >$500	
No	328 (51.7)
Yes	307 (50.3)
Residential move in past 6 months	
No	391 (61.6)
Yes	244 (38.4)

identifiability problems in the 3-class model. These findings support the hypothesis that social stability indicators are inter-related in identifiable latent subgroups. More than three-quarters of the respondents were classified into a "high stability" class, characterized by higher probability of each stability characteristic.

Association Between Stability Indicators and HIV-Related Risk Behaviors

Results of multivariate analyses of each stability indicator on each HIV related risk are presented in Table 3. Adjusting for age and education, each indicator was significantly associated with at least one HIV risk. Homelessness was significantly associated with higher odds of each of the HIV risks. Incarceration was significantly associated with higher odds of recent drug use, having multiple partners, and having any exchange partners, but was not associated with having a recent STI diagnosis. Lower monthly income was significantly associated with recent drug use and having sex exchange partners. Having moved in the past 6 months was significantly associated with having multiple partners and recent STI diagnosis.

Magnitude and statistical significance of associations varied when models were further adjusted for each of the other indicators, demonstrating covariance among the stability variables in relation to HIV risks. In fully adjusted models, drug use was no longer significantly associated with homelessness, although significant relationships with incarceration and lower income persisted. Although homelessness remained associated with multiple partners and recent STI diagnosis, incarceration and residential move were no longer significantly associated with multiple partners and residential move was no longer associated with STI diagnosis. Homelessness also remained significantly associated with exchange partners, while income and incarceration were no longer significant and the association with residential move switched direction.

Accumulated Social Stability and HIV-Related Risk Behavior

Results of multivariate analyses of cumulative and latent class measures of stability on HIV risk are presented in Table 4. Approximately 25% of participants reported stability in each of the four domains, 37% reported three, about 20% reported two, while 8% reported only one and 2.4% reported none. There was an overall trend of decreased HIV risk behavior associated with each additional cumulative stability characteristic. In adjusted analyses, those with three and four characteristics were significantly less likely to use drugs than respondents with the lowest number of stability characteristics. Compared to respondents with the lowest number of stability characteristics, the odds of multiple partnerships and exchange partners were significantly reduced with each additional stability characteristic. Increased numbers of stability characteristics were not significantly associated with having a recent STI diagnosis, although trends were similar to the other outcomes for those with three and four characteristics. Latent class regression indicated that each outcome was significantly less likely among respondents in the "high stability" class.

Table 2 Latent class analysis of social stability characteristics among female CHAT participants, Baltimore ($n = 635$)

	1-class model	2-class model[a]		3-class model		
	Class 1	"High" Class 1	"Low" Class 2	"High" Class 1	"Mixed" Class 2	"Low" Class 3
Characteristic						
No homelessness	0.70	0.91	0.13	1.00	0.44	0.21
No incarceration	0.85	0.90	0.73	0.91	0.80	0.75
Income > $500	0.48	0.55	0.29	0.52	1.00	0.00
No residential move	0.62	0.78	0.16	0.85	0.42	0.23
Class size	1.00	0.77	0.23	0.68	0.12	0.21
Pearson χ^2	183 ($P < 0.00$)	6 ($P < 0.41$)		1 ($P < 0.22$)		
Log-likelihood	−1515	−1439		−1437		
AIC	3038	2896		2902		
BIC	3055	2936		2964		
Sample-size adjusted BIC	3043	2908		2920		

[a] Best model given fit statistics and class size

Discussion

This study demonstrated that individual indicators of social stability were associated with HIV-related outcomes and additionally showed that increased multidimensional stability, measured both as a cumulative score and as a latent categorical variable, was associated with decreased HIV risk. These findings validate prior research regarding the HIV-related implications of instability in housing [47, 48], income [49, 50], residential mobility [43] and incarceration [51, 52]. Importantly, these findings also show that the tendency for instability experiences to occur in clusters adds an additional dimension of risk. Analytic models that assess risk by assuming independence among stability indicators may obscure important synergies among variables.

This study provides evidence in favor of both theories of multidimensional social stability as a health determinant. Each suggests a unique understanding of the ways in which stability characteristics amplify their impact and may be addressed through different strategies. The synergistic interaction of multiple diseases that co-occur as a product of social conditions has been referred to as a "syndemic" [21, 22]. These findings suggest that similar synergistic interaction also occurs within the circumstances of individual-level social structures and that combination of these factors is related to HIV vulnerability. The range of stability characteristics in this sample also reinforces the heterogeneity within low-income communities and suggests that the spectrum of stable social circumstances has health implications even among disadvantaged populations.

The finding that risk decreased with each additional stability characteristic for most of the outcomes indicates an additive effect of stability. Other researchers have demonstrated the negative implications of accumulated psychosocial disadvantage among those at risk for HIV [53–55], but few have examined the implications of accumulated disadvantage in one's social circumstances. These findings indicate that the extent of instability in one's life contributes to vulnerability. Although specific patterns of instability and experience with any one indicator may produce unique pathways of vulnerability, these results provide support for an additional pathway that is rooted plainly in instability and uncertainty regardless of the specific contributors.

Across outcomes, the effect of accumulated stability varied. Likelihood of sex exchange and multiple partners was significantly reduced with each additional stability characteristic, while likelihood of drug use was only significantly lower at the highest levels of accumulated stability, and recent STI diagnosis showed only a trend of association with increased cumulative stability. This suggests the possibility of plateaus of stability that are more helpful for certain outcomes. This also points to the relevance of the second theory of how the co-occurrence of each of the stability characteristics relates to health: that an overall pattern of stability versus instability may be valuable for health.

The finding that data-derived categories of severity of social stability were associated with each of the HIV-related outcomes validates the use of LCA to derive categories of stability that reflect patterns observed within the data. In contrast to previous studies that have determined categories of social stability severity based on the distribution of accumulated numbers of characteristics, this method allows categories to reflect the varying probability of each indicator within a population. In this case, this method identified a high and low stability group and demonstrated that those with higher probability of

Table 3 Multivariate analysis of stability indicators on HIV-related risks among female CHAT participants, Baltimore, ($n = 635$)

	Recent drug use O.R. (95% C.I.)			Multiple partners O.R. (95% C.I.)			Exchange partners O.R. (95% C.I.)			Recent STI diagnosis O.R. (95% C.I.)		
	% yes	Basic model[a]	Extended model:[b] basic + all indicators	% yes	Basic model[a]	Extended model:[b] basic + all indicators	% yes	Basic model[a]	Extended model:[b] basic + all indicators	% yes	Basic model[a]	Extended model:[b] basic + all indicators
Homeless												
Yes	73.4	1.0	1.0	59.0	1.0	1.0	47.3	1.0	1.0	10.6	1.0	1.0
No	64.2	**0.63** (0.43, 0.93)	0.77 (0.51, 1.18)	38.9	**0.44** (0.31, 0.62)	**0.46** (0.31, 0.68)	31.3	**0.51** (0.36, 0.73)	**0.47** (0.32, 0.68)	4.5	**0.39** (0.20, 0.74)	**0.46** (0.22, 0.95)
Incarceration												
Yes	79.8	1.0	1.0	58.5	1.0	1.0	45.7	1.0	1.0	7.5	1.0	1.0
No	64.7	**0.38** (0.22, 0.66)	**0.41** (0.24, 0.72)	42.5	**0.56** (0.36, 0.88)	0.64 (0.40, 1.02)	34.4	**0.61** (0.39, 0.96)	0.69 (0.43, 1.11)	6.1	.87 (0.37, 2.05)	1.07 (0.45, 2.56)
Monthly income												
<$500	71.3	1.0	1.0	46.3	1.0	1.0	40.9	1.0	1.0	5.5	1.0	1.0
>$500	62.2	**0.67** (0.48, 0.94)	**0.71** (0.51, 1.00)	43.3	0.86 (0.63,1.18)	0.98 (0.71, 1.36)	30.9	**0.66** (0.48, 0.92)	0.71 (0.50, 1.00)	7.2	1.32 (0.69, 2.50)	1.66 (0.85, 3.24)
Residential move												
Yes	69.3	1.0	1.0	50.8	1.0	1.0	36.1	1.0	1.0	9.8	1.0	1.0
No	65.5	0.76 (0.53, 1.07)	0.91 (0.62, 1.23)	41.2	**0.72** (0.52, 1.00)	1.01 (0.70, 1.46)	36.1	1.02 (0.73, 1.43)	1.51 (1.02, 2.23)	4.1	**0.41** (0.21, 0.80)	0.52 (0.25, 1.08)

[a] Basic models regress each indicator on the outcome, adjusting for age and education

[b] Extended models adjusted for age, education, and all stability indicators (homelessness, incarceration, income, and move)

Bold indicates significant at $P < .05$

Table 4 Multivariate analysis of cumulative stability and stability class on HIV-related risks among female CHAT participants, Baltimore, MD ($n = 635$)

	% total	Recent drug use		Multiple partners		Exchange partners		Recent STI diagnosis	
		% yes ($n = 425$)	O.R. (95% C.I.)	% yes ($n = 285$)	O.R. (95% C.I.)	% yes ($n = 229$)	O.R. (95% C.I.)	% yes ($n = 40$)	O.R. (95% C.I.)
# of stability characteristics									
0–1	18.4	75.2	1.0	61.5	1.0	53.0	1.0	8.6	1.0
2	19.4	70.7	0.66 (0.37, 1.18)	47.2	**0.59 (0.35, 0.99)**	32.5	**0.42 (0.25, 0.71)**	9.8	1.19 (0.49, 2.85)
3	36.9	68.0	**0.58 (0.35, 0.98)**	41.0	**0.44 (0.28, 0.70)**	33.3	**0.45 (0.29, 0.71)**	5.1	0.57 (0.24, 1.36)
4	25.4	56.5	**0.36 (0.21, 0.62)**	36.7	**0.38 (0.23, 0.62)**	30.4	**0.39 (0.24, 0.65)**	3.7	0.44 (0.16, 1.24)
Stability class membership									
Low	22.8	75.9	1.0	58.6	1.0	46.9	1.0	11.0	1.0
High	77.2	64.3	**0.55 (0.34, 0.90)**	40.8	**0.39 (0.26, 0.60)**	32.9	**0.47 (0.31, 0.72)**	4.9	**0.25 (0.09, 0.65)**

Models adjusted for age and education

Bold indicates significant at $P < .05$

exhibiting each of the stability characteristics were less likely to exhibit any of the HIV-related outcomes. This confirms that an overall pattern of stability is protective for HIV risk and suggests a need for attention to stability as a multidimensional construct. The LCA method also differs from the cumulative method in that it enables a classification of individuals into groups based on their exhibited patterns of stability characteristics. This classification may prove useful as a diagnostic criteria or evaluation indicator.

There are a few indications within these data that housing may require priority attention for intervention efforts. High and low stability classes were more distinguished by differences in probability of homelessness and residential moves. Additionally, homelessness was the only indicator consistently associated with each of the HIV-related outcomes in the basic models and remained associated with multiple partners, sex exchange and recent STI diagnosis in models that controlled for each of the other indicators. The association between housing instability and HIV risk has been well-demonstrated [47]. While evidence from this study indicates a need for attention to multidimensional stability beyond that of housing stability, this should not distract from the need to address the role of housing as HIV prevention.

In some cases, individual instability indicators were not associated with the HIV-related outcomes. For example, income was not significantly associated with having multiple partners. In this case, the income measure reflected average monthly income that may not fully account for the available resources during the 6 month period. Additionally, the distinction between higher and lower income was set at a relatively low threshold since the sample distribution was quite low overall. Even within this low-income sample, these findings show higher income to be associated with stability in other domains and with decreased likelihood of sex exchange. Those who had moved were not significantly more likely to use drugs and were actually less likely to have an exchange partner when accounting for other dimensions of instability. This finding may reflect that, even if it brings some degree of uncertainty, a residential move independent of other instability can be a positive event and may be precipitated by increased financial or social resources.

Having a recent STI was strongly associated with a pattern of overall instability, but no significant differences were found in the cumulative stability assessment, suggesting that this outcome may involve somewhat different pathways than the others. Unlike the other outcomes, exposure to an STI requires contact with an infected partner and this likelihood may be heightened among those whose unstable circumstances alter their sexual network composition. This is consistent with the finding that only

residential move and homelessness were associated with this outcome.

The social stability indicators assessed in this study were selected to reflect common experiences of instability among those at risk for HIV in urban settings. It is possible that other indicators would also have relevance among other populations or show somewhat different patterns of association with the study outcomes. For example, there is evidence that residential transience (defined as moving twice or more in a 6 month period) is associated with depressive symptoms [43] and injection risk behaviors [43] and housing instability (in contrast to homelessness) is associated with sexual risk [48]. Additional role relationships such as parenting, close friendships and relationships with family may also provide stability and counter-balance instability across domains. Indicator distributions and patterns of covariance in other samples may allow inclusion of additional indicators such as employment, which would broaden the spectrum of cumulative social stability and possibly allow for identification of additional clusters with latent class analysis. Understanding the relationships among a broader set of stability experiences in the context of HIV prevention may provide valuable insight and further our understanding of the ways in which instability fosters vulnerability to HIV risk. This study offers a foundation and framework for future endeavors.

There are several limitations to this study that should be noted. Data were cross-sectional and thus causal associations cannot be inferred. Data were collected using self-reported data collection methods and participants may have been reticent to disclose personal information or offered more socially desirable responses. Responses may have been subject to recall bias, although the recall time period was restricted partly in order to enhance recollection. Data collection occurred during standard business hours, which may have altered the pool of possible participants towards those without standard work hours. The minimal remuneration for study participation may also have provided incentive for individuals with greater financial need to participate in the study. There is some risk of sampling bias due to recruitment time periods and locations, although this is minimized with the variety of recruitment sources and network recruitment.

There are many successes in the history of U.S. HIV prevention efforts [56], yet much remains to be done [57]. The limitations of early HIV prevention strategies in addressing the complexity of HIV-related behaviors have been well-documented [58–60]. Based largely on psychological theories, early prevention strategies for sexual risk highlighted cognitive factors such as knowledge, attitudes, and self-efficacy [61]. These approaches assumed rational and voluntary decision-making and minimized the role of social and contextual factors in shaping behavior. In recognition of this, experts continue to highlight the social determinants of HIV and the need for interventions to shape the contextual determinants of HIV risk [1–4]. These efforts unfailingly conclude that addressing the social production of HIV vulnerability is necessary for effective long-term prevention.

Link and Phelan [62] point to the "need to contextualize risk factors by asking what it is about people's life circumstances that shapes their exposure to such risk factors as unprotected sexual intercourse, poor diet, a sedentary lifestyle, or a stressful home" (p. 85). The synergistic association among social stability elements creates a context of uncertainty, limited resources, stress and constraint such that risk reduction decisions must be considered to be a product of one's social circumstances. As such, social stability takes the form of a 'fundamental cause' of disease, defined as that which restricts access to resources that could enable risk avoidance or minimize consequences [62]. Fundamental causes function as contextual determinants of vulnerability by influencing multiple risk factors and multiple disease outcomes. The 'fundamental cause' perspective mandates that researchers seek to determine and understand the social factors that create conditions of disease vulnerability. As the HIV epidemic persists, addressing fundamental causes such as social stability creates the possibility of adequately addressing the roots of HIV transmission through appropriate social and policy interventions.

Foremost, these findings prompt further consideration of the complex life challenges facing those most at risk for HIV. It is clear that HIV is but one of many issues of potential concern among vulnerable populations. Perceptions of the comparatively distal consequences of risk-taking are valid and should not be discounted. But other pathways from instability to risk also deserve attention, particularly with the extent of commitment and political will necessary to achieve societal resolution of the roots of chronic and accumulated instability. Within the field of HIV prevention, it seems critical to evaluate the extent to which social policies, such as housing subsidies, job training, and welfare programs, ultimately contribute to reduced likelihood of HIV transmission, and explore possibilities for active integration of HIV prevention into social policy conversations. Furthermore, it is worth considering the extent to which such programs are grounded in the complex contextual realities of people's lives. For example, housing provision or training options that include restrictions based on prior incarceration may not be adequate given the co-occurrence of instability in all of these areas. Validating and bolstering informal social support and care-giving mechanisms may be one way to fill gaps by working within existing social structures. Although individual-level interventions have an important role in HIV

prevention activities, social and structural interventions will be critical to address the impact of instability on sustained HIV risk reduction.

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