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It's Complicated: Sexual Partner Characteristic Profiles and Sexually Transmitted Infection Rates within a Predominantly African American Population in Mississippi

Jalen Alexander, B.A.¹, Jennifer Rose, Ph.D.¹, Lisa Dierker, Ph.D.¹, Philip A. Chan, M.D.², Sarah MacCarthy, Sc.D.³, Dantrell Simmons, M.A.⁴, Leandro Mena, M.D.⁵, and Amy Nunn, Sc.D.²

¹Department of Psychology, Wesleyan University, Middletown, CT, USA

²Division of Infectious Diseases, Alpert Medical School, Brown University, Providence, RI, USA

³University of Southern California, Institute for Global Health, Program on Global Health and Human Rights, Los Angeles, CA, USA

⁴Jackson State University, Jackson, MS, USA

⁵Division of Infectious Diseases, University of Mississippi Medical Center, Jackson, MS, USA

Abstract

Background—Mississippi has among the highest prevalence of sexually transmitted infections (STIs) in the United States (US). Understanding sexual networks can provide insight on risk factors for transmission and guide prevention interventions.

Methods—Participants included 1,437 primarily African American (95%) adults presenting for care at an STI clinic in Jackson, Mississippi. Latent class analysis (LCA) identified underlying population subgroups with unique patterns of response on a comprehensive set of 14 sexual partner variables, such as living with or having a child with a partner, partner dependence and trust, one-time sexual encounters, multiple main partners, substance use, sexual concurrency, and incarceration. Classes were compared on participant age, gender, sexual orientation, public assistance, lifetime partners, relationship status, and self-reported past year STI.

Results—Three classes emerged. Class 1 (N=746) participants were less dependent on partners, and less likely to live with or have a child with a partner. Class 2 participants (N=427) endorsed multiple STI risk factors, including partner incarceration, six or more lifetime partners, sexual concurrency, one-time sexual encounters, and substance use at last sex. Class 3 participants (N=226) were more likely to be in dependent, committed relationships with children. Class 2 had a higher proportion of self report past year STIs (36.7%) compared to Classes 1 (26.6%) and 3 (26.1%).

Address Correspondence to: Jennifer Rose (jrose01@wesleyan.edu; phone: 860-685-2406; fax: 860-685-2761).

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Conclusions—Certain partner factors, such as incarceration, substance use, and concurrency, may contribute to increased STI risk. Partner factors may be useful proxies for STI risks and could be useful questions to include in screening questionnaires in clinical settings.

Keywords

Latent Class Analysis; Sexually Transmitted Infection; Sexual Behavior; Partner Risk

Introduction

It is estimated that there are 20 million new sexually transmitted infection (STI) cases yearly, generating over 16 billion dollars in medical costs [1]. In 2012, Mississippi (MS) ranked highest for the number of new chlamydia and gonorrhea diagnoses with 774 and 231 cases per 100,000, respectively, and ranked number 11 in syphilis diagnoses (5 cases per 100,000) [2]. Within Mississippi, Jackson consistently has had one of the highest rates of STIs, as does the STI clinic from which this study population was drawn [3-5]. African Americans have much higher rates of STIs than people of other races, and these disparities cannot be attributed to individual behavioral factors alone [6-8].

In addition to individual risk factors, research has focused on partner and sexual network characteristics that further increase STI risk [9-13]. Understanding sexual networks and characteristics of sexual partnerships may be important for reducing STI transmission in communities with high rates of infection. Sexual partner characteristics may more accurately predict STI prevalence than individual risk factors alone [13]. Individual and partner characteristics independently associated with increased STI risk include substance use [14, 15], alcohol problems [13], relationship type (e.g., main or non-main sexual partnerships) [10, 11, 16], previous history of incarceration [11, 12, 17], low educational attainment [12], and concurrent sexual partnerships [12]. However, the way these risk factors work together to increase STI risk is unclear [18]. Research focused on identifying population subgroups with similar patterns of risk factors might better identify how myriad risk factors go together in order to develop more effective interventions [19].

Latent class analysis (LCA) is a statistical method that can identify latent population subgroups defined by distinct response patterns on multiple STI risk factors. LCA provides a multidimensional description of how risk factors may work together to increase or decrease the likelihood of acquiring an STI. Recently, LCA was used to identify four population subgroups with distinct STI risk profiles based on substance use social networks [20]. Risk profile subgroups varied in the extent to which they used substances in isolation or with others in their social networks, and differed in likelihood of testing positive for HIV and hepatitis C virus (HCV) [20]. Other research identified groups of individuals that shared distinct profiles of substance use and sexual risk behaviors; these profiles were differentially related to likelihood of condom use, a critical factor in the transmission of STIs [21]. In addition, different types of substance users were more likely than others to use substances during sex [15] or to engage in transactional sex [22]. Finally, these studies indicated that women, African Americans, sexual minorities, and unmarried individuals are disproportionately represented in the highest sexual risk groups [7, 15, 21, 22].

To our knowledge, no studies have sought to identify population subgroups with unique STI risk profiles based on partner characteristics. Little is known about whether there are underlying partner related risk profiles that differ in STI risk. Consequently, the current study used LCA to identify latent population subgroups, defined by distinct response patterns on a range of sexual partner characteristics, and examined subgroup differences in past year STI rates. It was hypothesized that a small number of discrete classes would emerge showing unique partner risk profiles, and that these classes would differ in likelihood of having had STI in the past year. A better understanding of how partner characteristics work together can guide the development of interventions targeted to specific groups with partner risk networks that put them at risk for STIs and tailored to the unique needs of these groups.

Materials and Methods

Participants and Procedures

All individuals presenting for care at a publicly funded STI clinic in Jackson, MS, were offered enrollment in the study between January and June 2011. All participants were offered GC and CT testing, as well as testing for other STIs. Although clinic clients could refuse this testing, it was very unusual for them to do so. Eligibility criteria included: 1) being at least 18 years old, 2) presenting for STI or HIV screening, 3) willing to complete a 30-minute computerized survey, and 4) speaking English. Data were collected using a self-administered survey programmed on *Illume*™ software (*Datstat*, Washington). All participants provided informed consent. Participants did not receive compensation for their participation. The study was approved by the University of Mississippi Medical Center, the Mississippi State Department of Health, and The Miriam Hospital institutional review boards.

Measures

Participant demographics included age (24 or younger vs. older), gender, education (at least some college education vs. no college education), and self-identified sexual orientation (heterosexual, homosexual, or bisexual), whether or not the participant was currently in a long term relationship (married or long term domestic partnership vs. single or divorced), use of public financial assistance, and lifetime number of partners (1-5 vs. 6 or more).

Sexual partner characteristics were assessed as binary (yes/no) responses for respondents' self-report on their three most recent *past year* sexual partners. These included whether any partner had been incarcerated; whether any relationship was a one-time sexual encounter, living with or having a child with any of the partners; at least one partner considered to be a main partner; and whether participants agreed that they trusted at least one of their partners. In addition, for each partner, participants were asked whether they depended on their partner for anything (financial dependence, food, housing, transportation, and gifts) and whether their partner depended on them for the same things. Two binary dependency variables were created for participant and partner dependency.

Concurrency—Concurrency refers to sexual partnerships overlapping in time. Participants were asked to list their three most recent sexual partners in the past year. Sex was defined as vaginal, anal or oral intercourse. We then asked two questions. The first assessed participant sexual concurrency by asking: “During the time period you were having sex with [PARTNER INITIALS], did you also have other sexual partners?”, and the second assessed partner concurrency by asking “Do you think [PARTNER INITIALS] had other sexual partners during the time period he or she was having sex with you?”. Participants were coded as concurrent if they responded “yes” to the first question for any of their partners, and were coded as having partner concurrency if they responded “yes” to the second question for any of their partners.

Alcohol and drug use during sex—Participants were asked whether they or their partners had used alcohol or drugs during their last sexual encounter. Participants were categorized separately as positive for alcohol or drug use at last sex if they reported use during their last sexual encounter and positive for partner alcohol or drug use at last sex if they reported use by one or more partners during their last sexual encounter.

STI Outcomes—Participants were asked “In the last year, have you been told by a medical professional that you had any of the following sexually transmitted infections?” STIs included Chlamydia, Gonorrhea, Trichomonas, Herpes, Syphilis, Non-gonococcal Urethritis, Mucopurulent Cervicitis, Pelvic Inflammatory Disease, and/or other STI. Individuals who indicated that they had been diagnosed with any STI were coded as positive. Those who were indicated they were not diagnosed with any STI were coded as negative. In addition, test results for gonorrhea and chlamydia were obtained from medical record abstraction (MRA) for a subset (N=1,297) of the participants before data collection was halted prematurely as a result of administrative circumstances, and were coded as positive or negative.

Analysis

LCA was used to identify classes based on sexual partner characteristics, as well as participant concurrency and substance use at last sex. A series of LCA models specifying 2-8 latent classes were tested using Mplus Version 7 [23]. To avoid the likelihood of converging on a local maximum, 500 start values were generated for each model. Indices used to determine the optimal LCA solution included the sample size adjusted Bayesian Information Criterion (BIC) and the adjusted Lo Mendell Rubin likelihood ratio test for model fit (LMR)[24], which tests the null hypothesis of no improvement in fit for the model under consideration compared to a model with one less class. The average posterior probability of class membership (the closer to 1, the better) and interpretability of the classes were also considered.

Covariate and outcome analysis

After identifying the LCA model with the optimal number of classes based on the criteria above, participant demographic characteristics (age, gender, sexual orientation, education, and use of public assistance) were added to the LCA model. Latent classes were compared on the covariates using multinomial logistic regression analysis. Using separate log binomial

regression models, classes were also compared on past year prevalence of self-reported STIs including chlamydia, gonorrhea, trichomonas, herpes, and syphilis, and on a measure of any self reported STI. Classes were also compared on chlamydia and gonorrhea diagnoses from MRA. A Benjamini-Hochberg correction was applied to control for Type 1 error inflation resulting from multiple comparisons[25].

Results

The majority of patients (93%; N=1,542) offered an opportunity to participate by clinic staff completed the survey. The LCA was based on 1,437 participants with complete demographic data. Table 1 provides descriptive statistics on the measures for the data analytic sample. The majority (95.3%) was African-American, and 61.7% identified as female. Participants were between the ages of 18 and 65 with most aged 24 or younger (60.2%). A total of 82 (5.8%) participants identified as bisexual, 48 (3.3%) identified as gay, and 29 (2.0%) identified as lesbian. Over half had at least some college education (N=851; 59.2%).

Latent Class Analysis to Identify Sexual Partner Network Profiles

A comparison of model fit indices based on latent class models with no covariates showed that a 3-class solution was preferred (Table 2). The 3-class solution provided a lower BIC, entropy was acceptable at 0.81, and the LMR test indicated a significant improvement in fit over a 2-class model. There was no substantial difference in fit between the 3- and 4-class models, so the 3-class model was retained based on parsimony.

The 3-class solution was then modeled with the covariates gender, age, sexual orientation, education level, and use of public assistance along with the past year STI outcome variable. The BIC for this model was lower than it was for the 3 class model with no covariates, suggesting an improvement in fit for the models with the covariates and STI outcome (Table 2), and entropy and average probabilities for latent class membership exceeded 0.90 (Table 3).

Estimated prevalence for the variables used to identify latent classes is shown in Table 4. Class 1 was largest with 54.6% of the sample (N=784) having the highest probability of being in this class. Class 2 included 29.7% (N=427) of the sample and Class 3 included 15.7% (N=226) of the sample. Compared to Classes 2 and 3, Participants in Class 1 had significantly lower odds of living with (10.0%) or having a child (12.3%) with a partner compared to the other two classes, and virtually none (<1%) of the participants indicated that either they or their partner were dependent on each other. More than a third of the participants in this class reported participant concurrency (34.9%) having significantly greater odds compared to Class 3, but significantly lower odds compared to Class 2. In addition, an estimated 42.3% of Class 1 participants reported partner concurrency, having significantly lower odds compared to Class 2, but not significantly different from Class 3. Similarly, participants in Class 1 had significantly greater odds of engaging in one-time sexual encounters (34.8%) than Class 3, but did not differ from Class 2. Participants in this class had the lowest odds of alcohol and drug use at last sex (<6%), but did not differ from Class 3.

Compared to Classes 1 and 3, Participants in Class 2 had significantly greater odds of having a partner who had been incarcerated (25.6%) and concurrent relationships for both participants (71.5%) and their partners (76.4%). The odds of reporting any kind of dependency between themselves and their partners (<7%) compared to the other two classes. Participants in this class also significantly greater odds than Classes 1 and 3 of alcohol and drug use during their last sexual encounter, with 63.7% of participants and 70.4% of their partners using alcohol at last sex and 40.6% of participants and 49.2% of their partners using drugs at last sex.

Class 3 participants had significantly greater odds than the other classes to report living with (45.6%) and having a child (39.9%) with a partner. They also had significantly greater odds of dependence with an estimated 79.5% indicating that they were dependent on a partner and 76.2% indicating that they had a partner that was dependent on them. Participants in Class 3 also had lower odds than the other two classes to have multiple main partners in the past year (9.5%) or to have engaged in a one-time sexual encounter with a partner (8.1%). Finally, Class 3 had the lowest odds of self-reported sexual concurrency (18.2%) compared to the other two classes, yet 42.0% indicated that they had a partner that was involved in a sexually concurrent relationship. The odds of using alcohol and drugs at last sex by participants and partners was lower for Class 3 (<10%) compared Class 2, but not different from Class 1.

Class Differences on Demographic Covariates

Table 4 shows estimated prevalence for the three classes on the covariates and significant differences after applying a Benjamini-Hochberg[25] correction for Type 1 error rate. There were no gender differences. Compared to Class 2, participants in Class 1 had increased odds having six or more lifetime partners. Compared to Class 3, participants in Class 1 had increased odds of having some college education, and had significantly lower odds of using public financial assistance. Finally, compared to Class 3, participants in Class 2 had significantly greater odds of identifying as bisexual and having six or more lifetime partners. Participants in Class 2 had significantly lower odds of being in a long term relationship compared to Classes 1 and 3.

Class Differences on STI Prevalence Rates

Class 2 had the highest prevalence of having had a self-reported STI in the past year with 36.7% reporting that they had an STI in the past year (Table 5). After applying the Benjamini-Hochberg correction, this was significantly higher than Class 1 (26.1%), but not significantly different from Class 3 (26.6%). Class 1 and Class 3 did not differ significantly in self report of any STI. Class 2 also had the highest prevalence of self reported past year chlamydia, gonorrhea, trichomonas, and herpes. However, there were significant class differences only for trichomonas. Compared to Class 1, Class 2 had a significantly greater odds of having had trichomonas. There were no significant differences in STI prevalence between Classes 2 and 3 (Table 5).

Discussion

This study evaluated individuals presenting for HIV/STI testing at a public health clinic in Jackson, MS which has among the highest rates of STIs in the country. LCA revealed three underlying classes with different sexual partner characteristics. A single class (Class 2) was found to have individuals with significantly elevated risk factors for STIs and a significantly greater proportion with self-reported any past year STI and trichomonas. Another (Class 1) was found to have individuals who were less reliant on their partners, and one class (Class 3) was found to have individuals that appeared to be in more long term, dependent relationships. The latter two classes did not differ in the proportion of individuals with a past year STI.

Individuals in Class 2 had more one-time sexual encounters, lifetime partners, concurrent relationships, and alcohol and drug use at last sex. They had greater odds of identifying as bisexual and having a partner who had been incarcerated and lower odds of being college educated and in a long term relationship. Class 1 was a more independent group of participants who tended to be less likely to live with or have a child with a partner, to be dependent on a partner or have a partner that was dependent on them, and to receive public assistance. Individuals in Class 3 had higher rates of living with or having a child with a partner, and mutual partner dependency. They reported fewer one-time sexual encounters and fewer personal concurrent relationships. Interestingly, though, over 40% reported that their partner was involved in a concurrent relationship and did not trust their partner.

Unlike prior research, this study allowed us to identify how the interplay of partner risk characteristics might serve to increase or decrease the odds of having an STI. Future prevention efforts should consider these findings when educating and counseling individuals presenting for STI testing. In particular, the combination of sexual concurrency and substance use appeared to convey greater STI risk. Past research has been equivocal in identifying sexual concurrency as a consistent risk factor for the spread of STIs [26, 27]. However, this study suggests that concurrency may be a more salient risk factor for STIs in populations that also commonly use alcohol or drugs during sex. Therefore, STI risk screening might more accurately identify high-risk individuals by asking about both concurrency and substance use during sex. Conversely, mutual dependency in a partnership appears to be protective against STIs.

Individuals who are mutually dependent on each other may also have considerably lower rates of concurrency suggesting a smaller sexual network that might inhibit the spread of STIs. Finally, although Class 1 had higher rates of one-time sexual encounters, more lifetime sexual partners, and higher rates of participant concurrency, they had the same rate of self reported past year STIs as Class 3. It is possible that partner concurrency is an important factor in the likelihood of contracting an STI given that an equal percentage in both classes reported partner concurrency. This could mean that even though being in long term, dependent relationships are often considered protective factors, they aren't necessarily protective if partners are involved in concurrent relationships. Consequently, individuals presenting for STI testing who appear less at risk may be important targets for prevention

programs focusing on the risks of partner concurrency in the absence of other partner risk factors.

The current research has some limitations. The investigation was cross-sectional prohibiting inference regarding temporal ordering of the partner risk factors and STI outcomes. The research was conducted at an urban STI clinic with a high-risk population of predominantly African American adults, so the results may not be generalizable to the broader population of adults in MS or other regions. LCA is largely a descriptive method. Future replication of the analysis in independent samples would be useful to determine whether the same profiles emerge reliably. Furthermore, it may be important to conduct LCA using additional risk factors, as more informative profiles with greater predictive value may emerge.

Although there were significant differences between classes in some self-reported STIs, the classes did not differ in rates of diagnosed chlamydia or gonorrhea infections. This may be due to the fact that the timeframe for self reported STIs was much longer (past year), and included other STIs in addition to chlamydia and gonorrhea, whereas the MRA assessed only gonorrhea and chlamydia test results at the time of visit. In addition, there were significant class differences in prevalence of self reported trichomonas, which was not recorded in the MRA data. Finally, MRA was halted before MRA data were collected for all study participants, which was another limitation of this study. Future research that includes larger samples and biological markers for multiple prevalent STIs might help elucidate specific cluster infections for classes at highest risk for contracting STIs.

This study represents one of the largest studies exploring partner risk factors for STIs among a high-risk population of mainly African Americans in the Deep South with an extremely high response rate (93%), and is one of the first studies to utilize LCA to identify subgroups in this population based on shared patterns of relationships with their partners. By using a multidimensional approach, this study helps identify how certain partner related factors work together to identify groups of individuals at greatest risk for contracting STIs. LCA assessed the simultaneous interaction of multiple risk factors that place individuals at greatest risk for contracting STIs, which would be infeasible to test using standard regression methods. This type of analysis has the potential to improve clinical assessment of STI risk by identifying useful questions to ask during clinical intake that most efficiently identify patients at elevated risk. This in turn, could lead to more targeted and effective public health interventions.

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Table 1
Descriptive statistics for data analytic sample (N=1,437)

Variable	N (%)
<i><u>Participant Covariates</u></i>	
Female	886 (61.7)
Less than 24 years old	865 (60.2)
African American	1369 (95.3)
Sexual orientation	
Heterosexual	1277 (88.9)
Gay male	48 (3.3)
Lesbian	29 (2.0)
Bisexual	82 (5.7)
Some college education	851 (59.2)
Receives public assistance	578 (40.2)
In a committed relationship	114 (7.9)
More than 5 lifetime partners	965 (67.2)
<i><u>Partner Characteristics</u></i>	
Live with partner	266 (18.5)
Child with partner	281 (19.6)
Participant dependent on partner	221 (15.4)
Partner dependent on participant	202 (14.1)
Multiple main partners	338 (21.8)
One time sexual encounter	460 (32.0)
Partner incarceration	210 (15.1)
Trust partner	927 (64.5)
<i><u>Sexual Concurrency</u></i>	
Participant sexual concurrency	589 (43.6)
Partner sexual concurrency	714 (49.7)
<i><u>Substance Use at Last Sex</u></i>	
Participant alcohol use at last sex	327 (24.3)
Partner alcohol use at last sex	355 (26.1)
Participant drug use at last sex	194 (14.4)
Partner drug use at last sex	235 (17.3)
Past year STI	413 (29.6)
Chlamydia diagnosis from MRA *	210 (16.2)
Gonorrhea diagnosis from MRA *	61 (4.7)

Note: Partner characteristics reflect characteristics of the participant's three most recent past year partners. MRA=medical record abstraction.

* N=1297

Table 2
Latent class analysis fit indices and class membership probabilities for 3 class model with covariates and self reported STI outcome

	Two Class (No Covariates or STI Outcome)	Three Class (No Covariates or STI Outcome)	3 Class with Covariates and STI Outcome
Log likelihood	-11328.53	-10792.14	-10141.40
Number of Parameters	35	53	71
Sample size adjusted BIC	22803	21805	20573
Entropy	0.91	0.81	0.82

Average Most Likely Latent Class Membership Probabilities for Final 3 Class Model			
	Class 1	Class 2	Class 3
Class 1	.91	.02	.06
Class 2	.02	.93	.01
Class 3	.07	.01	.96

Table 3
Estimated percentages for LCA classification variables and odds ratios and confidence intervals for differences between classes

	Class 1 (N=784; 4.6%)	Class 2 (N=427; 29.7%)	Class 3 (N=226; 15.7%)
Variable	%	%	%
<i>Partner Characteristics</i>			
Live with partner	10.0	18.5	45.6
Child with partner	12.3	20.9	39.9
Participant dependent on partner	0.5	6.4	79.5
Partner dependent on participant	0.0	4.6	76.2
Multiple main partners	24.2	24.7	9.5
One night sexual encounter	34.8	40.0	8.1
Partner incarceration	9.2	25.6	13.5
Trust partner	66.5	65.1	57.2
<i>Sexual Concurrency</i>			
Participant sexual concurrency	34.9	71.5	18.2
Partner sexual concurrency	42.3	76.4	42.0
<i>Substance Use at Last Sex</i>			
Participant alcohol use at last sex	5.4	63.7	7.3
Partner alcohol use at last sex	4.4	70.4	9.1
Participant drug use at last sex	1.6	40.6	4.0
Partner drug use at last sex	1.6	49.2	5.4

Note: Bolded values represent variables that are most clearly define the profile for each class.

Table 4

Estimated latent class prevalence for covariates.

	Class 1	Class 2	Class 3
Variable	%	%	%
Gender			
Female	56	29	15
Male	55	30	14
Age			
25 or older	52	29	18
24 or younger	58	29	13
At least some college education ^b			
No	52	29	19
Yes	58	29	12
WSW			
No	56	29	15
Yes	42	44	14
MSM			
No	55	30	15
Yes	74	18	7
Bisexual ^c			
No	58	28	14
Yes	47	48	4
On public assistance ^b			
No	61	27	12
Yes	47	32	20
In a committed relationship ^{bc}			
No	57	29	13
Yes	31	26	44
Six or more lifetime partners ^{ac}			
No	68	11	20
Yes	46	43	12

Note: A Benjamini-Hochberg correction for Type 1 error inflation was applied to all significance tests.

^aSignificant difference between Classes 1 and 2;

^b significant difference between Classes 1 and 3;

^cSignificant difference between Classes 2 and 3.

Table 5
STD prevalence and prevalence ratios for differences between classes

Variable	Class 1		Class 2		Class 3		Class 1 compared to Class 2		Class 1 compared to Class 3		Class 2 compared to Class 3	
	%		%		%		PR (95%CI)		PR (95%CI)		PR (95%CI)	
Self report past year STI	26.6		36.7		26.1		0.72 (0.61, 0.86) *		1.02 (0.79, 1.31)		1.41 (1.09, 1.82)	
Self report past year chlamydia	18.8		22.5		16.8		0.84 (0.66, 1.07)		1.12 (0.79, 1.58)		1.33 (0.93, 1.92)	
Self report past year gonorrhea	7.4		12.5		8.9		0.59 (0.40, 0.88)		0.84 (0.48, 1.44)		1.41 (0.82, 2.44)	
Self report past year trichomonas	7.0		16.4		8.8		0.43 (0.29, 0.63) *		0.79 (0.46, 1.37)		1.85 (1.10, 3.14)	
Self report past year herpes	2.5		3.3		3.1		0.76 (0.33, 1.74)		0.81 (0.30, 2.22)		1.06 (0.36, 3.11)	
Self report past year syphilis	1.8		1.5		1.9		1.20 (0.38, 3.78)		0.96 (0.27, 3.44)		0.80 (0.18, 3.54)	
Chlamydia diagnosis from MRA ^a	18.1		14.1		14.0		1.28 (0.96, 1.72)		1.29 (0.89, 1.87)		1.00 (0.66, 1.52)	
Gonorrhea diagnosis from MRA ^a	3.8		6.3		4.8		0.60 (0.35, 1.02)		0.78 (0.38, 1.59)		1.30 (0.64, 2.65)	

^aNote: MRA=medical record abstraction.

* Statistically significant after Benjamini-Hochberg correction for Type 1 error inflation.