J Urban Health (2020) 97:642–652
https://doi.org/10.1007/s11524-019-00413-w

Foretelling the Future: Predicting STI Diagnosis and Its Implications for Ending the HIV Epidemic among Black Men Who Have Sex with Men

Paul A. Burns · Leandro A. Mena · Richard L. Crosby

Published online: 2 January 2020

Abstract Despite evidence of the link between STI and HIV transmission, STI rates remain alarmingly high, particularly among racial/ethnic minorities. This study examined the relationship between earlier STI diagnoses (gonorrhea and chlamydia) and future STI acquisition and its implications for HIV prevention among a sample of urban Black men who have sex with men (Black MSM). Data from a cohort of 600 Black MSM (15–29 years of age) residing in a medium-size Southern city enrolled in a HIV prevention intervention were analyzed. We used multivariate logistic regression to assess the association between STI diagnosis (baseline: Time 1) and subsequent STI diagnosis (90-day post-diagnosis: Time 2). Repeated measures analyzed at Time 1 and Time 2 included condomless sex, insertive and receptive sex, concurrent sexual partnerships, multiple partners, and age of partner. Independent of socio-demographic factors, we found having a prior GC/CT increased the likelihood of a future GC/CT by a factor of 15 (OR = 15.2, $p = 0.01$). Participants were statistically more likely to have been diagnosed with an extragenital STI (OR = 2.3, $p = 0.05$). Present findings suggest that time of initial STI diagnosis is a critical period in which to intervene to reduce future STI/HIV acquisition. Screening guidelines should be expanded to include testing for extragenital infection. STI screening and treatment and counseling programs should be culturally appropriate to account for the unique needs and the social and environmental context of the population. Additional research is needed to design STI prevention interventions that address social and environmental factors to reduce sexual risk behaviors that increase HIV vulnerability for Black MSM.

Short Summary A longitudinal study of Black MSM diagnosed with gonorrhea and chlamydia at baseline found clients were 15 times more likely to have a subsequent diagnosis 90-day post-initial diagnosis compared to those who were not diagnosed with STI. There is an urgent need to expand HIV prevention efforts to include routine STI screening, particularly screening for extragenital STI and to develop new HIV prevention programs that promote condom use and safer sex practices alongside PrEP for at-risk Black MSM.

P. A. Burns (✉) · L. A. Mena
Department of Population Health Science, John D. Bower School of Population Health, University of Mississippi Medical Center, 2500 N. State Street, Jackson, MS 39216, USA
e-mail: pburns@umc.edu

R. L. Crosby
College of Public Health, University of Kentucky, Lexington, KY, USA

Keywords Sexually transmitted infections · Sexually transmitted diseases · Extragenital · Acquired immunodeficiency syndrome · AIDS · Human immunodeficiency virus · HIV · HIV/AIDS · Gonorrhea · Chlamydia · Men who have sex with men · MSM · Black MSM

Introduction

Research has shown that having a sexually transmitted disease (STI) increases the likelihood of acquiring human immunodeficiency virus (HIV) [1–3]. As such, STI

prevention and interventions are public health priorities in the USA and globally. Black/African-American men who have sex with men are disproportionately impacted by HIV, particularly in the Southern region of the USA [4–6]. According to the Centers for Disease Control and Prevention (CDC), Blacks represent 14% of the US population, yet they account for 50% of syphilis cases, two thirds of reported cases of gonorrhea, one third of chlamydia, and 59% of HIV diagnoses [7]. In 2016, among all men who have sex with men, Black MSM was the most affected group representing 38% of new HIV diagnoses [8]. Research suggests that patterns of stigma and discrimination, residential segregation-derived sexual networks, and lack of access to STI testing and treatment are associated with increased rates of STIs among African-Americans [9–12]. Also, studies have shown disparities in STI rates are more pronounced among Black MSM who are younger, unemployed, and from lower socioeconomic strata [13–15].

The prevention of sexually transmitted infections has been widely promoted as an efficacious strategy in preventing HIV infection, particularly among high-risk populations [16–19]. The CDC recommends all sexually active men who have sex with men (MSM) are screened at least once a year for syphilis, chlamydia, and gonorrhea [1]. Despite these efforts, STIs remain some of the most common infections in the USA. It is estimated that annually 19 million Americans are diagnosed with an STI and the overall medical costs associated to be approximately $14 billion/year [20]. Effective STI control depends on ensuring access to and utilization of sexual health services as well as an understanding of the social and contextual factors that drive sexual risk behavior. While a number of studies have examined the relationship between STIs and HIV vulnerability [21–30], there is limited research examining the influence of receiving a STI diagnosis on subsequent STI acquisition [5]. Typically, these studies examine subsequent STI diagnosis by STI type such as syphilis, gonorrhea, or chlamydia. However, little is known about the influence of the site of the infection on subsequent acquisition. Further research is needed to better understand pathways to STI risk as well as factors promoting safer sex and condom use to inform the development of effective HIV preventive interventions and policies.

Given the high rates of STI and HIV infections, particularly among Black MSM residing in urban areas, there is an urgent need for research that helps to identify new pathways and mechanisms for HIV acquisition. Understanding the potential role of the anatomical site of STI exposure on predicting subsequent STI acquisition may (1) advance our knowledge regarding STI/HIV transmission among understudied populations; (2) determine whether existing screening guidelines are sufficient; and (3) assist in the development of new and innovative HIV prevention interventions to improve the HIV prevention continuum for young Black MSM.

In the present study, we extend STI/HIV research by elaborating and testing hypotheses regarding the association of receiving a gonorrhea/chlamydia (GC/CT) diagnosis and subsequent GC/CT outcomes, specifically diagnoses of new infections by anatomical type. We examine associations between being diagnosed with a GC/CT across time points, Time 1 (baseline) and later infection at Time 2 (90 days) on five site-specific categories: (1) any GC/CT, (2) pharyngeal GC/CT, (3) urethral GC/CT, (4) rectal GC/CT, and (5) extra-genital GC/CT. To our knowledge, this is the first longitudinal study to examine correlates of STI diagnosis stratified by anatomical site among a cohort of Black MSM. Notably, our findings are context-specific for young urban Black MSM residing in the South, which is a subpopulation that has the highest prevalence of HIV in the USA.

Materials and Methods

Study Population

Data for this investigation were derived from an NIH-funded randomized controlled trial (RCT) of a HIV prevention intervention to reduce STI incidence and risk of HIV acquisition/transmission among young Black MSM [31]. Recruitment occurred at a publicly funded clinic designated for the diagnosis and treatment of HIV and other STIs. Consenting, age-eligible volunteers were asked to participate in an HIV prevention intervention study. All study procedures were approved by the Institutional Review Boards of the University of Mississippi Medical Center, the Mississippi State Department of Health, and the University of Kentucky.

The study comprised 600 young Black MSM residing in Jackson, MS, a medium-sized city located in the Southern region of the USA. Participant inclusion criteria included (1) assigned male at birth; (2) self-identification as Black/African-American; (3) aged 15 to 29 years; (4) attending the clinic to be tested for HIV

or other STIs; (5) having engaged in penile-anal sex with a male partner at least once in the past 6 months; and (6) the ability to speak and comprehend English. Specimen collection and specimen processing have been described in detail previously [31].

Measures

Following informed consent procedures, participants were provided a computer equipped with audio computer-assisted self-interview (ACASI) software to complete a survey. Participants responded to questions about their demographic characteristics, sexual role (anal insertive or anal receptive), STI history (e.g., STI diagnoses and HIV status), and sexual risk behaviors (response categories are shown in Table 1).

Sociodemographic Characteristics

Sociodemographic variables associated with sexual risk behavior were added to control for socioeconomic status. For age, we categorized individuals as young adults (15–19 years) or adults (20–29 years of age). Education was divided into a dichotomous variable (0 = high school or less; 1 = some college or higher). Income was a dichotomous variable (0 = < US$1000/month, 1 = > US$1000/month).

STI History

All eligible patients were screened for gonorrhea and chlamydia. Those who were diagnosed with a gonorrhea or chlamydia infection were treated at point of care according to CDC guidelines. For gonorrhea, a dual therapy consists of a single dose of 250 mg of intramuscular ceftriaxone and 1 g of oral azithromycin and 1 g of azithromycin orally in a single dose for treatment of chlamydia. These medications have been shown to be highly efficacious for treating gonorrhea and chlamydia with a cure rate of 97% and 95%, respectively. A meta-analysis of 12 randomized clinical trials of azithromycin for the treatment of urogenital chlamydial found microbial cure rates of 97% [32]. Additionally, studies show that standard treatment regimen for gonorrhea has a cure rate of 95% [33]. All participants were instructed to return to the clinic if symptoms persisted after a few days post-treatment for reevaluation. Any participants who returned for treatment prior to 90-day follow-up

Table 1 Differences in sexual risk behavior and GC/CT diagnosis between baseline and Time 2 (HIV-negative)

	HIV-negative status			
	Time 1 ($n = 421$)	Time 2 ($n = 277$)		
	Mean or n (%)	Mean or n (%)	χ 2/t	*p*
Sexual risk behavior				
Concurrent sexual partners	105 (25.4%)	57 (20.6%)	1.57	0.05
Has older partner (≥ 5 years)	68 (16.5%)	43 (15.5%)	1.26	0.20
Number of sex partners (AI)	2.6 (8.1)	2.1 (9.4)	3.04	0.003
Number of sex partners (AR)	2.1 (4.4)	2.1 (12.3)	4.92	0.000
Anal receptive	261 (62.0%)	173 (58.9%)	10.10	0.001
Anal insertive	297 (70.6%)	178 (42.3%)	16.89	0.000
Used condom (AI)	277 (72.5%)	183 (69.1%)	1.95	0.05
Used condom (AR)	250 (88.7%)	159 (57.6%)	5.34	0.000
STI type				
Any GC/CT	120 (34.4%)	47 (21.0%)	3.60	0.0004
Pharyngeal	50 (13.3%)	17 (7.2%)	2.84	0.005
Urethral	45 (11.3%)	13 (5.2%)	3.24	0.0013
Rectal	87 (23.9%)	31 (13.1%)	3.22	0.0015
Extragenital	111 (31.4%)	39 (17.0%)	3.81	0.0002

Note. AI = anal insertive; AR = anal receptive

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

were treated and monitored for reinfection. Only participants with new infections were included in the analysis.

STI Risk Factors

Sexual risk behaviors hypothesized to be associated with STI transmission included the following variables:

- Participants were characterized as anal insertive (AI) or anal receptive (AR). Anal insertive (AI) intercourse: defined as inserting the penis rectally during anal sex (0 = no, 1 = yes).
- Anal receptive (AR) intercourse: defined as being penetrated during anal sex (0 = no, 1 = yes). The association between unprotected receptive anal intercourse and HIV acquisition in MSM is well documented [34]. For this study, we examined the potential effect of role segregation on STI acquisition defined by two broad categories AI and AR. These independent measures were designed to help us better understand transmission dynamics among our target population. Participants responded to two separate questions regarding their sexual role (AI vs AR) during intercourse in the last 90 days. Those respondents who indicate dual roles are included in both categories.
- Condom use: defined as using a condom during sex in the past 90 days. Two separate variables were created: (1) condom usage if anal receptive (0 = no, 1 = yes) and (2) condom usage if anal insertive (0 = no, 1 = yes).
- Concurrent sexual partners: defined as overlapping sexual partnerships in which sexual intercourse with one partner occurs between two acts of intercourse with another sexual partner [8] was coded (0 = no, 1 = yes).
- Older sexual partner: defined as a having a sexual partner 5 years or older than the respondent (0 = no; 1 = yes). The difference in age of sexual partner has been associated with increased risk of HIV infection [9].
- Multiple sexual partners: measured by two separate continuous variables defined by the respondent's sexual role: (a) number of sexual partners (anal receptive) and (b) number of sexual partners (anal insertive).

Table 2 Differences in sexual risk behavior and GC/CT diagnosis between baseline and Time 2 (HIV-positive)

HIV-positive status				
	T1 ($n = 179$) Mean (SD) or n (%)	T2 ($n = 107$) Mean (SD) or n (%)	χ 2 or t	p
Sexual risk behavior				
Concurrent sexual partners	48 (27.3%)	22 (20.6%)	1.34	0.18
Older partner (≥ 5 years)	58 (32.9%)	29 (27.1%)	1.58	0.12
Number of sex partners (AI)	2.2 (4.8)	1.2 (1.5)	3.04	0.003
Number of sex partners (AR)	2.5 (3.7)	1.0 (1.2)	4.92	0.000
Anal receptive	143 (79.9%)	82 (45.8%)	8.31	0.000
Anal insertive	118 (65.9%)	56 (31.3%)	8.37	0.000
Used condom (AI)	125 (82.8%)	67 (65.7%)	2.91	0.005
Used condom (AR)	136 (93.8%)	65 (61.9%)	4.55	0.000
STI type				
Any GC/CT	64 (44.4%)	21 (26.3%)	2.35	0.01
Pharyngeal^	26 (17.0%)	9 (10.7%)	0.89	0.37
Urethral^	15 (9.8%)	5 (5.6%)	1.30	0.20
Rectal	53 (34.6%)	16 (19.1%)	3.22	0.0015
Extragenital	63 (42.3%)	21 (25.6%)	3.81	0.0002

Note. AI = anal insertive; AR = anal receptive

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Data Analysis

We used logistic regression to assess the association between STI risk factors (i.e., sexual role, concurrent partnerships, and condomless sex) and STI diagnosis among a sample of Black MSM participants. Participants' HIV status was dichotomized (positive vs negative) to assess how perceived risk might influence sexual risk behavior.

First, we performed bivariate comparisons of individual characteristics by HIV status using t-test (Tables 1 and 2). Bivariate analysis of association of background characteristics (socio-demographics and sexual risk behaviors) of participants at Time 1 (baseline) and Time 2 (90-day post-diagnosis) was performed to determine variables of interest for inclusion in a multivariable model (Table 3-4). Variables significant at the bivariate level and conceptually relevant covariates were included in a multivariable logistic regression model predicting STI diagnosis. Next, we performed logistic regression to assess associations between baseline, time-dependent STI risk factors, and STI outcomes in a 90-day interval using robust variance estimation to account for repeated measures on participants (Table 5). The final model was simplified using stepwise variable selection.

Results

Profile of Respondents

In this section, we present sociodemographic, behavioral, and clinical characteristics for the entire sample. Of the 600 respondents surveyed, they ranged in ages from 15 to 29, with a median age of 22.6 years. Two fifths (40%) had a high school education or less, 44% earned less than US$1000/month, and 42% indicated they were currently not working. In regard to their sexual role, 67% indicated they were anal receptive compared to 69% who were anal insertive. Among anal receptive participants, 90.4% used a condom compared to only 75% of anal insertive participants. The mean (2.3) number of sexual partners was the same for both anal receptive and anal receptive respondents. Over a quarter (26%) had a concurrent partnership, and 20% had an

Table 3 Odds ratios for STI infection types and sociodemographic and sexual risks (Time 1) ($n = 600$)

Sexually transmitted disease (GC/CT) anatomical type					
	GC/CT OR (95% CI)	Pharyngeal OR (95% CI)	Urethral OR (95% CI)	Rectal OR (95% CI)	Extra-genital OR (95% CI)
Sociodemographic characteristics					
Age	0.79 (0.52–1.19)	0.82 (0.47–1.45)	0.77 (0.41–1.44)	0.67 (0.42–1.06)	0.71 (0.46–1.09)
HIV status	1.53 (1.03–2.27)*	1.33 (0.80–2.24)	0.86 (0.46–1.58)	1.68 (1.11–2.54)**	1.60 (1.08–2.37)**
Educational status	1.12 (0.78–1.61)	1.29 (0.79–2.10)	0.89 (0.52–1.51)	1.14 (0.77–1.69)	1.16 (0.80–1.67)
Income	1.14 (0.79–1.65)	1.13 (0.69–1.85)	1.14 (0.67–1.97)	1.33 (0.89–1.97)	1.25 (0.86–1.81)
Employment status	0.66 (0.46–0.97)*	0.89 (0.53–1.44)	0.62 (0.35–1.10)	0.74 (0.50–1.10)	0.70 (0.48–1.02)*
Sexual risk behavior					
Concurrent sexual partners	1.74 (1.15–2.64)**	1.81 (1.09–3.03)**	1.09 (0.59–2.00)	1.33 (0.86–2.06)	1.78 (1.18–2.70)**
Has older partner (≥ 5 years)	0.92 (0.58–1.44)	1.21 (0.68–2.15)	0.65 (0.31–1.38)	0.89 (0.55–1.44)	0.96 (0.6–1.51)
Number of sex partners (AI)	1.01 (0.98–1.03)	1.00 (0.96–1.04)	1.02 (1.00–1.05)	1.00 (0.97–1.03)	1.01 (0.97–1.03)
Number of sex partners (AR)	1.02 (0.98–1.06)	1.00 (0.95–1.06)	0.92 (0.81–1.04)	1.02 (0.98–1.06)	1.02 (0.98–1.06)
Anal receptive	1.34 (0.90–2.00)	1.50 (0.86–2.61)	0.61 (0.36–1.06)	1.73 (1.11–2.70)**	1.53 (0.88–2.30)
Anal insertive	1.46 (0.97–2.19)	1.91 (1.05–3.48)**	3.10 (1.44–6.69)**	0.94 (0.62–1.43)	1.24 (0.82–1.86)
Used condom (AI)	1.13 (0.72–1.77)	0.77 (0.44–1.34)	1.27 (0.63–2.55)	1.19 (0.73–1.94)	1.10 (0.70–1.74)
Used condom (AR)	0.86 (0.43–1.71)	0.98 (0.39–2.46)	1.23 (0.36–4.23)	0.78 (0.38–1.60)	0.78 (0.39–1.56)

Note. AI = anal insertive; AR = anal receptive

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

older sexual partner (≥ 5 years). Results indicate nearly a third (30%) of participants were HIV-positive at baseline. Many (37.3%) tested positive for either gonorrhea or chlamydia. Of those respondents who tested, 35% tested positive for gonorrhea and 26% for chlamydia.

Bivariate Analyses

In Tables 1 and 2, we present bivariate associations stratified by HIV status of selected covariates associated with STI acquisition. A t-test was calculated to assess whether sexual risk behavior and STI diagnoses decreased from Time 1 to Time 2. Participants sexual risk behavior and STI diagnosis varied between baseline evaluation and Time 2 (90-day post-initial diagnosis). In Table 1, we present findings for HIV-negative participants. Overall, we found significant declines in sexual risk behavior between T1 and T2 on a number of sexual behavior characteristics including concurrent partners (25.4% vs 20.6%), having an older partner (16.5% vs 15.5%), anal receptive (AR) 62% vs 59%, anal insertive (AI) 71% vs 42%, used condom (AI) (73% vs 69%), and used condom (AR) (89 vs 57%). In terms of STI diagnosis, extragenital STI was the most common diagnosis at baseline (31%) and at T2 (17%). There were statistically significant declines for each anatomical type: any GC/CT (13%); pharyngeal (5.1%), urethral 5.9%, rectal (10.8), and extragenital (14.4%) among HIV-negative participants.

Among HIV-positive participants, we found similar patterns in sexual risk behavior and STI diagnosis 90-day post-initial evaluation (Table 2). Comparing T1 and T2, we found statistically significant differences in sexual risk behavior on all variables except sexual concurrency and having a sexual partner (≥ 5 years). The mean number of sexual partners declined for both AI (2.2 vs 1.2) and AR (2.5 vs 1.0) participants. Also, our findings show significant declines between T1 and T2 among HIV-positive participants who are AR and AI identified. At baseline 80% indicated, they were AR, however, 90 days later only 45.8% identified as AR. At 90-day post initial diagnosis, 35 % fewer participants surveyed indicated they were AI. Additionally, there was an 18% decline in overall GC/CT diagnoses; and for rectal GC/

Table 4 Odds ratios for GC/CT infection types by sociodemographic and sexual risks (Time 2) (n-600)

Sexually transmitted disease (GC/CT) anatomical type ($n = 600$)					
	GC/CT OR (95% CI)	Pharyngeal OR (95% CI)	Urethral OR (95% CI)	Rectal OR (95% CI)	Extra-genital OR (95% CI)
Sociodemographic characteristics					
Age	0.97 (0.89–1.06)	1.04 (0.91–1.18)	1.03 (0.89–1.20)	0.95 (0.86–1.05)	0.98 (0.90–1.07)
HIV status	1.34 (0.74–2.43)	1.55 (0.66–3.63)	1.09 (0.38–3.14)	1.56 (0.80–3.02)	1.68 (0.92–3.07)
Educational status^					
Income	1.06 (0.61–1.82)	1.34 (0.60–3.03)	0.81 (0.31–2.09)	1.05 (0.56–1.97)	1.26 (0.71–2.23)
Employment status	0.76 (0.43–1.32)	0.61 (0.27–1.36)	0.67 (0.26–1.76)	0.89 (0.47–1.71)	0.73 (0.41–1.31)
Sexual risk behavior					
Has multiple partners	1.15 (0.59–2.27)	0.99 (0.36–2.74)	0.52 (0.12–2.31)	1.31 (0.62–2.74)	1.35 (0.69–2.67)
Has older partner (≥ 5 years)	1.22 (0.50–2.06)	0.59 (0.17–2.05)	1.41 (0.45–4.44)	0.82 (0.35–1.95)	0.94 (0.44–1.99)
Number of sex partners (AI)	0.89 (0.34–0.97)*	1.00 (0.95–1.04)	1.00 (0.95–1.05)	0.58 (0.33–0.71)*	0.99 (0.93–1.05)
Number of sex partners (AR)	0.75 (0.91–0.78)*	0.99 (0.94–1.05)	0.80 (0.51–1.24)	1.00 (0.96–1.03)	0.99 (0.93–1.05)
Anal receptive	0.99 (0.51–1.58)	1.46 (0.59–3.58)	0.88 (0.33–2.33)	0.79 (0.42–1.50)	0.88 (0.49–1.59)
Anal insertive	1.00 (0.58–1.72)	1.16 (0.51–2.64)	1.82 (0.63–5.22)	0.87 (0.47–1.63)	0.99 (0.56–1.75)
Used condom (AI)	1.35 (1.23–7.64)*	0.93 (0.40–2.16)	1.12 (0.38–3.26)	1.09 (0.55–2.17)	1.01 (0.55–1.86)
Used condom (AR)	1.75 (1.59–4.91)*	2.52 (1.98–6.46)*	0.91 (0.35–2.37)	0.98 (0.52–1.85)	1.20 (0.67–2.15)

Note. AI = anal insertive; AR = anal receptive

*p < 0.05, **p < 0.01, ***p < 0.001

^Data not collected at Time 2

Table 5 Multiple logistic regression of STI-related factors predicting STI diagnosis (n-600)

	Any STI			Pharyngeal			Urethral			Rectal			Extragenital		
	OR	P	CI	OR	P	CI	OR	P	CI	OR	P	CI	OR	P	CI
Sociodemographic characteristics															
Age	0.46	0.30	0.11–2.00	0.32	0.33	0.03–3.21	0.67	0.76	0.05–8.76	1.19	0.81	0.29–4.85	0.51	0.34	0.12–2.06
Income	1.13	0.81	0.39–3.29	1.35	0.70	0.28–6.52	1.96	0.67	0.20–18.88	0.51	0.26	0.15–1.66	0.88	0.38	0.20–1.83
Education	1.27	0.66	0.43–3.71	0.66	0.59	0.15–2.95	0.92	0.94	0.10–8.25	1.55	0.47	0.47–5.17	1.71	0.32	0.58–5.01
Employment	0.70	0.51	0.24–2.04	1.11	0.89	0.25–5.02	1.68	0.63	0.22–14.00	0.59	0.39	0.17–1.99	0.61	0.39	0.20–1.83
STI types															
Any GC/CT	15.19	0.01**	3.27–45.54	5.31	0.51	0.18–35.28	9.74	0.29	0.14–64.05	11.03	0.11	0.55–52.98	2.31	0.03*	1.33–43.21
Pharyngeal[1]	3.45	0.05*	1.35–8.68	1.35	0.79	0.14–4.23	0.46	0.60	0.02–8.61	3.15	0.15	0.60–24.89	3.89	0.05*	1.74–19.34
Urethral[1]	1.36	0.74	0.21–7.58	2.69	0.35	0.33–21.88	3.89	0.39	0.18–81.06	1.43	0.94	0.60–24.89	0.99	0.99	0.16–5.32
Rectal[1]	1.42	0.75	0.16–11.67	1.17	0.91	0.07–18.62	0.58	0.76	0.18–18.28	1.35	0.05*	1.22–19.92	5.33	0.20	0.38–67.16
Extragenital[1]	1.24	0.05*	1.04–5.95	0.55	0.80	0.05–5.19	1.29	0.92	0.01–22.71	1.27	0.34	0.10–24.89	2.19	0.001***	0.06–2.65
HIV status[1]	0.55	0.43	0.16–2.22	1.19	0.84	0.21–6.58	0.97	0.98	0.08–11.77	1.24	0.05**	1.04–2.47	0.71	0.60	0.25–2.43
Sexual risk behaviors															
Condom (AI)	1.43	0.57	0.42–4.63	0.81	0.81	0.14–4.47	0.17	0.17	0.01–2.19	2.12	0.22	0.57–10.48	2.30	0.21	0.62–8.56
Condom (AR)	0.24	0.04	0.05–0.87	0.80	0.86	0.07–8.58	0.21	0.16	0.22–1.89	0.41	0.05*	1.05–11.38	0.41	0.30	0.08–2.21
Anal insertive	0.18	0.004*	0.05–0.65**	0.89	0.88	0.181	0.64	0.71	0.06–6.43	0.13	0.007**	0.03–0.57	0.27	0.03*	0.08–0.91
Anal receptive	3.45	0.38	0.30–25.44	–	–	–	0.88	0.93	0.04–18.84	1.37	0.77	0.16–11.40	2.09	0.48	0.29–16.22
Concurrent partner	1.99	0.22	0.67–5.77	2.35	0.27	0.51–10.86	3.15	0.34	0.29–33.13	1.13	0.31	0.57–6.14	1.89	0.24	0.65–5.51
Age partner (> = 5)	3.42	0.02	1.21–5.53*	0.60	0.54	0.10–3.50	6.22	0.10	0.69–8.98	4.24	0.01**	1.31–13.67	2.31	0.12	0.81–6.63
Multiple partners (AR)	1.86	0.05	1.71–7.03*	1.04	0.67	0.87–1.23	1.07	0.36	0.92–1.24	1.12	0.05*	1.07–1.23	1.10	0.10	0.98–1.24
Multiple partners (AI)	0.86	0.13	1.03–4.13	0.91	0.57	0.64–1.28	0.56	0.27	0.20–1.54	0.88	0.14	0.75–1.04	0.91	0.21	0.18–1.31
Intervention	0.48	0.14	0.18–1.26	0.72	0.65	0.19–2.82	1.6	0.21	0.21–12.13	0.42	0.25	0.16–1.58	0.49	0.16	0.18–5.81

Note. AI = anal insertive; AR = anal receptive

*p < 0.05, **p < 0.01, ***p < 0.001,[1] Time 1

CT, we saw a decline from 35% to 19% and 42% vs 27% for extragenital GC/CT between T1 and T2. However, extragenital (42%) was the most common STI diagnosis type among HIV-positive participants.

Next, using bivariate logistic regression, we examined statistical associations between sociodemographic characteristics, STI risk factors, and five STI diagnosis categories including GC/CT (combined gonorrhea and chlamydia and four site-specific STIs). As shown in Table 3, HIV-positive individuals with GC/CT were almost 53% more likely (OR.1.53; $p = 0.05$) to be diagnosed with gonorrhea or chlamydia, 68% more likely to be diagnosed with rectal (OR 1.68, $p = 0.05$) and 60% more likely for extra-genital (OR 1.60, $p = 0.05$). Also, being in a concurrent relationship increased the likelihood of being diagnosed with gonorrhea or chlamydia by 74% (OR 1.74, $p = 0.05$), 81% for pharyngeal (OR 1.81, $p = 0.05$), and 78% for extra-genital (OR 1.78, $p = .0.05$). Respondents who were anal receptive were at greater risk (73%) for rectal (OR 1.73, $p = 0.0.1$) and 53% for extra-genital (OR 1.53, $p = 0.10$). Anal insertive respondents were nearly twice as likely to be diagnosed with pharyngeal (OR 1.91, $p = 0.01$) and three times more like for urethral (3.10, $p = 0.01$) GC/CT. These analyses were repeated at Time 2 (Table 4). Those individuals who were diagnosed with any GC/CT were more likely to use a condom, both anal receptive (AR) (1.75, $p = 0.05$) and anal insertive (AI) (1.35, $p = 0.05$) at Time 2. Also, we found that they were less likely to have multiple partners AI (0.89, $p = 0.05$) and AR (0.75, $p = 0.05$). For those who were diagnosed with pharyngeal GC/CT, they were 2.5 times more likely to use a condom (2.5; $p = .0.05$).

Multivariate Regression Analysis of STI-Related Risk Factors and STI Diagnosis

Table 5 shows adjusted odds ratios (OR) for five STI diagnosis categories by anatomical site: (1) any GC or CT (gonorrhea or chlamydia), (2) pharyngeal, (3) urethra, (4) rectal, or (5) extragenital gonorrhea or chlamydia. Respondents who had an STI diagnosis at Time 1 were 15 times more likely to be diagnosed with gonorrhea or chlamydia at Time 2 (OR 15.2, CI 3.27–45.54). These individuals were 24% more likely to have an extragenital GC/CT (OR = 1.24, CI 1.04–5.95), 82% less likely to be anal insertive (OR = 0.18, CI0.05–0.65), and almost 3.5 times more likely to have an older sexual partner (≥ 5 years) (OR = 3.42, CI 1.35–8.68). Also, individuals diagnosed with rectal GC/CT at Time 1 were 35% more likely to have a rectal GC/CT at Time 2 (OR 1.35, CI 1.22–19.92). There was a statistically significant likelihood to be HIV-positive (OR 1.24, CI 1.04–2.47) and less likely to be anal insertive (OR = 0.13, CI 0.03–0.57).. Also, having an older sexual partner ≥ 5 years increased the likelihood of being diagnosed with a rectal GC/CT by a factor of four (OR = 4.24, CI 1.31–13.67).

Next, our findings show individuals diagnosed with extragenital GC/CT at Time 2 were 2.3 times more likely to have been diagnosed with "any GC/CT" (OR = 2.3 1, CI 1.33–43.21) at Time 1. In addition, they were almost four times more likely to have been diagnosed with pharyngeal (OR = 3.89, CI 1.74–19.34) and twice as likely to be diagnosed with extragenital (OR = 2.19, CI 0.06–2.65) STI GC/CT. Individuals diagnosed with an extragenital GC/CT at Time 2 were 73% (OR = 0.27, CI 0.08–0.91) less likely to be anal insertive.

Discussion

This study examined the effect of receiving a GC/CT diagnosis on five site-specific GC/CT outcomes, 90-day post-diagnosis. We found a high prevalence of gonorrhea and chlamydia among the young Black MSM population in this study, with both HIV-positive and HIV-negative respondents reporting high levels of sexual risk behaviors including anal receptive sexual practices, inconsistent condom use, high frequency of sexual partners, and concurrent sexual partners and having an older sexual partner 5 or more years older. Individuals diagnosed with gonorrhea or chlamydia (GC/CT) at baseline were 15 more likely of being diagnosed with a gonorrhea or chlamydia at T2, and it was statistically more likely to be an extragenital STI. At both baseline and 90-day post-evaluation, extragenital was the most common STI diagnosis among our sample population, 42% and 27%, respectively.

Moreover, our sample reported high rates of socioeconomic insecurity with 40% of participants with a high school diploma or less, 44% living below the poverty line, and 42% were unemployed. Research has demonstrated social determinants such as race/ethnicity, education, and income are risk factors that increase HIV vulnerability among racial/ethnic and sexual minority groups [35]. HIV vulnerability includes a diverse range of social and structural factors that militate against the

ability of some individuals and populations to avoid HIV infection. These vulnerability factors can be divided into three groups: (1) individual-level factors, e.g., the lack of knowledge, skills, and beliefs required to protect oneself and others from acquisition or transmission of HIV/STIs; (2) socioeconomic factors, e.g., educational attainment, income, and racial/ethnic background that may impact the quality and type of services, including accessibility (e.g., distance to healthcare facilities lack of transportation, cost of care, and utilization); and (3) structural level factors (e.g., social and cultural norms, practices, beliefs, and laws that stigmatize and disempower poor and vulnerable populations) may act as barriers to accessing essential HIV/STI prevention, care, and treatment [36]. All of these risk factors may act independently or in combination with other biological mechanisms to contribute to conditions of individual vulnerability or, in the case of Black MSM, a collective vulnerability, which may serve to further exacerbate individual vulnerability. It is within this toxic mix of debilitating vulnerabilities, whereby the distress of receiving a STI diagnosis might explain why some individuals may not adhere to prosocial sexual behavior or HIV prevention messages putting them at increased risk of STI/HIV infection. Since we did not include nor is there a global measure of HIV vulnerability, we cannot categorically state that HIV vulnerability influenced an individual's sexual risk behavior and subsequent STI diagnoses. However, several studies have documented that HIV vulnerability related to racial/ethnic background, income, and education increases odds for sexual risk behavior and hence the possible influence of an earlier STI diagnosis on subsequent sexual risk behavior and HIV [37–39].

Given the highest prevalence of cases of new infections that are occurring among African-Americans in the Southern USA, it is imperative that we increase research to develop HIV prevention interventions that take into account the unique vulnerabilities that emerge out of a history of persistent and chronic racialized social, economic, and political marginalization. Moreover, additional research is needed to examine the relationship between discrimination, stigma, and shame and racialized HIV vulnerability in regard to sexual risk behaviors that foster STI acquisition and transmission. Moreover, it is critical we have an understanding of the progression and cumulative effect of these social and structural factors in the context of HIV vulnerability and how they interact to promote the onset, persistence, increase, or change in the expression of negative sexual risk behavior and practices, which will be useful for designing and implementing HIV/STI prevention interventions.

Challenges and Limitations

Our findings were limited by the utilization of a convenience sample, and as a result, the findings may not be generalizable to the broader population of Black MSM. Also, the study may be susceptible to recall bias as it relies on the validity of respondents' self-report of sexual risk behaviors, thus limiting reliability and complete accuracy. Limited sample sizes for HIV-positive participants precluded our ability to conduct additional multivariate analyses stratified by HIV status. Additionally, we acknowledge sexual roles among MSM may be fluid depending on context, therefore using a binary measure (anal receptive vs anal insertive) may not fully capture the complexity of Black MSM as it relates to sex role segregation. Finally, we were constrained by the data, since the socioeconomic measures may not fully capture the impact of minority stress in the context of chronic and persistent structural/racial discrimination and its impact on HIV-related sexual behaviors and outcomes. These limitations, notwithstanding, are among the first longitudinal studies examining the influence of STI diagnosis on future STI acquisition among a sample of young, urban Black MSM.

Conclusion

The relationship between GC/CT diagnosis and subsequent STI acquisition is complex, multifactorial, and site-specific. Evidence has shown biological mechanisms explain only a small part of the STI transmission phenomenon. Our findings suggest that an association between prior GC/CT diagnosis, infection site, and subsequent diagnosis is likely an interaction between biological mechanisms and social and contextual factors (e.g., racial discrimination-related norms and policies in the form of racial segregation-derived sexual networks, poverty, stigma, low educational, limited access, and service utilization rates on/STI resources and services) relevant to our population that increase susceptibility for STIs among urban African-American youth. This study is timely as it highlights the importance of a prior STI diagnosis in predicting future STI acquisition and

identifying likely repeaters early, as well as an urgent need to improve current screening guidelines, particularly enhanced extragenital testing and the development of HIV prevention interventions and programs targeting Black MSM.

Given the strength of evidence of the links between STI and HIV and the enormous burden of disease represented by HIV among Black MSM, there is an urgent need for additional research on subsequent STI diagnosis and the development and implementation of more culturally appropriate prevention interventions that take into account the socio-ecological context and realities of the affected populations and communities. Future research should investigate the mechanisms through which structural stigma and discrimination influences sexual risk behavior in the context of the STI screening, diagnosis, and treatment continuum and prioritize the development and the implementation of evidenced-based structural level HIV prevention interventions and policies that reduce racial/ethnic disparities in STI- and HIV-related outcomes. From a population health and service provision point of view, it is imperative for national and local governments, healthcare providers, researchers, and AIDS service organizations (ASOs) take a more integrated approach to meet the HIV prevention, care, and treatment needs of sexual and racial minorities, particularly Black MSM.

Acknowledgements We wish to thank the participants of the Better Sex with Latex Initiative. The study was supported by the National Institute of Mental Health [5RO1MH092226].

References

1. Galvin SR, Cohen MS. The role of sexually transmitted diseases in HIV transmission. *Nat Rev Microbiol*. 2004;2:33–42.
2. Gray RH, Wawer MJ, Brookmeyer R, et al. Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1- discordant couples in Rakai, Uganda. *Lancet*. 2001;357:1149–53.
3. Royce RA. Et al. "sexual transmission of HIV.". *N Engl J Med*. 1997;336(15):1072–8.
4. Grey JA, Bernstein KT, Sullivan PS, Purcell DW, Chesson HW, Gift TL, et al. Estimating the population sizes of men who have sex with men in US states and counties using data from the American community survey. *JMIR Public Health Surveill*. 2016;2(1):e14.
5. Stenger M, Pathela P, Anschuetz G, Bauer H, Simon J, Kohn R, et al. Increases in the rate of Neisseria gonorrhoeae among gay, bisexual and other men who have sex with men (MSM) — findings from the STI surveillance network 2010–2015. *Sex Transm Dis*. 2017;44(7):393–7.
6. Kirkcaldy RD, Harvey A, Papp JR, et al. *Neisseria gonorrhoeae* antimicrobial susceptibility surveillance — the Gonococcal Isolate Surveillance Project, 27 sites, United States, 2014. *MMWR Surveill Summ*. 2016;65(SS-7):1–19.
7. Centers for Disease Control and Prevention. HIV and African American. National Center for HIV/AIDS, Viral Hepatitis, STI, and TB Prevention, Accessed 5/31.2019 https://www.cdc.gov/hiv/group/racialethnic/africanamericans/index.html
8. Centers for Disease Control and Prevention. HIV and African American Gay and Bisexual Men Division of HIV/AIDS Prevention, National Center for HIV/AIDS, Viral Hepatitis, STI, and TB Prevention Accessed 3/01/2019. https://www.cdc.gov/hiv/group/msm/bmsm.html
9. Balaji AB, Bowles KE, Hess KL, Smith JC, Paz-Bailey G, NHBS study group. Association between enacted stigma and HIV- related risk behavior among MSM, national HIV behavioral surveillance system, 2011. *AIDS Behav*. 2017;21(1):227–37.
10. Spicknall IH, Gift TL, Bernstein KT, Aral SO. Sexual networks and infection transmission networks among men who have sex with men as causes of disparity and targets of prevention. *Sex Transm Infect*. 2017;93(5):307–8.
11. Jeffries WL, Marks G, Lauby J. Homophobia is associated with sexual behavior that increases risk of acquiring and transmitting HIV infection among black men who have sex with men. *AIDS Behav*. 2013;17(4):1442–53.
12. Díaz RM, Ayala G, Bein E. Sexual risk as an outcome of social oppression: data from a probability sample of Latino gay men in three US cities. *Cultur Divers Ethnic Minor Psychol*. 2004;10(3):255–67.
13. Mayer KH, Wang L, Koblin B, Mannheimer S, Magnus M, del Rio C, et al. Concomitant socioeconomic, behavioral, and biological factors associated with the disproportionate HIV infection burden among black men who have sex with men in 6 US cities. *PLoS One*. 2014;9(1):e87298.
14. Millett GA, Flores SA, Peterson JL, et al. Explaining disparities in HIV infection among black and white men who have sex with men: a meta-analysis of HIV risk behaviors. *AIDS*. 2007;21(15):2083–91.
15. Sullivan PS, Peterson J, Rosenberg ES, Kelley CF, Cooper H, Vaughan A, et al. Understanding racial HIV/STI disparities in black and white men who have sex with men: a multilevel approach. *PLoS One*. 2014;9(3):e90514.
16. Centers for Disease Control and Prevention. *Sexually transmitted disease surveillance 2016*. Atlanta: U.S. Department of Health and Human Services; 2017.
17. CDC 2018. 2016 sexually transmitted diseases surveillance. Fact Sheet. Accessed 5/31/2019 https://www.cdc.gov/STI/stats16/msm.htm
18. Patton ME, Kidd S, Llata E, Stenger M, Braxton J, Asbel L, et al. Extragenital gonorrhea and chlamydia testing and infection among men who have sex with men — STI surveillance Network, United States, 2010–2012. *Clin Infect Dis*. 2014;58(11):1564–70.
19. An Q, Wejnert C, Bernstein K, et al. Syphilis screening and diagnosis among men who have sex with men, 2008–2014, 20 US cities. *JAIDS*. 2017;75(Suppl 3):S363–9.

20. Katz DA, Dombrowski JC, Bell TR, Kerani RP, Golden MR. HIV incidence among men who have sex with men after diagnosis with sexually transmitted infections. *Sex Transm Dis*. 2016;43(4):249–54.
21. Rottingen JA, Cameron DW, Garnett GP. A systematic review of the epidemiologic interactions between classic sexually transmitted diseases and HIV: how much really is known? *Sex Transm Dis*. 2001;28(10):579–97.
22. Brewer TH, Schillinger J, Lewis FM, et al. Infectious syphilis among adolescent and young adult men: implications for human immunodeficiency virus transmission and public health interventions. *Sex Transm Dis*. 2011;38(5):367–71.
23. Pathela P, Braunstein S, Schillinger J, et al. Men who have sex with men have a 140-fold higher risk for newly diagnosed HIV and syphilis compared with heterosexual men in New York City. *J Acquir Immune Defic Syndr*. 2011;58:408–16. https://doi.org/10.1097/QAI.0b013e318230e1ca.
24. Peterman T, Newman D, Maddox L, Schmitt K, Shiver S. Risk for HIV following a diagnosis of syphilis, gonorrhea or chlamydia: 328,456 women in Florida, 2000–2011. *Int J STI and AIDS*. 2015;26(2):113–9. https://doi.org/10.1177/0956462414531243.
25. Johnson LF, Lewis DA. The effect of genital tract infections on HIV-1 shedding in the genital tract: a systematic review and meta-analysis. *Sex Transm Dis*. 2008;35(11):946–59.
26. Kalichman SC, Pellowski J, Turner C. Prevalence of sexually transmitted co-infections in people living with HIV/AIDS: systematic review with implications for using HIV treatments for prevention. *Sex Transm Infect*. 2011;87(3):183–90.
27. Crosby RA, RJ DC, Wingood GM, et al. Associations Between Sexually Transmitted Disease Diagnosis and Subsequent Sexual Risk and Sexually Transmitted Disease Incidence Among Adolescents. *Sex Transm Dis*. 2004;31(4):205–8.
28. Boily MC, Baggaley RF, Wang L, Masse B, White RG, Hayes RJ, et al. Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. *Lancet Infect Dis*. 2009;9:118–29.
29. Celum C, Wald A, Hughes J, Sanchez J, Reid S, Delany-Moretlwe S, et al. Effect of aciclovir on HIV-1 acquisition in herpes simplex virus 2 seropositive women and men who have sex with men: a randomised, double-blind, placebo-controlled trial. *Lancet*. 2008;371(9630):2109–19.
30. Freeman EE, Weiss HA, Glynn JR, Cross PL, Whitworth JA, Hayes RJ. Herpes simplex virus 2 infection increases HIV acquisition in men and women: systematic review and meta-analysis of longitudinal studies. *Aids*. 2006;20:73–83.
31. Crosby RA, Mena L, Salazar LF, Hardin JW, Brown T, Vickers SR. Efficacy of a clinic-based safer sex program for human immunodeficiency virus-uninfected and human immunodeficiency virus-infected young black men who have sex with men: a randomized controlled trial. *Sex Transm Dis*. 2018;45(3):169–76. https://doi.org/10.1097/OLQ.0000000000000721.
32. Lau CY, Qureshi AK. Azithromycin versus doxycycline for genital chlamydial infections: a meta-analysis of randomized clinical trials. *Sex Transm Dis*. 2002;29:497–502.
33. Piszczek J, St Jean R, Khaliq Y. Gonorrhea: treatment update for an increasingly resistant organism. *Can Pharm J*. 2015;148(2):82–9. https://doi.org/10.1177/1715163515570111.
34. Baggaley RF, White RG, Boily MC. HIV transmission risk through anal intercourse: systematic review, meta-analysis and implications for HIV prevention. *Int J Epidemiol*. 2010;39(4):1048–63. https://doi.org/10.1093/ije/dyq057.
35. 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. https://doi.org/10.2105/AJPH.2008.140327.
36. Tsasis P, Nirupama N. Vulnerability and risk perception in the management of HIV/AIDS: public priorities in a global pandemic. *Risk Manag Healthc Policy*. 2008;1:7–14. https://doi.org/10.2147/RMHP.S4245.
37. Pellowski JA, Kalichman SC, Matthews KA, Adler N. A pandemic of the poor: social disadvantage and the U.S. HIV epidemic. *Am Psychol*. 2013;*68*(4):197–209. https://doi.org/10.1037/a0032694.
38. Ayala G, Bingham T, Kim J, Wheeler DP, Millett GA. Modeling the impact of social discrimination and financial hardship on the sexual risk of HIV among Latino and Black men who have sex with men, 102. *Am J Public Health*. 2012;(Suppl 2):S242–9. https://doi.org/10.2105/AJPH.2011.300641.
39. Gordon KS, Edelman EJ, Justice AC, Fiellin DA, Akgün K, Crystal S, et al. Minority men who have sex with men demonstrate increased risk for HIV transmission. *AIDS Behav*. 2017;21(5):1497–510. https://doi.org/10.1007/s10461-016-1590.