



The Relationship Between Economic Deprivation, Housing Instability and Transactional Sex Among Women in North Carolina (HPTN 064)

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Published online: 22 July 2019
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Abstract

Transactional sex is associated with socioeconomic disadvantage and HIV risk but few studies in the United States (US) have examined both individual and area-level predictors of transactional sex or distinguished transactional sex from sex work. We combined data from HIV Prevention Trials Network 064 study and the US Census to estimate prevalence ratios (PR) for the relationship between census-level and individual measures of economic deprivation and housing instability on transactional sex in 417 women in North Carolina. Increased transactional sex was associated with food insecurity (PR 1.86; 95% CI 1.57, 2.19), housing instability (PR 1.33; 95% CI 1.11, 1.59), substance abuse (PR 1.90; 95% CI 1.64, 2.19) and partner incarceration (PR 1.32; 95% CI 1.09, 1.61). Census-level indicators were not associated with transactional sex, adjusted for individual-level covariates. Interventions should support housing stability and financial opportunities among southern African American women to reduce HIV risk, particularly among women with incarcerated partners.

Keywords Transactional sex · Economic deprivation · Housing instability · Multilevel

Introduction

HIV among women in the United States remains concentrated in socioeconomically disadvantaged areas in the South [1, 2]. Although HIV diagnoses have declined in recent years in the United States, 19% of new infections occurred among women in 2015 [2]. New infections in women were predominately through heterosexual transmission (87%) and 61% were among black women [2]. HIV prevalence is highest

in women of color, those living in poverty, and who reside in the Southern United States [1, 2]. Transactional sex is an HIV risk behavior that is strongly tied to socioeconomic status and has been associated with individual economic disadvantage, low levels of education, and housing instability in the United States [3–7]. Given the strong relationship between transactional sex and indicators of socioeconomic status, it is likely that transactional sex would be related to area-level in addition to individual measures of socioeconomic status but evidence is lacking [8–10].

Transactional sex is defined as “noncommercial, non-marital sexual relationships motivated by the implicit assumption that sex will be exchanged for material support or other benefits” [11, 12]. Transactional sex is distinct from sex work because individuals who report transactional sex do not see themselves as sex workers [11]. Transactional sex has been associated with an increased prevalence and incidence of HIV in women [4, 13–16]. However, the bulk of evidence is from populations in sub-Saharan Africa and studies from the US, are largely cross-sectional or conflate sex work with transactional sex [4, 13–16]. Evidence from the US shows that while the overall prevalence of transactional sex is low (2%) [17], prevalence of transactional sex is much higher in urban, heterosexual women including those with an elevated risk of HIV (41%) [18]. Economic

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disadvantage can increase likelihood of transactional sex and HIV through a desire or need to access financial and material resources, unequal power dynamics in relationships, increased likelihood of violence and substance abuse [4]. Housing instability and homelessness have been associated with HIV infection and with sexual risk behaviors, including transactional sex, by creating barriers to the formation of stable relationships [19, 20], stress [7, 21, 22], increasing exposure to violence [23, 24], and limiting economic opportunities [25, 26]. A multilevel study, found that living in a census-tract with a high ratio of men to women (more men than women) was associated with a higher number of sexual partners and this relationship was explained by transactional sex [9]. However, few studies among women in the US have differentiated between transactional sex and commercial sex work or investigated both area-level and individual predictors of transactional sex [4, 8–10].

The primary aim of this paper is to explore the relationship between area and individual level measures of economic deprivation and housing instability on likelihood of transactional sex in women in the Raleigh-Durham area of North Carolina. Our study focuses on North Carolina as women living in the southern states, including in North Carolina, have the highest incidence rates of HIV among women of all regions of the country [27]. Our second research aim is to understand how transactional sex may affect other HIV risk behaviors in this population by examining the association between transactional sex and other characteristics related to HIV risk.

Methods

Study Population

HPTN 064, or the Women's HIV Seroincidence Study, was a multisite, longitudinal cohort study designed to estimate the incidence of HIV infection in women at risk for HIV in the United States [28]. The study recruited women living in geographic areas of the US ranked in the top 30th percentile of HIV prevalence and that had > 25% of inhabitants living in poverty. Eligible persons identified themselves as women; reported having no prior positive HIV test; lived in a census tract with high ranked poverty and HIV prevalence; had at least one reported unprotected vaginal or anal sex act with a man in the last 6 months; and self-reported at least one personal or sex partner characteristic that increased risk of HIV acquisition (e.g. illicit substance use) [28]. A total of 2099 women between the ages of 18 and 44 years were enrolled from 10 communities in six distinct areas in the northeast and southeast regions of the US: Atlanta, GA, Raleigh-Durham, NC, Washington DC, Baltimore, MD, Newark, NJ, New York City, NY.

Women were enrolled between May 2009 and July 2010 and followed up at 6-month intervals for up to 12 months. At each visit they received a rapid HIV test and completed an audio computer-assisted self-interview (ACASI) [28, 29]. The ACASI included self-reported questions about mental health, sexual behavior, history of sexually transmitted infections (STIs), domestic violence, social support, financial insecurity, housing stability and health care utilization. Information on sexual behaviors was asked in reference to the previous 6 months and included information about the characteristics of the three most recent male partners during this period. Participant home addresses were collected at baseline by study staff and were linked to a census tract using the US Census Bureau online geocoder. More detail is available in previous publications [28, 29]. The analyses herein are restricted to 417 participants enrolled from the Raleigh-Durham site in North Carolina.

Outcome Ascertainment

Primary Outcome

The primary research aim explored the relationship between area and individual level measures and transactional sex. Transactional sex was measured at all study visits using four separate questions all including the phrase, "Of the men you have had sex with in the last 6 months, how many did you have sex with because you needed..." The four questions were asked in reference to: (1) a place to stay, (2) food or things for yourself or your family, (3) money, or (4) drugs. Transactional sex was a binary variable defined as answering yes to one or more of these four questions. At all study visits, the ACASI also asked the participant "Do you consider yourself to be 'a commercial sex worker (prostitute)?" [response choices: Yes, No, Don't know]. This variable was used to distinguish commercial sex work from transactional sex in sensitivity analyses and don't know was considered missing information on commercial sex work.

Secondary Outcomes

Our secondary research question examined the relationship between transactional sex as an exposure and other characteristics related to HIV risk. Outcomes in this analysis included: (1) self-reported sexually transmitted infection (a diagnosis of gonorrhea, syphilis, trichomonas, chlamydia, bacterial vaginosis, pelvic inflammatory disease or genital herpes) in the last 6 months; (2) partner non-monogamy; (3) participant non-monogamy; (4) any emotional, sexual or physical abuse in the last 6 months; and (5) condomless sex. All outcomes were measured at all study visits for which data were available. Partner non-monogamy was a binary variable defined by the participant reporting that any of her

last three partners “definitely did” have sex with another person during the course their sexual relationship [3]. Participant non-monogamy was a binary variable constructed by comparing the dates (recorded as month and year) of first and last sexual intercourse among each of the three reported most recent partners (definition based on past HPTN 064 analyses by Adimora and colleagues) [3]. Participant non-monogamy was defined as having two or more sexual partnerships whose dates overlapped by more than 1 month. Any condomless sex was a binary variable defined as having either condomless vaginal or anal sex at last sex. Experience of abuse was a binary variable defined as a report of any physical, sexual or emotional abuse in the last 6 months, each posed as a separate question.

Exposure Ascertainment

At the individual level, we examined self-reported measures at each time point (baseline, 6 months and 12 months) known to be associated with housing instability and economic deprivation including: food insecurity, unemployment status, housing instability, substance abuse, and partner incarceration [3]. Information was only included for time points where women were seen. Partner incarceration was defined as any of 3 most recent partners in the last 6 months has ever been to jail or prison for more than 24 h. Housing instability was constructed based on the question “where do you live now?” with nine possible responses. Participants were defined as living in unstable housing if they reported living in a halfway house or treatment center; at a homeless shelter; in temporary housing (motel, hotel, boarding house); or in the street, a park, an abandoned building, or a car. Participants who answered that they lived in a home that was owned or rented by themselves, their partner, a family member or a friend were defined as having stable housing. Food insecurity was a binary variable defined as answering yes to the question “In the past 6 months, have you been concerned about having enough food for you and/or you family?” A binary variable defined whether the participant was unemployed (the participants’ main source of income was not from a job). Sources of income for those who were unemployed could include unemployment insurance, government sponsored assistance or benefit programs such as Temporary Assistance to Needy Families (TANF), veteran’s benefits, disability or social security, a spouse, friend, other family, selling drugs, sex work, or other. Alcohol abuse was defined as ≥ 4 alcoholic beverages on one occasion at least weekly [3]. Drug abuse was defined as use of any type of illicit drug (cocaine, amphetamines, inhalants, sedatives, hallucinogens, opioids or other but not marijuana) at least weekly in the last 6 months [3]. Any substance abuse was a binary variable defined as either alcohol or drug abuse.

Measures of area-level economic deprivation and housing instability were constructed using the American Community Survey (ACS) 5-year estimates (2007–2011). Measures of area-level economic deprivation were all continuous and included: percent with less than high school degree among those 25 years and over; unemployment rate; percent of persons in poverty; percent of households on food stamps or government benefits and percent of units lacking kitchen facilities. Measures of area-level housing instability were all continuous and included: residential instability (percent residents who moved in last 12 months); percent vacant housing units; percent rental occupied housing units; rental burdened household (household spends 35 percent or more of income on housing rental costs); and percent of households with more people than rooms. Percent of households with more people than rooms, and percent rental burdened households were later removed after conducting principal components analysis. Area-level analyses are done at the level of the census-tract.

Given the large number of possible census-tract level exposures and the strong correlations among these exposures, we used principal components analysis as a data reduction technique to create an index of housing deprivation and economic instability at the census level [30]. First, we standardized all variables to have a mean of 0 and standard deviation of one and examined a correlation matrix (a correlation above 0.7 was considered high) [31]. Second, we performed principal components analysis with an orthogonal rotation (varimax) using the full set of variables. We identified three factors with an eigenvalue greater than one but the first two factors explained a much greater portion of the variance (variance factor 1 = 3.94, variance factor 2 = 2.48, variance factor 3 = 1.31 [30]). We retained variables that fit within the two factors that explained a greater portion of the variance and corresponded meaningfully with our constructs of (1) economic deprivation and (2) housing instability. The variables that were removed did not fit meaningfully with either of the factors (values of 0.40 or higher were considered meaningful) [30] (Table 10 in appendix). Factors loading for the retained variables were high as was the total amount of variation explained by each factor (variance factor 1 = 3.37, variance factor 2 = 2.59).

Covariate Ascertainment

Covariates examined in our analysis included age at baseline, level of education at baseline, time-varying annual income, time-varying employment status, time-varying report of no health insurance in the last 6 months and time-varying mental health symptoms (depression and post-traumatic stress disorder [PTSD], defined per Radloff [32] and Prins [33], respectively). We also descriptively examined national rankings of census tracts from the 2010 Social Vulnerability

Index (SVI) created by the Centers for Disease Control using census data but this measure was not included in principal components analysis or other models [34].

Statistical Analysis

Our first research question examined the relationship between individual and census-tract characteristics and transactional sex. Descriptively, we examined individual and census-tract characteristics of women reporting transactional sex versus not. Given the relatively low correlation of transactional sex within clusters ($ICC=0.041$), we then estimated crude and adjusted prevalence ratios for the relationship between each individual and census-level characteristic and transactional sex. Prevalence ratios were estimated using a log-binomial model with generalized estimating equations and an exchangeable correlation structure to account for clustering by census tract [35] [36]. Each exposure-outcome relationship was examined separately. As a sensitivity analysis for the census-level exposures, we estimated the same associations using a random effects model. Adjusted models for included age in years, level of education, housing insecurity, income level and substance use. These confounders were selected based on prior literature linking these characteristics to transactional sex and HIV risk [3–5, 7, 37–42].

Our secondary research aim examined the relationship between transactional sex and other HIV risk characteristics at the individual level. Again, we examined each exposure-outcome relationship separately and used a log-binomial model with generalized estimating equations to estimate crude and adjusted prevalence ratios [36]. Adjusted models included age in years, level of education, housing insecurity, income level and substance use.

Two sensitivity analyses were done; one to distinguish sex work from transactional sex and one to account for temporality in predictors of transactional sex. First, we reran all models excluding commercial sex workers to distinguish between transactional sex alone and commercial sex work. Due to the similarity of these results, we present the primary analysis including all women. Second, to ensure temporality, we reran models for our association between individual level measures and transactional sex using the value of transactional sex at the time point after exposures.

Results

Our study includes 417 women enrolled in the in the Raleigh-Durham study sites in North Carolina. Among these 417 women (Table 1), the median age was 27 years (interquartile range 22–34), 93% were black ($N=384$), 40.9% had less than a high school education ($N=169$) and 67.7% had a household income less than 20,000 a year ($N=260$).

The weighted average poverty threshold for a family of four in 2010 was \$22,314 [43].

A third (33.9%; $N=140$) of participants reported transactional sex in the last 6 months at baseline. Women who reported transactional sex were older (median age 30 vs. 25) and more likely to be food insecure (62.5% vs. 39.4%), unemployed (66.4% vs. 54.6%), and live in unstable housing (20.0% vs. 10.9%). They were also more likely to have experienced any emotional, sexual or physical abuse; report drug and alcohol abuse; and to have an STI diagnosis ($p<0.05$). Among women who reported transactional sex in the 6 months before baseline, 11.4% ($N=16$) reported commercial sex work compared to 0.4% ($N=1$) among women who did not report transactional sex.

Table 2 shows census-tract level characteristics in relation to individual transactional sex in 6 months prior to the baseline assessment. Overall, there were 22 census tracts with the number of women in each tract ranging from 5 to 133. Women enrolled in the study lived in census tracts with high CDC social vulnerability index rankings (above the 95th percentile) indicating high levels of socioeconomic disadvantage. Women who reported transactional sex had a similar score for economic deprivation (median 0.09; interquartile range (IQR) – 1.01, 0.57) compared to those who did not (median 0.09; IQR – 0.85, 1.00). Exposures related to housing instability did not vary by transactional sex nor did our index of housing instability.

At the individual level, food insecurity (PR 2.02; 95% CI 1.65, 2.47), housing instability (PR 1.42; 95% CI 1.17, 1.72), substance abuse (PR 1.96; 95% CI 1.70, 2.26) and partner incarceration (PR 1.28; 95% CI 1.04, 1.58) were associated with an increased prevalence of transactional sex, adjusted for confounding (Table 3). Individual unemployment was not associated with an increased prevalence of transactional sex. In a sensitivity analysis excluding commercial sex workers, patterns remained the same. Although, partner incarceration was not significant (PR 1.23; 95% CI 0.99, 1.54), and estimates were generally closer to the null and less precise (Tables 6 and 7 in appendix). In the second sensitivity analysis, we examined individual level measures predicting transactional sex at the time point after exposure (i.e. 6 months later) (Table 8 in appendix). Again, patterns remained similar but estimates were much less precise because the analyses only included women who had information at subsequent visits.

We did not find an association between census-level economic vulnerability (PR 0.98 95% CI 0.81, 1.08) or housing instability (PR 1.03; 95% CI 0.88, 1.20) and transactional sex, adjusted for confounders (Table 3). Results remained similar (PR within 10%) when using a random effects model to estimate effects (Table 4).

Table 5 shows results from our secondary research question examining associations between transactional sex and other HIV risk characteristics. Transactional sex

Table 1 Individual descriptive characteristics by transactional sex at the baseline visit

	Transactional sex				Total (N = 413)	
	No (N = 273; 66.1%)		Yes (N = 140; 33.9%)		N (%)	Median (IQR)
	N (%)	Median (IQR)	N (%)	Median (IQR)		
Age		25 (22,31)		30 (24,39)		27 (22,35)
18–24	121 (44.3)		35 (25.0)		156 (37.8)	
25–35	106 (38.8)		53 (37.9)		159 (38.5)	
> 35	46 (16.9)		52 (37.1)		98 (23.7)	
Race						
Black	257 (94.1)		127 (90.7)		384 (93.0)	
White	14 (5.1)		13 (9.3)		27 (6.5)	
American Indian	1 (0.4)		3 (2.1)		4 (0.9)	
Other	3 (1.1)		1 (0.7)		4 (1.0)	
Site						
Durham	138 (50.6)		69 (49.3)		207 (50.1)	
Raleigh	135 (49.4)		71 (50.7)		206 (49.9)	
Sexual orientation						
Straight/heterosexual	228 (85.7)		109 (80.1)		337 (83.8)	
Gay/lesbian/homosexual	2 (0.7)		1 (0.7)		3 (0.7)	
Bisexual	32 (12.0)		18 (13.2)		50 (12.4)	
Other or not sure	4 (1.5)		8 (5.9)		12 (2.9)	
Less than high school education	115 (42.1)		54 (38.6)		169 (40.9)	
Income < 20,000	171 (68.1)		89 (66.9)		260 (67.7)	
Food insecurity	104 (39.4)		85 (62.5)		189 (47.3)	
Unemployed	149 (54.6)		93 (66.4)		242 (58.6)	
Housing instability	29 (10.9)		27 (20.0)		56 (14.0)	
No health insurance in the last 6 months	80 (30.2)		60 (44.1)		140 (34.9)	
Depressive symptoms ^a	58 (21.2)		55 (39.4)		140 (33.9)	
Post-traumatic stress disorder ^b	56 (20.9)		53 (39.8)		113 (27.4)	
Experienced any emotional, physical or sexual abuse in last 6 months	94 (34.9)		79 (58.5)		173 (42.8)	
Binge drinking at least weekly in past 6 months ^c	34 (12.6)		36 (26.7)		70 (17.3)	
Drug abuse at least weekly in the past 6 months	14 (5.7)		40 (30.1)		54 (14.3)	
Any partner ever used injection drugs	3 (1.1)		10 (7.1)		13 (3.1)	
Any partner jail or prison > 24 h	200 (73.5)		110 (78.6)		310 (75.2)	
Partner non-monogamy	85 (31.1)		85 (60.7)		170 (41.2)	
Participant non-monogamy	78 (28.7)		77 (55.0)		155 (37.6)	
No condom use at last sex	29 (37.2)		111 (33.3)		140 (34.1)	
Commercial sex worker	1 (0.4)		16 (11.4)		17 (4.1)	
Any STI diagnosis	91 (33.3)		56 (40.0)		147 (5.6)	

Missing: exchange sex = 4; sexual orientation 11; unprotect sex 1; abuse 11; sex work 1; partner in prison 1; income 130; participant concurrency 1; PTSD 12; alcohol abuse 8; substance abuse 35; housing 12; food insecurity 13; income 29

^aBinge drinking: defined as ≥ 4 alcoholic beverages on one occasion

^bThe Center for Epidemiologic Studies - Depression Scale (CES-D) was administered, with a score of ≥ 7 (on 8-item scale) indicating psychological distress or depressive symptoms

^cThe Primary Care PTSD screen was administered, with a score > 3 denoting PTSD; abuse 35; housing 12; food insecurity 13; income 29

was associated with an increased prevalence of participant non-monogamy (PR 2.46; 95% CI 2.05, 2.95), partner non-monogamy (PR 2.02; 95% CI 1.68, 2.41) and experience of emotional, physical or sexual abuse (PR 1.84; 95% CI 1.56,

2.17). We did not identify an association between transactional sex and any self-reported STI or condomless sex. Again, in a sensitivity analysis excluding commercial sex workers, patterns remained the same (Table 9 in appendix).

Table 2 Census-level descriptive characteristics by transactional sex at the baseline visit

	Transactional sex	
	No	Yes
	Median (IQR)	Median (IQR)
Economic deprivation index score (standardized)	0.09 (−0.85, 1.00)	0.09 (−1.01, 0.57)
Percent with less than high school degree among those 25 years and over	21.1 (20.1, 36.5)	27.9 (20.1, 33.8)
Unemployment rate	20.5 (12.2, 23.5)	18.5 (9.2, 23.3)
Percent of persons in poverty	37.6 (27.0, 57.1)	42.1 (27.0, 49.2)
Percent of households on food stamps/government benefits	37.4 (20.0, 49.3)	38.4 (20.0, 41.6)
Percent of units lacking kitchen facilities	5.7 (3.4, 11.7)	5.7 (1.1, 12.5)
Housing instability index score (standardized)	0.18 (−0.70, 0.46)	0.25 (−0.70, 0.46)
Residential instability	31.4 (25.7, 36.8)	31.4 (25.7, 36.8)
Percent vacant housing units	7.1 (5.4, 7.5)	7.2 (5.5, 8.1)
Percent rental occupied housing units	77.4 (67.3, 83.3)	71.4 (67.3, 77.8)
CDC Social Vulnerability Index (overall percentile ranking)	96.6 (91.1, 96.6)	95.2 (79.1, 96.6)

Table 3 Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for the association between each individual and census-level characteristic and transactional sex

	Crude PR (95% CI)	Adjusted PR (95% CI)
Individual level^a		
Food insecurity	2.19 (1.81, 2.66)	2.02 (1.65, 2.47)
Unemployed	1.23 (1.03, 1.47)	1.09 (0.87, 1.38)
Housing instability	1.71 (1.36, 2.17)	1.42 (1.17, 1.72)
Substance abuse	2.31 (2.02, 2.54)	1.96 (1.70, 2.26)
Partner in prison	1.21 (0.12, 1.45)	1.28 (1.04, 1.58)
Census level^b		
Economic factor	0.96 (0.85, 1.09)	0.98 (0.81, 1.08)
Housing factor	1.05 (0.87, 1.26)	1.03 (0.88, 1.20)

^aAge, level of education, housing insecurity, food security and substance abuse

^bICC for transactional sex = 4.13%

Discussion

Over a third of women in our study reported engaging in transactional sex, which is over 16 times what has been reported in the general population [17]. Individual food insecurity, housing instability, substance abuse and partner incarceration were associated with an increased prevalence

of transactional sex. Additionally, we found that women who reported transactional sex were more likely to also report non-monogamy (both self and partner) and to have experienced any physical, emotional or sexual abuse. These relationships held when excluding women who reported commercial sex work.

Socioeconomic factors have been shown to be closely tied to individuals’ motivations for transactional sex and vulnerability to HIV infection [3–7]. Our findings are consistent with previous studies, including one using HPTN 064 data, which have shown similar relationships between substance abuse [4, 41, 42, 44, 45], housing instability [6, 7, 37–39], food insecurity [3, 5, 40, 46] and transactional sex. Each of these relationships highlight that transactional sex is often a means to procure resources that women seek to access but these relationships are complex and interrelated. Motivations for engaging in transactional sex are varied and overlapping but are commonly related to basic need, social status, or an expression of love [11, 12]. Most women who engage in transactional sex do not consider themselves commercial sex workers and therefore exchanges are less explicit and women are vulnerable to power imbalances within these relationships [11]. One example of the complex and interrelated nature of these relationships is that economic disadvantage can translate to unaffordable housing where women may

Table 4 Sensitivity analysis for Table 3 using a random effects model

	Crude OR (95% CI)	Adjusted OR (95% CI) ^a	OR (95% CI) adjusted for the other factor
Census level^b			
Economic factor	1.03 (0.79, 1.33)	1.04 (0.79, 1.36)	1.04 (0.79, 1.36)
Housing factor	0.90 (0.71, 1.15)	0.94 (0.73, 1.20)	0.93 (0.73, 1.20)

^aAge, level of education, housing insecurity, and substance abuse

^bICC for transactional sex = 5.10%

Table 5 Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for the association between transactional sex and other sexual behaviors

Outcome	Crude PR (95% CI)	Adjusted PR (95% CI) ^a
Any self-reported sexually transmitted infection	1.16 (0.96, 1.42)	1.20 (0.98, 1.47)
Concurrent (self)	2.60 (2.20, 3.08)	2.46 (2.05, 2.95)
Concurrent (partner)	2.03 (1.71, 2.40)	2.02 (1.68, 2.41)
Sexual or physical abuse	2.02 (1.72, 2.37)	1.84 (1.56, 2.17)
Unprotected sex	0.98 (0.93, 1.02)	0.95 (0.91, 1.00)

^aAdjusted for age, level of education, housing insecurity, income level and substance abuse

trade sex for accommodation [26, 47]. Unstable housing can then also disrupt relationships [19, 20, 38]; expose women to violence [23, 24]; limit access to resources like employment and social services [38]; and lead to depression, anxiety, isolation and substance use [48–50] which only further increase economic vulnerability and subsequent risk of transactional sex and HIV. The central role of economic disadvantage and housing instability is evident in our study population; women were economically vulnerable and engaged in transactional sex at a prevalence far exceeding national estimates (33%) with an incidence of HIV 6 times that of the general population of US black women of a similar age [28]. Given the inter-connected nature of these relationships and the central role of economic disadvantage and housing instability, programs and policies to reduce transactional sex and risk of HIV must consider and address how lack of good economic options for women drive behavior and HIV risk.

In addition to these better-established relationships between transactional sex and socioeconomic disadvantage, we identified an association between prevalence of transactional sex and partner incarceration, which is not as well understood. High-rates of incarceration and re-incarceration can affect partners left behind by decreasing the numbers of available sexual and marriage partners; disrupting existing sexual relationships; and changing norms related to sex, and monogamy [51–55]. While evidence is primarily cross-sectional, studies in North Carolina [56] and in two other US cities [52] have shown similar associations between having a partner who was ever incarcerated and transactional sex. High male incarceration rates disrupt the economic stability of a household by removing financial or material support from a male partner [52, 57]. Women with sexual partners with a history of incarceration have reported engaging in transactional sex during periods where their partner was absent, un- or underemployed to supplement household income [52]. Women enrolled in HPTN 064 were predominantly low-income and nearly half reported food insecurity,

making them particularly vulnerable economically. Partner incarceration has also been associated with other concurrent HIV risk factors that were common in our study population including multiple new sexual partnerships, condomless sex, non-monogamy, injection drug use, history of STIs and experience of violence [55, 56, 58, 59]. More longitudinal evidence is needed to further understand how incarceration drives economically motivated sexual relationships among women in the United States and how area-level factors contribute to these relationships [53].

We did not find an association between census-tract level characteristics and transactional sex. The lack of association between census-level exposures and transactional sex in our study may reflect the high prevalence of poverty and HIV in our study site and lack of variation across geographic areas. Our study includes only 22 census tracts. Additionally, women were recruited into the study who lived in census tracts with a high HIV prevalence and high poverty rate [28]. Geographic areas included in our study ranked above the 95th percentile on social vulnerability compared to other areas across the United States, reflecting the high rates socioeconomic disadvantage. Given the high levels of poverty and housing instability within these areas, it is probable that we were not able to identify an association between census-level markers of deprivation and transactional sex even if one exists because we do not have enough census tracts with lower levels of deprivation for comparison. Past researchers have cited the challenges of studying area-level determinants among disadvantaged populations [9, 60, 61].

Our study has several other limitations. HPTN 064 was designed to identify women at greatest risk of HIV acquisition in the US. Study eligibility criteria included characteristics commonly associated with transactional sex such as self-reporting at least one personal or sex partner behavior related to HIV acquisition. Therefore, prevalence of transactional sex in our population was extremely high (33%), which may limit generalizability of findings. In addition, we rely on self-reported information about sexual-behavior but use ACASI which has been shown to minimize social desirability bias [62]. Lastly, there was some loss to follow up in our study with visit completion rates of 93% and 94% at 6 and 12 months, respectively [63]. Unstable housing and later date of enrollment were associated with increased likelihood of missed study visits in a prior analysis [63].

In summary, prevalence of transactional sex was extremely high (33%) in our population which was at high risk for HIV. Food insecurity, housing instability, substance abuse and partner incarceration were all associated with increased prevalence of transactional sex. Transactional sex was associated with other HIV risk characteristics including experience of abuse, and participant and partner non-monogamy. Policies and interventions that provide economic opportunities for women by implementing economic

strengthening, increasing education, and increasing income generation may work in combination with HIV prevention programs to reduce transactional sex and decrease HIV risk. However, more research is needed in the United States to determine whether economic strengthening could reduce transactional sex overall, particularly among women with incarcerated partners.

Funding Research reported in this publication was supported by the National Institute of Allergy and Infectious Diseases of the National Institutes of Health under Award Number UM1AI068619. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Appendix

See Tables 6, 7, 8, 9, and 10.

Table 6 Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for the association between each individual and census-level characteristic and transactional sex, excluding commercial sex workers

	Crude PR (95% CI)	Adjusted PR (95% CI) ^a
Individual level		
Food insecurity	2.10 (1.64, 2.68)	1.99 (1.57, 2.53)
Unemployed	1.20 (0.97, 1.46)	1.09 (0.85, 1.39)
Housing instability	1.54 (1.15, 2.08)	1.33 (1.03, 1.72)
Substance abuse	2.11 (1.75, 2.55)	1.85 (1.54, 2.22)
Partner in prison	1.13 (0.93, 1.37)	1.23 (0.99, 1.54)
Census level^b		
Economic factor	1.02 (0.87, 1.18)	1.01 (0.90, 1.13)
Housing factor	1.02 (0.84, 1.25)	1.01 (0.84, 1.21)

^aAge, level of education, housing insecurity, food security and substance abuse

^bICC for transactional sex = 5.10%

Table 7 Sensitivity analysis for Table 3 using a random effects model, excluding commercial sex workers

	Crude OR (95% CI)	Adjusted OR (95% CI) ^a	OR (95% CI) adjusted for other factor
Census level^b			
Economic factor	0.97 (0.73, 1.29)	1.00 (0.74, 1.35)	1.00 (0.74, 1.35)
Housing factor	0.94 (0.72, 1.22)	0.97 (0.73, 1.29)	0.97 (0.73, 1.29)

^aAge, level of education, housing insecurity, food security and substance abuse

^bICC for transactional sex = 5.10%

Table 8 Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for the association between each individual characteristic with transactional sex at the next time point

	Crude PR (95% CI)	Adjusted PR (95% CI) ^a
Individual level		
Food insecurity	1.73 (1.26, 2.39)	1.58 (1.14, 2.19)
Unemployed	1.47 (1.08, 2.00)	1.31 (0.97, 1.77)
Housing instability	1.72 (1.19, 2.50)	1.51 (1.07, 2.23)
Substance abuse	2.14 (1.60, 2.86)	1.78 (1.27, 2.49)
Partner in prison	1.23 (0.89, 1.44)	1.21 (0.93, 1.57)

^aAge, level of education, housing insecurity, food security and substance abuse

Table 9 Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for the association between transactional sex and other sexual behaviors, excluding commercial sex workers

Outcome	Crude PR (95% CI)	Adjusted PR (95% CI) ^a
Any self-reported STI	1.06 (0.86, 1.32)	1.11 (0.97, 1.38)
Concurrent (self)	2.30 (1.92, 2.75)	2.23 (1.84, 2.70)
Concurrent (partner)	1.79 (1.49, 2.15)	1.84 (1.52, 2.22)
Sexual or physical abuse	1.92 (1.62, 2.28)	1.89 (1.58, 2.25)
Unprotected sex	0.98 (0.94, 1.03)	0.96 (0.91, 1.02)

^aAdjusted for age, housing insecurity, level of education, income level and substance abuse

Table 10 Factor loadings for each variable from final principle components analysis

Variable	Factor 1	Factor 2
Percent with less than high school degree among those 25 years and over	65*	56*
Unemployment rate	80*	-32
Percent of persons in poverty	90*	22
Percent residents that moved within past year	-20	88*
Percent of households renter occupied	36	77*
Percent vacant housing units	15	85*
Percent households on food stamps/government benefits	96*	11
Percent lacking kitchen facilities	62*	18

Values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.35 are flagged by an **

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