AIDS Behav (2014) 18:2457–2468
DOI 10.1007/s10461-014-0777-0

ORIGINAL PAPER

Prevalence and Predictors of Concurrent Sexual Partnerships in a Predominantly African American Population in Jackson, Mississippi

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Published online: 7 May 2014

Abstract Concurrent sexual partnerships, or sexual partnerships that overlap in time, have been associated with HIV and sexually transmitted infections (STI). How best to measure concurrency and the personal characteristics and predictors of concurrency are not yet well understood. We compared two frequently used concurrency definitions, including a self-reported measure based on participant response regarding overlapping sex with partners, and the UNAIDS measure based on overlapping dates of last sex and intention to have sex again. We performed multivariable logistic regression analyses to identify socio-demographic, behavioral, and structural predictors of concurrency among 1,542 patients at an urban STI clinic in Jackson, Mississippi. Nearly half (44 %) reported concurrency based on self-reported sex with other partners, and 26 % reported concurrency according to the UNAIDS concurrency measure. Using the self-reported concurrency measure, the strongest predictors of concurrency were perceived partner concurrency, drug use at last sex, having more than 10 lifetime partners, and being recently incarcerated. Strongest predictors of concurrency using the UNAIDS measure were lifetime number of partners and perceived partner concurrency. Concurrency is highly prevalent in this population in the Deep South and social, structural and behavioral factors were important predictors of concurrency for both measures. Future research should use time anchored data collection methods and biomarkers to assess whether both definitions of concurrency are associated with HIV outcomes.

Keywords HIV · African Americans · Epidemiology · Risk factors · Mississippi

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Introduction

The human immunodeficiency virus (HIV) infection rate among African Americans is eight times that of Whites [1]. While African Americans represent 13 % of the US population, they represent 44 % of new HIV infections [1]. Behavioral risk factors, including condom use, number of lifetime sexual partners, and substance use do not fully account for these racial disparities [2–4].

In 2010, over 50 % of new HIV infections in the US occurred in the South. Seven of the ten states with the highest prevalence rates are in the South [5]. Mississippi ranks ninth in the nation in new HIV case rates, with an

estimated rate of 19.1/100,000 [5, 6]. Jackson, Mississippi has the third highest rate of people living with an AIDS diagnosis of any US metropolitan area [7]. Mississippi has wide racial disparities in HIV infection; African Americans represent 37 % of the state's population, but comprised 76 % of new AIDS cases in 2011 [8].

Factors other than HIV risk behaviors, such as sexual networks, or groups of people linked directly or indirectly through sexual contact, may contribute to African Americans' HIV risks [2, 9–11]. Concurrent sexual partnerships, or partnerships that overlap in time, are a type of sexual network characteristic that has been posited to raise HIV transmission risks more than having the same number of consecutive, monogamous partnerships [2, 11–14]. Analyses from the National Survey of Family Growth found African American men had 2.56 times the odds of engaging in concurrency than White men [9], and African American women had 1.78 times the odds of engaging in concurrency than White women [15]. However, the role of concurrency in potentiating the spread of HIV is controversial and not yet fully understood [13].

Debates about how best to measure concurrency are ongoing [16–18]. One commonly used measure of concurrency is self-reported overlapping sexual relationships with more than one partner within the past year. This measure allows for easier reporting and may include more complete information, but the data may be subject to recall bias. A second frequently employed measure developed by UNAIDS requires overlapping dates of sex within the past year and intention to have sex with these partners again. This calculated measure aims to provide a more precise measure of concurrency, but can also be subject to even greater recall bias and has been shown to underestimate concurrency [16, 19].

Regardless of the definition used, concurrency has been associated with specific socio-demographic, behavioral and structural factors. For the purpose of this study, we define socio-demographic factors as the background characteristics of an individual, behavioral factors as "individual behaviors related to sexual networks and substance abuse that influence HIV risk," and structural factors as "physical, environmental, or economic factors" that influence HIV risk [20]. Concurrency has been associated with socio-demographic factors such as low income [10, 11, 21–23], single marital status [9, 10], and co-parenting (defined as having a child together) [21, 22, 24]; behavioral factors such as drug use [9, 10, 25], and heavy drinking [9, 10]; as well as structural factors such as incarceration [9, 10, 26–28], and a low "sex ratio" (defined as the ratio of eligible African American men to African American women in a community) [2].

Few studies have examined prevalence and correlates of concurrent sexual partnerships in African Americans at high-risk for contracting HIV, particularly in the South. The purpose of this investigation was to compare two commonly used measures of concurrency to assess prevalence and correlates of concurrent sexual partnerships among male and female patients at an urban sexually transmitted infection (STI) clinic in Jackson, MS, USA.

Methods

Individuals ($N = 1{,}542$) who presented for care at Crossroads Clinic, a publicly funded STI clinic in Jackson, MS, were enrolled between January and June 2011. Eligibility criteria included: (1) being at least 18 years of age, (2) presenting for STI or HIV screening, (3) willing to complete a 30-min computerized survey, and (4) speaking English. All patients presenting at Crossroads Clinic during the study period were offered an opportunity to participate by clinic staff; 93 % of individuals invited to participate then completed the survey. Data were collected on a desktop computer with a self-administered survey programmed using *Illume*™ software (*Datstat*, Washington). Participants did not receive compensation for their participation. The survey included questions about socio-demographic, behavioral, and structural factors. All participants provided informed consent and this study was approved by the University of Mississippi Medical Center, the Mississippi State Department of Health, and the Miriam Hospital institutional review boards.

Of the 1,542 participants, 141 (9.1 %) who reported concurrent partners did not report detailed information on each sexual partnership and 94 (6.1 %) provided insufficient information to establish whether partnerships overlapped. Consequently, analyses using self-reported concurrency were based on $N = 1{,}401$ participants, and analyses using the UNAIDS consensus measure were based on $N = 1{,}307$ participants.

Measures

Independent Variables: Socio-demographic, Behavioral and Structural Factors

Socio-demographic characteristics included gender, ethnicity, age, self-identified sexual orientation (heterosexual; homosexual; and bisexual) never having been married, level of education, monthly income, and monthly religious service attendance. Behavioral characteristics included variables related to sexual behaviors and substance use. Sexual network characteristics included lifetime number of partners, gender for the three most recent sexual partners, and lifetime report of sex with intravenous drug users, men

who have sex with men, or HIV-positive individuals. Additionally, individuals were asked about having ever had sex in exchange for money, drugs or alcohol. The primary measure for alcohol use was frequency of heavy episodic drinking and the measure for drug use included lifetime use of marijuana, cocaine or crack, and other drugs. Participants were asked about alcohol and drug use at last sex, defined by reported use of alcohol or drugs at last sex with at least one partner. Participants were also asked event level questions about whether their three most recent partners had used alcohol or drugs during their last sexual encounter. Structural factors included personal and partner's incarceration history, and beliefs about whether or not there were enough suitable partners in their communities.

Dependent Variables of Interest: Measures of Concurrency

We defined concurrent partnerships using two methods: the first included a self-reported measure in which participants were provided the following instructions: "please list your three most recent sexual partners in the past six months. Sex in this context is defined as vaginal, anal or oral intercourse. There will be a set of questions for each partner. So you can keep track, please enter each person's initials below." We then asked the following question with a binary (yes/no) response scale: "during the time period you were having sex with PARTNER INITIALS, did you also have other sexual partners?" For the self-reported measure, participants were coded as concurrent if they responded "yes" to this question for any of their partners. The second measure utilized the UNAIDS consensus measure, which uses overlapping partnership dates within the last year and intentions to have sex again with each partner [17]. For each partner, participants were asked "When was the first time you had sex with PARTNER INITIALS?", and reported in three separate items the month, day, and year that they first had sex with their partner. Likewise for each partner, participants were asked "When was the last time you had sex with PARTNER INITIALS?", and reported in three separate items the month, day, and year that they last had sex with their partner. A dummy variable was created that was coded "1" if the date of first sex for a partner overlapped with the date of last sex with another partner, and "0" if there was no overlap. Intentions were measured with a single question with a binary (yes/no) response scale: do you think that you will have sex with PARTNER INITIALS again? For the UNAIDS measure, participants were coded as concurrent if they had overlapping dates of sex between any two partners, and reported that they intended to have sex with their prior partner again. Only data from the past year were included; therefore participants were only considered concurrent if there were overlapping dates of sex during that time period. Finally, we asked participants about perceived partner concurrency, including the question "Do you think PARTNER INITIALS had other sexual partners during the time period he or she was having sex with you?" as well as the number of concurrent partners within the last year. We also asked participants "Do you believe there are enough suitable partners in your community?"

Analyses

The two measures of concurrency were compared by calculating the sensitivity and specificity of the self-reported measure of concurrency for estimating the UNAIDS measure. In the absence of a standardized measure for concurrency, in this analysis, to compare the two definitions, we chose to compare the self-reported measure to the UNAIDS measure, since it has been endorsed by UNAIDS consensus. We calculated sensitivity (the proportion of those concurrent by the UNAIDS definition who were also concurrent according to the self-reported measure) and specificity (the proportion of those not concurrent by the UNAIDS definition who were also not concurrent according to the self-reported definition). Sensitivity estimates the probability that participants are concurrent under both definitions, and specificity estimates the probability that participants are not concurrent under both definitions.

Bivariate associations with concurrency were examined using chi square tests. Since concordance between behavior and self-reported sexual orientation was very high, we present data by sexual orientation. Variables associated with concurrency at $p < 0.10$ were included in multiple logistic regression models predicting concurrency for both definitions. Because lifetime number of partners can be strongly associated with concurrency and may confound the association of other factors with concurrency, lifetime number of partners was also included as a categorical variable with three categories (1–5, 6–10, 11 or more) in the multiple logistic regression models. Gender interactions for all of the correlates were tested in single multiple logistic regression models for each of the definitions; however the final multiple logistic regression models excluded interactions with p values >0.10.

Results

Table 1 demonstrates that nearly half of the data analytic sample (43.6 % $N = 611$; 51.5 % of men and 38.9 % of women, $\chi^2(1) = 21.13$, $p = 0.0001$) reported having a concurrent partner during the last 6 months based on self-reported sex with other partners, and only (25.7 %

Table 1 Number of concurrent partnerships for the full data analytic sample ($N = 1,401$)

Variable	Data analytic sample *N* (%)
Number of overlapping concurrent partnerships in the past year[a]	
None	772 (55.2)
One	226 (16.1)
Two	208 (14.8)
Three	195 (13.9)
Self-reported concurrency measure	
Total	611 (43.6)
Men	269 (51.5)
Women	341 (38.9)
UNAIDS concurrency measure	
Total	336 (25.7)
Men	132 (27.2)
Women	202 (24.7)
Agreement between concurrency measures[b]	
Concurrent on both measures	261 (20.1)
Concurrent on self-reported concurrency only	309 (23.7)
Concurrent on UNAIDS concurrency only	75 (5.8)
Not concurrent on either definition	657 (50.5)

Self-reported concurrency was defined by self-report of having sex with one partner during the time the participant was having sex with another partner during the last year. UNAIDS-defined concurrency required overlapping partnership dates during the last year and intentions to have sex again with that partner

[a] Based on self-reported sex with another partner

[b] Based on $N = 1,302$ with data on both concurrency measures

$N = 336$; 27.2 % of men and 24.7 % of women, $\chi^2(1) = 0.98$, $p = 0.321$) reported having a concurrent partner according to the UNAIDS measure. Table 1 also shows a cross tabulation of the two measures. Agreement between the two measures was relatively low, with only 20.1 % of the total sample concurrent according to both measures (Cohen's kappa = 0.37; kappa = 0.34 and 0.39 for men and women, respectively), and 50.5 % were not concurrent on either measure. When the two definitions were discordant, 23.7 % were concurrent only on the self-reported measure, and 5.8 % were concurrent only on the UNAIDS measure. Overall, 72.8 % of individuals were concordant. Sensitivity for the self-reported measure compared to the UNAIDS measure was 0.78 (95 % CI 0.73, 0.82), and specificity was 0.68 (95 % CI 0.65, 0.71), suggesting that, when the two definitions were discordant, it was more likely that participants were concurrent based on self-report but not concurrent based on the UNAIDS measure. Participants with missing data on the UNAIDS measure ($N = 100$) were compared to participants with data on both concurrency measures on the socio-demographic, behavioral and structural factors. Results indicated that those missing data on the UNAIDS variable did not differ on any of the correlates, with the exception of education and perceived partner concurrency: participants were more likely to have a college degree (OR = 2.42; 95 % CI 1.36, 4.33; $p = 0.003$) and were less likely to have perceived partner concurrency (OR = 0.51; 95 % CI 0.30, 0.85; $p = 0.007$).

Descriptive characteristics for the analytic sample ($N = 1,401$) are presented in Table 2. The population was largely African American ($N = 1,353$; 95.6 %), and the majority were women (62.6 %). Participants ranged in age from 18 to 61 years, with 61.4 % under the age of 25, and 10.9 % of the population self-identified as homosexual or bisexual. Further, 8.9 % reported heavy episodic drinking at least once a month, 5.6 % had ever used crack and/or cocaine, and 30.3 % reported using alcohol or drugs at last sex. Nearly one-fifth (19.0 %) of participants had a history of incarceration, including 11.7 % of women and 31.3 % of men. Over half of the participants (55.5 %) attended religious services at least monthly; 65.2 % of those individuals were Baptist (data not shown).

Bivariate Analyses

Concurrency

Bivariate results for both measures of concurrency are reported in Table 3. We found that men were significantly more likely to be concurrent on the self-reported measure (men: 51.5 %, women: 38.9 %) but not on the UNAIDS measure (men: 27.2 %, women: 24.7 %). Compared to heterosexual participants, bisexual participants were more likely to be concurrent based on the self-reported measure (bisexual participants: 60.8 %, heterosexual participants: 42.9 %), but there were no significant differences by sexual orientation in concurrency rates for the UNAIDS measure.

A sub analysis exploring gender differences by self-reported sexual orientation indicated that women who self-identified as bisexual had the highest rates of concurrency for both the self-reported measure (66.7 %) and the UNAIDS measure (41.4 %), compared to heterosexual women (self-report: 36.8 %, UNAIDS: 23.6 %) or homosexual women (self-report: 40.0 %, UNAIDS: 17.9 %). The odds ratio for concurrency for bisexual women compared to heterosexual women was 3.44 (95 % CI 1.97, 6.00; $p = 0.0001$) on the self-reported measure and 2.29 (95 % CI 1.32, 3.96; $p = 0.003$) on the UNAIDS measure. There was no significant difference in the likelihood of concurrency for homosexual women compared to heterosexual women on either measure. In contrast, heterosexual men had the highest rate of concurrency for the

Table 2 Participant characteristics ($N = 1,401$)

Variable	Data analytic sample *N* (%)
Socio-demographic characteristics	
Male	528 (37.4)
African American	1,353 (95.6)
Less than 25 years old	845 (61.4)
Self-reported sexual orientation	
Heterosexual	1,258 (89.2)
Homosexual	74 (5.2)
Bisexual	81 (5.7)
Marital status	
Never married	1,235 (87.3)
Married, common-law partner, divorced, or other	179 (12.3)
Education	
High school or less	586 (41.4)
Some college	633 (44.8)
College degree or higher	195 (13.8)
Monthly income	
<$500	441 (31.5)
$501–$1,500	518 (37.0)
$1,501–$3,000	264 (18.9)
>$3,000	177 (12.6)
Attends religious services at least once a month	759 (55.5)
Behavioral characteristics: sexual networks	
Lifetime number of partners	
1–5	460 (32.7)
6–10	379 (27.0)
>10	566 (40.3)
Ever received gifts, favors, food, shelter, transportation, money, drugs or alcohol for sex	83 (5.9)
Reported sex with a high-risk partner[a]	93 (6.6)
Believes partner has other partners	744 (53.2)
Behavioral characteristics: substance use	
Frequency of heavy episodic drinking	
Never	1,012 (71.6)
Less than once a month	224 (15.8)
At least once a month	126 (8.9)
Weekly or more	52 (3.7)
Lifetime use of cocaine and/or crack	79 (5.6)
Lifetime use of other drugs	153 (10.8)
Participant alcohol or drug use at last sex	424 (30.3)
Partner alcohol or drug use at last sex	462 (32.7)
Structural characteristics	
Ever incarcerated	
Total	262 (19.0)
Men	160 (31.3)
Women	101 (11.7)
Any partner incarcerated in the past 6 months	90 (6.6)
Believes there are enough suitable partners[b]	
Total	302 (22.0)
Men	138 (27.2)
Women	162 (18.8)

[a] Sex with a high-risk partner included sex with intravenous drug users, MSM, or HIV-positive individuals

[b] Participants were asked whether they believed that there were enough suitable partners in their community

self-reported measure (53.5 %) and UNAIDS measure (29.0 %), compared to bisexual men (self-report: 38.9 %, UNAIDS: 6.3 %) or homosexual men (self-report: 37.2 %, UNAIDS: 17.5 %). Compared to heterosexual men, the odds of concurrency were lower for homosexual men on the self-reported measure (OR = 0.52; 95 % CI 0.27, 0.98; $p = 0.044$), but bisexual men did not significantly differ from heterosexual men on the likelihood of concurrency. There were no significant differences by sexual orientation in the likelihood of concurrency for the UNAIDS measure.

Socio-demographic correlates of concurrency differed across measures. The self-reported measure of concurrency demonstrated an increased odds of concurrency among males, bisexual men and women, and among individuals who completed some college but did not graduate or who had monthly income above $1,500. For the UNAIDS measure, completion of some college decreased the odds of concurrency, while it increased the odds of concurrency with the self-reported measure. Participants who attended church services at least once a month had high rates of concurrency (self-report: 43.3 %, UNAIDS: 24.5 %) as did those who attended church services less frequently (self-report: 43.8 %, UNAIDS: 26.2 %).

Several behavioral correlates were associated with concurrency. With respect to sexual network characteristics, both measures found that compared to those with 1-5 lifetime partners, having six or more lifetime sex partners and having had sex in exchange for things like money, drugs or alcohol increased the odds of concurrency. In addition, among individuals who did not know if their partners were high-risk experienced increased odds of concurrency compared to those who had not had sex with a high risk partner. Finally, we found that concurrency rates were higher for participants who believed their partner had other concurrent partners, hereafter referred to as "perceived partner concurrency," compared to those with no perceived partner concurrency. With respect to substance use, frequent heavy episodic drinking, lifetime use of

Table 3 Bivariate correlates of self-reported concurrency and UNAIDS definitions of concurrency

Variable	Self-reported concurrency		UNAIDS concurrency	
	% Concurrent	OR (95 % CI)	% Concurrent	OR (95 % CI)
Socio-demographic characteristics				
Male	51.5	**1.67 (1.34, 2.08)*****	27.2	1.14 (0.88, 1.47)
Less than 25 years old	43.1	0.96 (0.77, 1.19)	25.7	1.04 (0.80, 1.34)
Self-reported sexual orientation				
Heterosexual	42.9	REF	25.6	REF
Homosexual	37.8	0.81 (0.50, 1.31)	17.6	0.62 (0.33, 1.17)
Bisexual	60.8	**2.06 (1.29, 3.28)****	34.7	1.54 (0.94, 2.52)[§]
Never married	44.1	1.15 (0.84, 1.59)	26.4	1.30 (0.88, 1.93)
Education				
High school or less	39.5	REF	28.9	REF
Some college	46.7	**1.34 (1.07, 1.69)***	23.4	**0.75 (0.58, 0.98)***
College degree or higher	45.9	1.30 (0.94, 1.81)	23.3	0.74 (0.50, 1.11)
Monthly income				
<$500	38.4	REF	23.9	REF
$501–$1,500	44.4	1.28 (0.99, 1.65)[§]	28.0	1.23 (0.91, 1.67)
$1,501–$3,000	47.1	**1.43 (1.05, 1.95)***	27.1	1.18 (0.83, 1.70)
>$3,000	50.6	**1.64 (1.15, 2.33)****	22.8	0.94 (0.61, 1.45)
Attends religious services at least once a month	43.3	0.98 (0.79, 1.21)	24.5	0.90 (0.70, 1.15)
Behavioral characteristics: sexual networks				
Lifetime number of sex partners				
1–5	22.7	REF	15.2	REF
6–10	39.5	**2.23 (1.65, 3.01)*****	26.8	**2.04 (1.43, 2.91)*****
>10	63.8	**6.00 (4.54, 7.93)*****	33.6	**2.81 (2.04, 3.88)*****
Ever received gifts, favors, food, shelter, transportation, money drugs or alcohol for sex	71.7	**3.56 (2.23, 5.68)*****	42.9	**2.35 (1.51, 3.65)*****
Reported sex with a high risk partner[a]				
No	35.0	REF	17.1	REF
Don't know	55.9	**1.78 (1.34, 2.37)*****	25.1	0.93 (0.67, 1.30)
Yes	41.1	0.76 (0.47, 1.22)	25.6	0.57 (0.03, 1.06)[§]
Believes partner has other partners				
No	15.6	REF	12.1	REF
Don't know	31.3	**2.47 (1.61, 3.78)*****	22.9	**2.15 (1.30, 3.55)****
Yes	59.0	**7.78 (5.19, 11.66)*****	31.1	**3.27 (2.03, 5.25)*****
Behavioral characteristics: substance use				
Frequency of heavy episodic drinking				
Never	40.1	REF	24.2	REF
Less than once a month	52.5	**1.65 (1.23, 2.21)*****	28.2	1.23 (0.87, 1.73)
At least once a month	47.6	1.36 (0.94, 1.97)	35.9	**1.75 (1.17, 2.63)****
Weekly or more	65.4	**2.83 (1.57, 5.07)*****	20.4	0.80 (0.39, 1.63)
Lifetime use of cocaine and/or crack	54.6	**1.59 (1.00, 2.53)***	26.3	1.03 (0.61, 1.75)
Lifetime use of other drugs	60.2	**2.23 (1.67, 2.98)*****	41.3	**2.04 (1.50, 2.78)*****
Participant alcohol use at last sex	64.1	**2.99 (2.32, 3.87)*****	35.6	**1.87 (1.42, 2.47)*****
Participant drug use at last sex	70.6	**3.71 (2.68, 5.13)*****	38.2	**1.88 (1.36, 2.60)*****
Partner alcohol use at last sex	61.5	**2.69 (2.11, 3.44)*****	34.6	**1.82, (1.39, 2.38)*****
Partner drug use at last sex	67.8	**3.36 (2.50, 4.50)*****	35.2	**1.75 (1.29, 2.37)*****

Table 3 continued

Variable	Self-reported concurrency		UNAIDS concurrency	
	% Concurrent	OR (95 % CI)	% Concurrent	OR (95 % CI)
Structural characteristics				
Ever incarcerated				
No	41.1	REF	24.9	REF
Yes	53.8	**1.67 (1.28, 2.19)*****	28.3	1.19 (0.87, 1.63)
Any partner incarcerated in the past 6 months	58.9	**1.95 (1.26, 3.00)****	34.6	**1.60 (1.00, 2.58)***
Believes there are enough suitable partners[b]	46.8	1.19 (0.92, 1.54)	24.9	0.96 (0.71, 1.31)

Bold values are statistically significant

[§] $p < 0.10$;* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Sex with a high-risk partner included sex with intravenous drug users, MSM, or HIV-positive individuals

[b] Participants were asked whether they believed that there were enough suitable partners in their community

drugs, and use of alcohol and drugs at last sex by either the participant or partner were associated with an increased odds of concurrency for both measures.

Regarding structural correlates, partner incarceration in the past 6 months was associated with increased odds of concurrency for both measures, and history of incarceration was associated with an increased odds of concurrency with the self-reported measure only.

The sub analysis examining gender differences in beliefs that there are enough suitable partners indicated that, for the self-reported measure, concurrency rates were 38.3 % for women who believed there were enough suitable partners compared to 39.1 % for women who did not (OR = 0.97; 95 % CI 0.68, 1.37; $p = 0.844$). UNAIDS measure concurrency rates were 21.7 % for women who believed there were enough suitable partners compared to 25.0 % for women who did not (OR = 0.83; 95 % CI 0.54, 1.27; $p = 0.395$). For men, self-reported concurrency rates were 56.9 % for men who believed there were enough suitable partners compared to 25.0 % for men who did not (OR = 1.37; 95 % CI 0.92, 2.03; $p = 0.122$). UNAIDS measure concurrency rates were 27.5 % for men who believed there were enough suitable partners compared to 26.8 % for men who did not (OR = 1.04; 95 % CI 0.66, 1.63; $p = 0.871$).

Multivariable Analyses

Results for the multiple logistic regression model are shown in Table 4. The omnibus Chi square for the test of significance of the multivariate model was significant for both concurrency measures [$\chi^2(33) = 415.47$, $p < 0.0001$ for self-reported concurrency and $\chi^2(24) = 113.06$, $p < 0.0001$ for the UNAIDS measure]. Several socio-demographic, behavioral and structural variables demonstrated statistically significant effects with concurrency.

With respect to socio-demographic characteristics, being male, bisexual, having at least some college education and having a monthly income of >$1,500 were significantly associated with an increased likelihood of self-reported concurrency. Having some college education was the only variable associated with a lower likelihood of being concurrent based on the UNAIDS measure.

Several behavioral characteristics were associated with concurrency. Having a greater number of lifetime partners and perceived or unknown partner concurrency remained significantly associated with an increased likelihood of concurrency for both measures. Having sex with a high-risk partner was associated with a decreased likelihood of self-reported concurrency. Substance use, including lifetime use of cocaine and/or crack was associated with a lower likelihood of concurrency using the self-reported measure of concurrency, whereas weekly heavy episodic drinking was the only substance use variable associated with a decreased likelihood of concurrency when using the UNAIDS measure. Using alcohol or drugs at last sex was significantly associated with an increased likelihod of concurrency with the self-reported measure. Significant gender interactions were found for using drugs at last sex [$\chi^2(1) = 8.47$, $p = 0.004$] and partner use of drugs at last sex [$\chi^2(1) = 6.84$, $p = 0.009$] for self-reported concurrency only. The gender interaction for partner use of alcohol at last sex approached statistical significance for self-reported concurrency [$\chi^2(1) = 3.80$, $p = 0.051$]. Drug use at last sex was associated with an almost three-fold increase in the probability of self-reported concurrency for women compared to men. Partner use of alcohol at last sex was not significant for either gender, but the association was positive for women and negative for men. Partner use of drugs at last sex was associated with a significantly greater probability of concurrency for men (OR = 3.35; 95 % CI 1.36, 8.24; $p = 0.009$) but not women (OR = 0.91; 95 % CI 0.53, 1.58; $p = 0.737$). These interactions were not significant for the UNAIDS measure.

Table 4 Multivariable logistic regression results

Variable	Self-reported concurrency		UNAIDS concurrency	
	OR (95 % CI)	*p*	OR (95 % CI)	*p*
Socio-demographic characteristics				
Male	**1.93 (1.33, 2.81)**	**0.001**	1.13 (0.80, 1.59)	0.475
Self-reported sexual orientation				
Heterosexual	REF		REF	
Homosexual	1.04 (0.51, 2.12)	0.917	0.84 (0.39, 1.84)	0.67
Bisexual	**2.18 (1.18, 4.01)**	**0.012**	1.24 (0.70, 2.21)	0.461
Education				
High school or less	REF		REF	
Some college	**1.45 (1.09, 1.94)**	**0.012**	**0.75 (0.56, 1.00)**	**0.05**
College degree or higher	1.32 (0.87, 2.00)	0.198	0.67 (0.43, 1.03)	0.07
Monthly income				
<$500	REF			
$501–$1,500	1.22 (0.89, 1.68)	0.215		
$1,501–$3,000	**1.58 (1.08, 2.32)**	**0.019**		
>$3,000	**1.63 (1.05, 2.52)**	**0.029**		
Behavioral characteristics: sexual networks				
Lifetime number of sex partners				
1–5	REF		REF	
6–10	**1.68 (1.19, 2.37)**	**0.003**	**1.74 (1.18, 2.56)**	**0.005**
>10	**3.83 (2.70, 5.43)**	**0.0001**	**1.85 (1.25, 2.74)**	**0.002**
Ever received gifts, favors, food, shelter, transportation, money drugs or alcohol for sex	1.51 (0.84, 2.71)	0.168	1.56 (0.94, 2.59)	0.086
Reported sex with a high-risk partner[a]				
No	REF		REF	
Don't know	0.89 (0.59, 1.34)	0.585	0.89 (0.59, 1.35)	0.591
Yes	**0.11 (0.02, 3.77)**	**0.005**	0.43 (0.11, 1.64)	0.22
Gender * sex with high-risk partner		0.098		0.075
Men				
No	REF		REF	
Don't know	2.08 (0.91, 4.77)		0.27 (0.11, 0.66)	
Yes	0.60 (0.16, 2.29)		0.60 (0.12, 2.62)	
Women				
No	REF		REF	
Don't know	0.92 (0.61, 1.38)		0.90 (0.58, 1.38)	
Yes	0.12 (0.03, 0.58)		0.42 (0.11, 1.61)	
Believes partner has other partners				
No	REF		REF	
Don't know	**1.88 (1.15, 3.07)**	**0.012**	**1.91 (1.12, 3.23)**	**0.017**
Yes	**6.30 (3.91, 10.13)**	**0.0001**	**2.59 (1.55, 4.33)**	**0.0003**
Behavioral characteristics: substance use				
Frequency of heavy episodic drinking				
Never	REF		REF	
Less than once a month	1.01 (0.70, 1.46)	0.941	0.98 (0.67, 1.43)	0.915
At least once a month	0.74 (0.46, 1.19)	0.212	1.19 (0.75, 1.88)	0.455
Weekly or more	1.31 (0.63, 2.73)	0.47	**0.42 (0.19, 0.94)**	**0.035**
Lifetime use of cocaine and/or crack	**0.50 (0.27, 0.93**	**0.028**		

Table 4 continued

Variable	Self-reported concurrency		UNAIDS concurrency	
	OR (95 % CI)	*p*	OR (95 % CI)	*p*
Lifetime use of other drugs	1.09 (0.73, 1.63)	0.659	1.40 (0.98, 2.01)	0.067
Participant alcohol use at last sex	**1.88 (1.27, 2.79)**	**0.002**	1.36 (0.58, 1.51)	0.133
Participant drug use at last sex	**2.74 (1.39, 5.43)**	**0.004**	0.94 (0.58, 1.51)	0.799
Gender * drug use at last sex		**0.004**		
Men	0.66 (0.30, 1.46)			
Women	**2.96 (1.45, 6.01)**			
Partner alcohol use at last sex	1.28 (0.81, 1.92)	0.281	1.16 (0.79, 1.70)	0.453
Gender * partner alcohol use at last sex		0.051		
Men	0.55 (0.27, 1.10)			
Women	1.31 (0.84, 2.08)			
Partner drug use at last sex	0.88 (0.51, 1.51)	0.64	1.04 (0.66, 1.63)	0.87
Gender * partner drug use at last sex		**0.009**		
Men	**3.35 (1.36, 8.24)**			
Women	0.92 (0.53, 1.58)			
Structural characteristics				
Ever incarcerated	0.88 (0.55, 1.17)	0.211		
Any partner incarcerated in the past 6 months	**2.04 (1.16, 3.60)**	**0.013**	1.31 (0.79, 2.19)	0.298
Gender * past 6 month partner(s) incarcerated		0.053		
Men	0.45 (0.12, 1.70)			
Women	**2.02 (1.14, 3.57)**			

Bold values are statistically significant

This final model included all variables with p values <0.10 in the bivariate analyses and significant gender interactions only

[a] Sex with a high-risk partner included sex with intravenous drug users, MSM, or HIV-positive individuals

Finally, with respect to structural factors, the gender interaction for having an incarcerated partner in the past 6 months approached significance ($\chi^2(1) = 3.73$, $p = 0.053$), suggesting that the probability of self-reported concurrency was significantly greater for women who had an incarcerated partner (OR = 2.02; 95 % CI 1.14, 3.57; $p = 0.016$) than for men (OR = 0.45 95 % CI 0.12, 1.70; $p = 0.239$), but this interaction was not significant for the UNAIDS measure.

Discussion

Prevalence of Concurrency

Concurrent sexual partnerships were highly prevalent in this population; 51 % of the men and 39 % of the women self-reported concurrent partnerships, and approximately one-quarter of men and women were concurrent based on the UNAIDS measure. There was a fair amount of discordance between the two definitions in measuring concurrency with 27 % of participants being discordant on the two measures. When there was discordance, the participants were more likely to be concurrent based on self-report, but not concurrent based on the UNAIDS measure, suggesting that compared to self-report, the UNAIDS measure is more conservative.

The adjusted odds of engaging in concurrent partnerships were 1.93 times greater for men than women using the self-reported concurrency measure. This finding is consistent with results from the Family Life Survey, a nationally representative telephone-based survey, which also found that concurrency was more prevalent among men (11 %) than women (8 %) [9, 10]. High prevalence of concurrency in our sample suggests that concurrency is socially normalized in this population. While it is not surprising that patients presenting for care at an STI clinic might report higher rates of concurrency than the general population, these are among the highest rates of concurrency presented in scientific literature [8, 15, 16, 29, 30]. These sexual network phenomena may have important impacts on HIV risks in this population and suggest that both reducing concurrent partnerships and encouraging condom use for those engaged in concurrent partnerships are important for reducing HIV transmission in this population.

Gender, sexual orientation, number of lifetime sexual partners, perceived partner concurrency, and using drugs or

alcohol at last sex were among the strongest correlates of self-reported concurrency in this population. In bivariate analyses, bisexual women were two times more likely to be concurrent than heterosexual women for both measures of concurrency, whereas bisexual men were less likely than heterosexual men to be concurrent based on the self-report measure. These findings suggest the sexual networks of sexual minorities may be unique and that the social norms related to concurrency for sexual minorities may differ among men and women, particularly given that bisexual women and heterosexual men were most likely to engage in concurrent partnerships. These groups are often not the focus populations for many HIV prevention interventions, but the high rates of concurrency in this sample highlight the need for greater sexual health and HIV risk reduction efforts among these groups in Mississippi.

Although poverty has also been strongly correlated with concurrency in other US populations [11, 15], higher household income was correlated with greater likelihood of self-reported concurrency in this population. The relationship between income, sexual networks, and HIV risks in this population is complex and warrants further exploration in subsequent studies.

Several different behavioral characteristics were strongly associated with concurrency. For example, the strongest correlate of self-reported concurrency was perceived partner concurrency. Studies among similar populations in several settings found that perceived partner concurrency was an important factor predicting or influencing concurrency [10, 21, 22, 28, 31–35]. Our findings further underscore the role of social factors and relationship dynamics on individual HIV risks; social and structural factors may be paramount for understanding HIV transmission dynamics among African Americans in the Deep South. Interestingly, high rates of participation in religious services among this high risk population underscores the opportunity to partner with African American churches on HIV prevention interventions in the Deep South.

Other research has found that behavioral factors such as heavy episodic drinking [5, 10] and cocaine use [15, 21, 22, 28] are associated with concurrency. In this investigation, alcohol and drug use at last sex significantly increased the odds of self-reported concurrency by 1.88 and 2.74 respectively, underscoring the possible synergistic association between substance use during sex and concurrency. Indeed, the association between substance use during sex and self-reported concurrency was stronger than the association between self-reported concurrency and global (lifetime) indicators of substance use, with the exception of heavy episodic drinking, which decreased the likelihood of concurrency based on the UNAIDS measure. Although cocaine use has been associated with concurrency in men and women [15, 21, 22, 28], we are unable to conclude whether it played an important role in this population, given the change in direction of the effect from bivariate to multivariate analyses. Importantly, the effects of drug and alcohol use at last sex on self-reported concurrency varied widely by gender; participant use of drugs at last sex increased the odds of concurrency much more for women than men; whereas partner use of drugs at last sex increased the odds of concurrency much more for men than women. Other qualitative studies suggest that incarceration and substance abuse may impact concurrency differentially for men and women [21, 22]; gender differences in this study suggest that interventions to address concurrency may need to address complex gender dynamics related to sexual behaviors.

Previous research has found that structural factors such as incarceration [16, 26, 28, 32] and poverty [10, 23] are associated with concurrent partnerships. In our analysis, after taking into account other factors, self-reported history of incarceration was not associated with concurrency. However, having an incarcerated partner within the last 6 months was associated with nearly twice the odds of self-reported concurrency for women only. This underscores the importance of structural factors, such as partner incarceration, that interrupt sexual partnerships, in potentiating HIV risks, and highlights how incarceration affects men and women's sexual networks differently. This supports other research showing that high rates of incarceration among African American men have systematically removed men from the community, culminating in detrimental impacts on the sexual networks and health risks of African American women [10, 35, 36]. Further, the sex ratio, defined as the ratio of eligible African American male to female partners, has been posited as a contributor to racial disparities in HIV and STI infection [2, 35]. Although women in this sample were more likely to perceive a lack of available partners than men (43.2 vs 34.4 %, respectively), this was not a significant predictor of concurrency in men or women in this population. This structural phenomenon warrants further exploration in subsequent studies.

After adjusting for key variables of interest, sociodemographic, behavioral, and structural factors were all associated with concurrency in this population using the self-reported concurrency measure, whereas fewer variables were associated with the UNAIDS concurrency measure. These differences may be related to the fact that the two measures differed both in terms of their definition of concurrency and in the methodology used to assess concurrency. Methodological differences may be attributed to participants having greater difficulty recalling exact dates of sex in on a computer-based, self-administered survey that did not include verbal prompts and anchor dates

to assist recall in an interview. For example, fewer than 1 % of participants provided no dates for first and last sex for partner 1, compared to 3.4 % for partner 2 and 6.1 % for partner 3. Missing data patterns for participants who did provide at least some date information indicated that participants were less likely to be able to provide exact days for dates of first or last sex. Of those providing any date information, 8.8, 6.6, and 5.3 % were missing days for partners 1, 2 and 3, respectively, compared to 2 % or less missing months or years of first or last sex for each partner. In addition, 5.7 % of participants provided illogical dates (for example, date of last sex preceded date of first sex, or reported dates of first and/or last sex that were later than the date the survey was completed). This suggests there may be challenges with recalling precise dates of sex, particularly on a self-administered survey, which could lead to misclassification of true concurrency for a large number of participants using the UNAIDS measure. Similar challenges have been reported in other studies employing measures of concurrency using data based on self-report versus overlapping dates [16, 19].

Interestingly, a comparison of participants with insufficient data to determine concurrency on the UNAIDS measure to those who provided enough data to determine concurrency based on both measures, indicated that those who did not provide enough data differed very little on the socio-demographic, behavioral and structural factors examined in this study. Therefore, despite the greater potential for missing data when using the UNAIDS measure, both produced samples that did not differ substantially on most factors believed to be related to concurrency. As a result, observed differences in this study cannot be attributed solely to differences in the samples produced by each of the measures.

The study has several strengths. This is one of the largest studies exploring prevalence of concurrency among a high-risk population in the Deep South. Taken together, our findings suggest that dense sexual networks and their contributions to HIV risk behaviors and among African Americans in the Deep South may be distinct from those of the US more broadly [35], and in other populations engaged in concurrency in the Northeast, where concurrency may be more strongly correlated with drug use and incarceration [27, 28]. Additionally, substance abuse during sex and incarceration seemed to impact women's self-reported concurrency risks more than men's. Moreover, event-level use of alcohol and drugs seems more important than global substance use trends in this population. Additional analyses exploring partner-related substance use might also provide more insight about its role in contributing to HIV risk among this population.

In sum, concurrency was highly prevalent based on both measures. However, the wide differences observed in our results between the two definitions of concurrency, as well as challenges associated with recalling precise dates of overlapping sex, suggest that studies examining concurrency that seek precise dates for overlap of sex might be best conducted with an interviewer and timeline approach rather than a self-administered survey. Other concurrency analyses in Sub-Saharan Africa and the US faced similar challenges [16, 19, 37]. However, in the absence of biomarkers to verify which definition better predicts HIV and other STI outcomes, it is difficult to endorse one definition over the other. Subsequent research should use biomarkers to examine correlations between HIV infection and concurrency.

Our research is subject to several limitations. The investigation was cross-sectional and causation cannot be inferred from associations. This research was conducted at an urban STI clinic among a particularly high-risk population, so the results may not be generalizable to all populations. Also, because the majority of our study sample was African American, we were unable to compare prevalence and correlates of concurrency across races. In addition, statistical power for testing gender interactions may have been limited for correlates with lower population prevalence rates. Further research with larger sample sizes may be warranted in order to more fully investigate gender differences in correlates of concurrency. To calculate sensitivity and specificity for a comparison of the two concurrency measures, the decision was made to use the UNAIDS measure as the criterion to which the self-report definition was compared, given that definition was endorsed by UNAIDS. However, we note that does not imply that the UNAIDS measure is more accurate than the self-reported measure. Sensitivity and specificity were used to facilitate comparison in measurement, but we were unable to gauge accuracy for either measure with our current study design. We also do not present data on condom use with main and non-main partners in this analysis; nor were we able to collect complete detailed information on all participants' partners. Finally, we were unable to measure correlations between concurrency and HIV outcomes.

Our findings suggest that a range of social, behavioral and structural factors such as perceived partner concurrency, substance use during sex, and incarceration may impact concurrency and HIV risks among this population in Mississippi. These factors may contribute to the disproportionately high rates of HIV infection among African Americans in the Deep South.

Acknowledgments Amy Nunn developed the idea for this paper and led all data collection, data analysis, and writing. Jennifer Rose led statistical analysis and contributed writing for this paper. Sarah MacCarthy, Nancy Barnett, Alexandra Cornwall, Annajane Yolken, Dantrell Simmons, Reginald Riggins, Philip Chan, Nicholas

Chamberlain, Sharon Parker, and Elya Moore contributed to the data collection and writing of this paper. Leandro Mena contributed to the study design, data collection analysis, and writing of this paper. This manuscript was supported with NIH Grants K01 020228-01A1, P01 AA019072, K23AI096923, R25MH083620, T32 DA013911, and P30-A1042853.

References

1. CDC. Estimated HIV incidence in the United States, 2007–2010. 2012.
2. Aral SO, Adimora AA, Fenton KA. Understanding and responding to disparities in HIV and other sexually transmitted infections in African Americans. Lancet. 2008;372(9635):337–40.
3. Friedman SR, Cooper HL, Osborne AH. Structural and social contexts of HIV risk among African Americans. Am J Public Health. 2009;99(6):1002–8.
4. Millett GA, Peterson JL, Flores SA, Hart TA, Jeffries WLT, Wilson PA, et al. Comparisons of disparities and risks of HIV infection in black and other men who have sex with men in Canada, UK, and USA: a meta-analysis. Lancet. 2012;380(9839):341–8.
5. CDC. 2010 Sexually Transmitted Diseases Surveillance. Centers for Disease Control; 2011.
6. MSDH. Mississippi State Department of Health HIV/AIDS Surveillance Report, 2004–2008. Jackson; 2008.
7. CDC. Diagnoses of HIV Infection and AIDS in the United States and Dependent Areas, 2010. Centers for Disease Control; 2010.
8. Neaigus A, Jenness SM, Hagan H, Murrill CS, Wendel T. Reciprocal sex partner concurrency and STDs among heterosexuals at high-risk of HIV infection. J Urban Health. 2012;23:23.
9. Adimora AA, Schoenbach VJ, Doherty IA. Concurrent sexual partnerships among men in the United States. Am J Public Health. 2007;97(12):2230–7.
10. Adimora AA, Schoenbach VJ, Taylor EM, Khan MR, Schwartz RJ. Concurrent partnerships, nonmonogamous partners, and substance use among women in the United States. Am J Public Health. 2011;101(1):128–36.
11. Adimora AA, Schoenbach VJ, Martinson FE, Donaldson KH, Stancil TR, Fullilove RE. Concurrent partnerships among rural African Americans with recently reported heterosexually transmitted HIV infection. J Acquir Immune Defic Syndr. 2003;34(4):423–9.
12. Laumann EO, Youm Y. Racial/ethnic group differences in the prevalence of sexually transmitted diseases in the United States: a network explanation. Sex Transm Dis. 1999;26(5):250–61.
13. Morris M, Kretzschmar M. Concurrent partnerships and transmission dynamics in social networks. Soc Netw. 1995;17:299–318.
14. Garnett GP, Johnson AM. Coining a new term in epidemiology: concurrency and HIV. Aids. 1997;11(5):681–3.
15. Adimora AA, Schoenbach VJ, Bonas DM, Martinson FE, Donaldson KH, Stancil TR. Concurrent sexual partnerships among women in the United States. Epidemiology. 2002;13(3):320–7.
16. Nelson SJ, Manhart LE, Gorbach PM, Martin DH, Stoner BP, Aral SO, et al. Measuring sex partner concurrency: it's what's missing that counts. Sex Transm Dis. 2007;34(10):801–7.
17. UNAIDS. HIV: consensus indicators are needed for concurrency. Lancet. 2010;375(9715):621–2.
18. Kenyon C, Colebunders B. Role of concurrency in generalised HIV epidemics. Lancet. 2011;378(9806):1844. doi:10.1016/S0140-6736(11)61804-7.
19. Glynn JR, Dube A, Kayuni N, Floyd S, Molesworth A, Parrott F, et al. Measuring concurrency: an empirical study of different methods in a large population-based survey and evaluation of the UNAIDS guidelines. Aids. 2012;26(8):977–85.
20. WHO. Closing the gap in a generation: health equity through action on the social determinants of health. Geneva: World Health Organization; 2008.
21. Nunn A, Dickman S, Cornwall A, Rosengard C, Kwakwa H, Kim D, et al. Social, structural and behavioral drivers of concurrent partnerships among African American men in Philadelphia. AIDS Care. 2011;23(11):1392–9.
22. Nunn A, Dickman S, Cornwall A, Kwakwa H, Mayer KH, Rana A, et al. Concurrent sexual partnerships among African American women in Philadelphia: results from a qualitative study. Sex Health. 2012;9(3):288–96.
23. Tsui EK, Leonard L, Lenoir C, Ellen JM. Poverty and sexual concurrency: a case study of STI risk. J Health Care Poor Underserved. 2008;19(3):758–77.
24. Taylor EM, Behets FM, Schoenbach VJ, Miller WC, Doherty IA, Adimora AA. Coparenting and sexual partner concurrency among white, black, and Hispanic men in the United States. Sex Transm Dis. 2011;38(4):293–8.
25. Khan MR, Doherty IA, Schoenbach VJ, Taylor E, Epperson M, Adimora AA. Incarceration and high-risk sex partnerships among men in the United States. J Urban Health. 2009;86(4):584–601.
26. Khan MR, Behrend L, Adimora AA, Weir SS, Tisdale C, Wohl DA. Dissolution of primary intimate relationships during incarceration and associations with post-release STI/HIV risk behavior in a Southeastern city. Sex Transm Dis. 2011;38(1):43–7.
27. Grieb SM, Davey-Rothwell M, Latkin CA. Social and sexual network characteristics and concurrent sexual partnerships among urban African American high-risk women with main sex partners. AIDS Behav. 2012;16(4):882–9.
28. Grieb SM, Davey-Rothwell M, Latkin CA. Concurrent sexual partnerships among urban African American high-risk women with main sex partners. AIDS Behav. 2012;16(2):323–33.
29. Drumright LN, Gorbach PM, Holmes KK. Do people really know their sex partners? Concurrency, knowledge of partner behavior, and sexually transmitted infections within partnerships. Sex Transm Dis. 2004;31(7):437–42.
30. Alexandra M, Oster M, Christina G, Dorell MD, et al. HIV risk among young African American men who have sex with men: a case-control study in Mississippi. Am J Public Health. 2011;101(1):137–43.
31. Carey MP, Senn TE, Seward DX, Vanable PA. Urban African-American men speak out on sexual partner concurrency: findings from a qualitative study. AIDS Behav. 2008;21:153–61.
32. Gorbach PM, Stoner BP, Aral SO, Whittington WL, Holmes KK. It takes a village: understanding concurrent sexual partnerships in Seattle, Washington. Sex Transm Dis. 2002;29(8):453–62.
33. Adimora AA, Schoenbach VJ. Contextual factors and the black-white disparity in heterosexual HIV transmission. Epidemiology. 2002;13(6):707–12.
34. Manhart LE, Aral SO, Holmes KK, Foxman B. Sex partner concurrency: measurement, prevalence, and correlates among urban 18–39-year-olds. Sex Transm Dis. 2002;29(3):133–43.
35. Adimora AA, Schoenbach VJ, Martinson F, Donaldson KH, Stancil TR, Fullilove RE. Concurrent sexual partnerships among African Americans in the rural south. Ann Epidemiol. 2004;14(3):155–60.
36. Adimora AA, Schoenbach VJ, Doherty IA. HIV and African Americans in the southern United States: sexual networks and social context. Sex Transm Dis. 2006;33(7 Suppl):S39–45.
37. Carael M, Kretzschmar M. Measuring concurrent partnerships: back on track. AIDS. 2012;26(8):1027–9. doi:10.1097/QAD.0b013e3283522d6b.