Published in final edited form as:

Sex Transm Infect. 2017 August ; 93(5): 348–355. doi:10.1136/sextrans-2016-052798.

Sexual partner characteristics and incident rectal *Neisseria gonorrhoeae* and *Chlamydia trachomatis* infections among gay men and other men who have sex with men (MSM): a prospective cohort in Abuja and Lagos, Nigeria

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Abstract

Background—Sexually transmitted infections (STIs) including *Neisseria gonorrhoeae* (GC) and *Chlamydia trachomatis* (CT) potentiate HIV acquisition and transmission especially among gay men and other men who have sex with men (MSM). We investigated the influence of sexual network composition on incident rectal GC and/or CT infections among Nigerian MSM.

Methods—TRUST/RV368 is a cohort of MSM recruited using respondent-driven sampling at trusted community centers in Abuja and Lagos, Nigeria. MSM respondents (egos) provided STI

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Contributors. Study concept HOR, MC, HL and RGN. Laboratory work: TN. Analysis and interpretation of the data: HOR, MC, HL, RGN and TAC. Drafting of manuscript: HOR, MC, HJ, RGN, TAC, SDB, JA, SP, NN and TN. Critical revision of manuscript for important intellectual content: MC, HL, TAC, SDB, CG RGN.

Ethical approval. The study was approved by the University of Maryland Baltimore Institutional Review Board (IRB), the Federal Capital Territory Health Research Ethics Committee, Abuja, and Walter Reed Army Institute of Research IRB.

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risk factors and demographic information for up to 5 of their most recent sexual partners (alters) within their sexual networks. Egos were tested for HIV, GC and CT every three months. Log-binomial regression was used to assess associations between alter characteristics and incident GC and/or CT.

Results—Between March 2013 and October 2015, 492 MSM were longitudinally screened for STIs, of which 28.0% (n = 138) were positive for incident rectal STI (61 GC only, 42 CT only, and 35 GC and CT). Among egos, condom use was associated with STIs [half of the time vs. never (adjusted risk ratio (aRR) 0.5; 95% CI 0.3–0.8), always/almost always vs. never (aRR 0.7; 95% CI 0.5–1.0)]. Incident STIs were associated with having a younger alter 19 vs. 30 years (aRR 0.6; 95% CI 0.4–1.0), HIV infection (aRR 1.5; 95% CI 1.1–2.0) and engaging in sex under the influence of alcohol (aRR 1.4 95% CI 1.1–1.7) among regular alters and age, 19 vs. 30 years (aRR 0.3; 95% CI 0.2–0.6), HIV infection (aRR 1.4; 95% CI 1.1–1.8) and engaging in sex under the influence of alcohol (aRR 1.2 95% CI 1.0–1.4) among casual alters.

Conclusion—Given the centrality of sexual partner characteristics as risks for incident STIs among Nigerian MSM, there is a need to move beyond individual interventions and syndromic surveillance and get “out there” in the STI management.

Keywords

Men who have sex with men (MSM); Gay; Sexually transmitted infections; Sexual partners; *Neisseria gonorrhoeae*; *Chlamydia trachomatis*

INTRODUCTION

Sexually transmitted infections (STIs) such as *Neisseria gonorrhoeae* (GC) and *Chlamydia trachomatis* (CT) disproportionately affect men who have sex with men (MSM),^{1, 2} in sub-Saharan Africa (sSA). These bacterial STIs are common, can easily be transmitted, and increase individual susceptibility to HIV acquisition and transmission,^{3, 4}. In Kenya and Senegal, the prevalence of GC in the general population is estimated at <1% whereas the prevalence among gay men and other MSM is 9.3%,⁵ and 5.5%,^{6, 7} respectively. A prior study with MSM in Nigeria estimated a GC prevalence of 23% and CT prevalence of 16%,⁸. To date, few studies have documented incidence of these infections,⁹ which indicates the current trend of the epidemics. Studies on incidence of STIs are important as they contribute to our understanding of infection risks and the STI epidemic dynamics among gay men and other MSM.

Among the prior cross-sectional studies, individual-level factors such as multiple sex partners, engaging in transactional sex, inconsistent condom use, and alcohol use were associated with prevalent,^{10, 11}. Risk for STIs cannot be attributed to a single factor, but rather a combination of factors that may include risks associated with specific characteristics of an individual's sexual partnerships. While there have been several studies that examined sexual network characteristics in relation to HIV infection,^{12, 13} studies that used a longitudinal approach to examine sexual network characteristics in the context of STIs among MSM in sSA are lacking. Partner characteristics may influence STI transmission within these sexual networks. For example, previous studies have shown that individuals are

less likely to consistently use condoms with trusted partners or partners who provide emotional support,¹⁴ Furthermore, condom use negotiation among gay men and other MSM varies according to partner characteristics, with the insertive partner being more likely to determine condom use than the receptive partner,¹⁵ Understanding network factors associated with STI acquisition is of public health importance because GC, CT, and HIV infections may act synergistically to facilitate onward transmission. For example, ulceration and inflammation resulting from GC or CT increases individual susceptibility for HIV acquisition,¹⁶.

The objective of these analyses was to describe the constitution of sexual networks and assess the impact of partner characteristics on the incidence of anorectal GC and CT infections among gay men and other MSM attending HIV prevention and treatment clinics in Abuja and Lagos, Nigeria.

METHODS

Study design and population

Between March 2013 and October 2015, MSM were recruited into a prospective combination HIV prevention and treatment study (TRUST/RV368) using respondent driven sampling in Abuja and Lagos, Nigeria as previously described,¹⁷. In brief, eligible participants were born male, age 16 years (Abuja) or 18 years (Lagos), engaged in receptive or insertive anal intercourse in the past year, and provided informed consent in English or Hausa. This study was conducted in collaboration with the Institute of Human Virology at the University of Maryland, the Institute of Human Virology Nigeria, Johns Hopkins University, the International Center for Advocacy on the Right to Health, and the US Military HIV Research Program. The study was approved by the University of Maryland Baltimore Institutional Review Board (IRB) (Reference No: HP-00052013), the Federal Capital Territory Health Research Ethics Committee, Abuja (Reference No: FHREC/2012/08/22/09-08-12), and Walter Reed Army Institute of Research IRB (Reference No: MODRHEC/APP/056).

Data collection

In this study, enrolled MSM were considered “egos” while their male partners were “alters”. After obtaining written informed consent, face-to-face interviews using a structured survey instrument were administered to each participant (ego) at baseline and every 3 months for up to 18 months. The questionnaire captured demographic characteristics as well as sexual behaviors such as sexual orientation, number of sex partners, frequency of condom use, difficulty insisting on condom use, sexual positioning, and type of sex. Egos were also asked to provide similar information for up to five of their most recent sexual partners (alters) at the first, third and fifth visits. The sexual network was delineated by a cue technique which has been shown to be effective in recalling sex partners in the past 1 year before the interview,¹² “I am going to ask you some questions about the men that you had anal sex with, starting with the man with whom you most recently had anal sex” in your sexual network. After the sexual networks were listed, egos were asked a detailed set of questions

pertaining to each alter, including age, gender, HIV status, condom use, alcohol use, transactional sex and sex with anonymous partners.

Clinical data and specimens such as blood, rectal swabs, and urine were collected at baseline and at each follow up visit. Blood samples were tested for HIV infection using rapid HIV antibody tests following the parallel testing algorithm for high-risk individuals according to national guidelines in Nigeria,¹⁸. For individuals who were HIV-negative, HIV testing continued every three months. At every visit, urine and rectal swabs were tested for GC and CT using the Aptima Combo 2 for GC and CT (Gen-Probe, California). All participants who tested positive for any infection were treated according to national guidelines in Nigeria,¹⁹.

Definition of Variables

The primary outcome was the occurrence of the first incident rectal GC or CT infection during follow up. Incident infections were defined as a positive GC or CT test from a participant who had a prior negative test result at enrollment or after successful treatment of a prevalent infection. Concurrency was defined as an overlapping of two or more sexual partnerships at the same time period. Network size was defined as the number of alters reported and dichotomized at the median number of alters (4 alters and 3). Frequency of condom use was categorized as always/almost always, about half of the time and never used. Based on self-assessment from each participant, the confidence of alter information was measured from 0 (none) to 10 (very strong confidence). We defined regular partners as those with whom the participant had sex with and feels committed to. Casual partners were those with whom the participant had sex with but do not feel committed to.

Statistical analysis

Because receptive anal sex bears higher risk of STI acquisition than insertive anal sex,²⁰ individuals who only engaged in insertive anal sex within their network were excluded from these analyses. Because sexual partner characteristics may change over time, data on sexual partner characteristics collected most closely prior to the diagnosis of an incident infection were used in statistical models to predict occurrence of GC or CT. Similarly, for participants without an incident infection, the last available sexual partner characteristics were used. Bivariate and multivariate log-binomial regression models were used to assess associations between ego characteristics and incident rectal GC or CT. In order to understand whether HIV positive individuals with small network size have different STI risk compared to HIV positive with large network size, an interaction term involving HIV and network size was included in the multivariate model containing ego characteristics. We then created ego-alter pair data from the list of alters. The ego-alter paired data consisted of one data record for each sex partner that included participant characteristics and STI diagnosis. Using this data, bivariate and multivariate log-binomial regression models were used to assess associations between alter characteristics and incident rectal GC or CT. All associations were presented as adjusted risk ratios (aRRs) with 95% confidence intervals (CIs). Statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

Study population

Of 683 study participants, 191 (28.0%) were engaged in insertive sex only and were excluded from these analyses. A total of 492 egos reported 1,975 sexual partners in the past year with a median network size of 5 (interquartile range [IQR] 3 – 5) partners. During follow-up, participants contributed a total of 13,827.4 weeks with each participant contributing a median of 14.1 (IQR 12.0–37.1) weeks. Participants with STIs had a median follow up of 22.7 (IQR, 13.4– 39.1) weeks and those without STIs had 12.1 (IQR, 12.0–34.0) weeks. Table 1 presents social-demographic characteristics and sexual behavior of the egos and their alters.

Ego characteristics—The median age of egos was 24 (IQR; 21 – 27) years. The majority of egos were between 20 and 29 years old (n=343, 69.7%), had senior secondary school education (n=259, 53.2%), and were bisexual (n=297, 60.6%). Slightly over half (51.3%) reported almost always or always using a condom during insertive anal sex, and a third (33.7%) almost always or always used a condom during receptive anal sex. Three hundred and twenty six (66.3%) had concurrent partnerships in the 12 months prior to enrollment, and 163 (39.6%) were HIV positive at the time of enrollment.

Alter characteristics—The median age of alters was 27 (IQR; 23 – 31) years. Of 1,975 alters, 1,037 (52.6%) were between 20 and 29 years old and 968 (49.1%) had more than senior secondary school education. Based on the egos' responses, 619 (31.5%) alters were reported to almost always or always use a condom during insertive anal sex and 915 (46.6%) during receptive anal sex. Five hundred and ninety two (30.0%) had received money/favor in exchange for sex, 1255 (63.8%) had more than one regular sex partner, and 542 (27.5%) had sex under the influence of alcohol. The median score measuring egos' confidence in alters information was 8(IQR; 6 – 9).

STI Incidence

At baseline, 56 (11.4%) of 492 participants had prevalent rectal GC and/or CT infections. During follow-up, there were 138 incident rectal infections; 106 cases were new infections after negative test results at baseline and 32 cases were re-infections after successful treatment of infections diagnosed at baseline. Of the 138 incident rectal infections, 61 were GC only, 42 were CT only, and 35 were GC and CT. The incidence of rectal GC was 12.4% (95% CI; 9.4 – 15.2) and of rectal CT was 8.5% (95% CI; 6.0 – 10.1). Overall, the incidence of rectal GC and/or CT was 28.0% (95% CI; 24.0 – 32.0). One hundred and ten (79.7%) of the incident STI's were asymptomatic.

Ego characteristics and incidence of rectal GC and/or CT

Multivariate analysis of ego characteristics (Table 2) showed that incidence of rectal GC and/or CT was significantly associated with younger age 20–29 vs. 30 years (aRR=2.1; 95% CI 1.5– 2.9), larger network size 4–5 vs. 1– 3, (aRR = 1.5; 95% CI 1.1–2.0) and having sexual concurrency (aRR=2.4; 95% CI 1.3–4.2). Compared to egos who never used condoms during receptive anal sex, those who used condoms always and about half the time

demonstrated decreased risk for incident GC and/or CT (aRR =0.7; 95% CI 0.3–0.8 and aRR =0.5; 95% CI 0.5–1.0 respectively). Individuals who self-identified as gay compared to bisexual had an increased risk (aRR =1.5; 95% CI 1.0 –2.1). Individuals who had been previously diagnosed with HIV (aRR =2.8; 95% CI 2.6 –4.9) and individuals newly diagnosed with HIV (aRR = 1.9; 95% CI 1.0 –3.7) were associated with increased risk compared to HIV-uninfected individuals. There were interaction effects of HIV status and the size of sexual network on incidence of GC and/or CT. That is, compared to HIV-uninfected individuals with small network size, previously diagnosed and newly diagnosed HIV infected individuals with large network size demonstrated significantly increased risk of incident rectal GC and/or CT (aRR =3.9; 95% CI 1.9–8.1 and aRR =3.2; 95% CI 1.5–6.8 respectively).

Alter characteristics and incidence of rectal GC and/or CT

Bivariate analyses on alters characteristics were presented in table 3. In Table 4, among casual alters, being HIV positive (aRR = 1.4; 95% CI 1.1–1.8) having sex under the influence of alcohol (aRR=1.2; 95% CI 1.0–1.4) and having sex with anonymous partners (aRR= 1.6; 95% CI 1.2–2.3) were each associated with increased risk of incident rectal GC and/or CT. Having younger alters was associated with decreased risk of incident GC and/or CT (aRR = 0.3; 95% CI 0.2–0.6, for 19 vs. 30 years old).

Among regular alters, having younger alters was associated with decreased incidence of rectal GC and/or CT (aRR=0.6; 95% CI 0.4–1.0 for 19 vs. 30 years old). Other alter characteristics associated with increased incidence included higher education, [senior secondary school vs. < senior secondary school, (aRR=2.3, 95% CI 1.2–4.4)], [> senior secondary school vs. < senior secondary school, (aRR=2.6; 95% CI 1.4–5.0)], HIV infection (aRR=1.5; 95% CI 1.1–2.0), and having sex while under the alcohol influence (aRR=1.4, 95% CI 1.1–1.7).

DISCUSSION

Using a well-characterized cohort of MSM in Nigeria with longitudinal testing for STIs, a high incidence of rectal infections with GC and/or CT was observed. The high incidence of STIs in this cohort is higher than has been previously reported among MSM,^{9, 21}. This high incidence of STIs highlights the importance of STI screening among MSM in order to curb the spread of these infections. By using the sexual network approach in explaining individual risk of STI acquisition, this study documented that alter age, engaging sex under influence of alcohol, HIV status and condom use as significant predictors of incident STIs among MSM in this cohort.

As indicated in this study, majority of STIs among MSM are asymptomatic and syndromic surveillance and management of STI would have missed 80% of all cases. Routine laboratory-based STI screening is an important strategy to prevent further transmission of GC, CT and HIV,⁹. Early detection and treatment of asymptomatic STIs prevents onward transmission. Furthermore, it has been shown previously that individuals who are newly diagnosed with STIs, such as HIV, are likely to change sexual practices until no longer at risk of onward transmission,^{22, 23}. Interventions that facilitate tracking of sex partners of

index cases have been shown to be critical to prevent STI transmission in other settings. Specifically, assisted partner notification, which has been shown to be a successful strategy in identifying unknown STI infected heterosexual individuals in many settings,^{24, 25} could be explored as a strategy, and its feasibility and acceptability assessed among populations with multiple partners.

Ego HIV status was associated with incident STIs. Participants with a previous or new HIV diagnosis had higher risk of incident GC and/or CT compared to HIV negative MSM, underscoring the need to expand integrated HIV and STI laboratory screening and management. We observed that HIV positive individuals with a large network size tended to be associated with higher risk of incident STIs than HIV negative individuals with a small network size. This finding is important in public health as the combination of HIV infection and a large sexual network facilitates transmissibility of STIs. Different sexual partners may engage in different high risk sexual behaviors, such as condomless sex or sex under the influence of drugs/alcohol. For example, we noticed an increased STI risk among those who had sex under the influence of alcohol. Alcohol use increases risk behaviors via various mechanisms including drinking environments, expectancies about its sexual enhancements, and associated poor decision-making. Because same-sex practices are culturally and legally unacceptable in Nigeria,²⁶ stigma and depression may trigger alcohol consumption. Severe alcohol consumption is linked with decreased risk perception and impaired condom use negotiating capacity,²⁷. We documented reduction of incident STI among consistent condom users underscoring the important role that condoms play in STI prevention. In circumstances where MSM report concurrency, alcohol consumption, and multiple sex partners, condom use remains one of the most effective methods to prevent STI including HIV acquisition or transmission. Therefore, along with other strategies, risk reduction interventions to reduce STIs among MSM should emphasize behavioral approaches that include the use of condom. Improving accessibility and emphasizing utilization of water based lubricants along with condom use is essential to prevent STIs transmission. In addition, supportive interventions in preventing and dealing with depressive behaviours, and either discontinue alcohol consumption or reduce level of harmful alcohol consumption may reduce STIs acquisition.

Consistent with previous study, having an older sex partner increased the risk of incident GC and/or CT,²⁸. Advancing age is associated with a longer period of exposure to high risk sexual behaviors and therefore increased likelihood of acquiring an STI such as HIV,²⁸. Moreover, evidence suggests that condomless sex and inconsistent condom use are higher among older MSM than among young MSM communities,²⁹ which contributes to a high incidence of STIs among older sex partners. Since older MSM may transmit STIs to younger MSM, interventions targeting young individuals for education about sexual risk, partner selection and consistent condom use are critical.

The use of a larger sample of MSM and laboratory measurement of all incident infections makes this study stronger than other studies that depended on self-reported prevalent STI results,³⁰. However, the limitations of this study should be noted. First, absence of overlap between the alters of one ego and the alters of other egos was assumed in the analysis of egocentric network data. The presence of any overlap might influence effect estimates.

Currently, no analytic methods to appropriately address the overlap. Second, alter characteristics were collected for up to 5 partners of each study participant. Since some participants have more than five sexual partners, our estimates of the association between network size and STI may be underestimated. Third, the findings may have limited generalizability to communities unlike the two large, urban Nigerian cities in which the study was conducted. Fourth, alter sexual behaviors were reported by the ego, reporting bias cannot be eliminated although we assessed the confidence in egos' recall on information about alters. Fifth, partner notification was not part of the program, so only study participants who tested positive for STIs were treated and not necessarily their partners. Future research needs to address this issue in the context of sexual networks.

In conclusion, sexual partner characteristics are important predictors of incident GC or CT infection. While current STI prevention interventions are important, documented high incidence of these infections suggests the need to implement strategies that are tailored to MSM in Nigeria. Since GC and/or CT infection may potentiate HIV acquisition and transmission, STI prevention interventions that are specific to MSM may be critical in reducing these infections within sexual networks. These interventions may include provision of friendly health care services, routine laboratory-based STI screening and treatment, and assisted partner notification.

Acknowledgments

Conflicts of Interest and Source of Funding. The TRUST/RV368 Study is supported by U.S. National Institutes of Health (NIH) under award numbers R01MH099001 and R01AI120913 and by a cooperative agreement (W81XWH-11-2-0174) between the Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., and the U.S. Department of Defense. Research training for this work was supported by the NIH Fogarty International Center (D43TW001041 and D43TW010051). The content is solely the responsibility of the authors and does not necessarily represent the official views of the U.S. NIH, the U.S. Army, the Department of Defense, or other funders.

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Key messages

- High incidence of STIs among Nigerian MSM underscores the importance of STI screening among MSM in order to curb the spread of these infections.
- Using the sexual network approach, this study documented that sexual partner's age, engaging sex under the influence of alcohol and HIV status predicted incident STIs.
- Beyond individual interventions and syndromic surveillance in the STI management, exploring sexual-network intervention is critical to prevent STI spread.

Table 1

General characteristics of ego and alter

Characteristic	Ego	Alters		
	n = 492	All n = 1975	Casual n = 642	Regular n = 1333
Age, (%)				
< 19 years	81 (16.5)	220 (11.1)	87 (13.5)	133 (10.0)
20 – 29 years	343 (69.7)	1037 (52.6)	362 (56.2)	675 (50.8)
> 30 years	68 (13.8)	559 (28.3)	163 (25.4)	396 (29.8)
Do not know		156 (7.9)	30 (4.7)	126 (9.4)
Education, n (%)				
< Senior secondary school	75 (15.4)	125 (6.3)	43 (6.7)	82 (6.2)
Senior secondary school	259 (53.2)	711 (36.1)	229 (35.7)	482 (36.3)
> Senior secondary school	153 (31.4)	968 (49.1)	335 (52.2)	633 (47.7)
Do not know		166 (8.4)	35 (5.4)	131 (9.9)
Missing	5	5	0	5
Religion, n (%)				
Christian	349 (71.2)			
Moslem	141 (28.8)			
Missing	2			
Condom use on IAS during last 12 months, n (%)				
Never	101 (20.8)	223 (11.3)	79 (12.3)	144 (10.9)
About half of the times	135 (27.9)	352 (17.9)	137 (21.4)	215 (16.2)
Always/almost always	149 (51.3)	619 (31.5)	205 (32.0)	414 (31.2)
Did not have insertive anal sex		773 (39.3)	220 (34.3)	553 (41.7)
Missing	7	8	1	7
Condom use on RAS during last 12 months, n (%)				
Never	93 (18.9)	299 (15.2)	99 (15.4)	200 (15.1)
About half of the times	166 (33.7)	412 (21.0)	137 (21.3)	275 (20.8)
Always/almost always	233 (47.4)	915 (46.6)	299 (46.5)	616 (46.6)

Characteristic	Ego	Alters		
	n = 492	All n = 1975	Casual n = 642	Regular n = 1333
Did not have anal sex		339 (17.2)	107 (16.8)	232 (17.5)
Missing		10	0	10
Trusting majority of MSM you know				
Disagree/strongly disagree	287 (58.3)			
Agree/strongly agree	205 (41.7)			
Ever received information about HIV prevention for MSM				
No	80 (16.3)			
Yes	412(83.7)			
Sex orientation, n (%)				
Bisexual	297(60.6)			
Homosexual	193(39.4)			
Missing	2			
Last month income in (thousands Naira)				
15000	186 (47.4)			
> 15000	206 (52.6)			
Missing	100			
Network size				
1 – 3	159 (32.3)			
4 – 5	333(67.7)			
Had 2 male sex partners in the last 12 months, n (%)				
No	166 (33.7)			
Yes	326 (66.3)			
Site, n (%)				
Abuja	287 (58.3)	1149 (58.2)	404 (62.9)	745 (55.9)
Lagos	205 (41.7)	826 (41.8)	238 (37.1)	588 (44.1)
SES of Alters compared to that of Ego's, n (%)				

Characteristic	Ego	Alters		
	n = 492	All n = 1975	Casual n = 642	Regular n = 1333
Lower		481 (24.4)	159 (24.7)	322 (24.2)
Same		405 (20.5)	131 (20.4)	274 (20.6)
Higher		1081 (54.8)	351 (54.7)	730 (54.8)
Do not know		6 (0.3)	1 (0.2)	5 (0.4)
Missing		2	0	2
HIV status, n (%)				
Negative	176 (42.7)	895 (45.4)	339 (52.8)	556 (41.8)
Positive previously diagnosed	163 (39.6)	115 (5.8)	48 (7.5)	67 (5.3)
Positive newly diagnosed	73 (17.7)			
Do not know		961 (48.7)	255 (39.7)	704 (53.1)
Missing/did not test	80	6	0	6
Ever received favors to have sex with somebody, n (%)				
No		820 (41.6)	293 (45.6)	527 (39.7)
Yes		592 (30.0)	192 (29.9)	400 (30.1)
Do not know		559 (28.4)	157 (24.5)	402 (30.2)
Missing		4	0	4
Ever had sex under influence of alcohol/drugs, n (%)				
No		1035 (52.5)	336 (53.6)	699 (52.6)
Yes		542 (27.5)	204 (31.8)	338 (25.4)
Do not know		394 (20.0)	102 (15.9)	292 (30.0)
Missing		4	0	4
Ever had sex with anonymous person				
No		526 (26.7)	232 (36.1)	294 (22.1)
Yes		680 (34.5)	173 (27.0)	507 (38.2)
Do not know		765 (38.8)	237 (36.9)	528 (39.7)
Missing		4	0	4

Characteristic	Ego	Alters		
	n = 492	All n = 1975	Casual n = 642	Regular n = 1333
Had >1 regular male sex partner in the last 12-months,n (%)				
No		367 (18.7)	159 (24.8)	208 (15.7)
Yes		1255 (63.8)	373 (58.1)	882 (66.5)
Do not know		346 (17.8)	110 (17.1)	236 (17.8)
Missing		7		7
Strength of partners information				
Median		1005 (51.1)	93 (14.5)	912 (68.9)
> Median		961 (48.9)	549 (85.5)	412 (31.2)
Missing		9	0	9

Abbreviations: IAS, Insertive Anal Sex; RAS, Receptive Anal Sex; SES, Social Economic Status; MSM, Men who have sex with men.

Bivariate and multivariate analyses on ego characteristics and incident rectal infections among MSM at HIV prevention care at treatment clinics in Abuja and Lagos, Nigeria, 2013 – 2015.

Table 2

	Rectal infections		Bivariate		Multivariate	
	n = 138	% *	RR	95 % CI	aRR	95 % CI
Age						
19 years	16	19.7	1.1	(0.6 – 2.2)	1.1	(0.5 – 2.1)
20 - 29 years	110	32.1	1.8	(1.1 – 3.1)	2.1	(1.5 – 2.9)
30 years	12	17.6	1		1.0	
Education						
< Senior secondary school	12	16.0	1.0		1.0	
Senior secondary school	73	28.2	1.8	(1.1 – 3.1)	1.3	(0.6 – 2.7)
> Senior secondary school	51	33.3	2.1	(1.2 – 3.7)	1.3	(0.6 – 2.8)
Religion						
Christian	111	31.8	1.0		1.0	
Moslem	27	19.1	0.6	(0.4 – 0.9)	0.9	(0.6 – 1.4)
Concurrence						
No	37	22.2	1.0		1.0	
Yes	101	31.0	1.4	(1.1 – 1.9)	2.4	(1.3 – 4.2)
Condom use on RAS 1 year prior to enrollment						
Never	40	43.0	1.0		1.0	
About half the time	36	21.7	0.5	(0.2 – 0.6)	0.5	(0.3 – 0.8)
Always	62	26.6	0.6	(0.4 – 0.9)	0.7	(0.5 – 1.0)
Last month income						
15000	71	38.2	1.0		1.0	
> 15000	67	32.5	0.8	(0.7 – 1.1)	1.2	(0.8 – 1.7)
Sexual orientation						
Bisexual	44	22.8	1.0		1.0	
Homosexual	94	31.6	1.4	(1.1 – 1.9)	1.5	(1.0 – 2.1)

	Rectal infections n = 138	% *	RR	95 % CI	aRR	95 % CI
HIV status						
Negative	23	13.1	1.0		1.0	
Positive previously diagnosed	63	38.7	3.0	(1.9 - 4.5)	2.8	(2.6 - 4.9)
Positive newly diagnosed	23	31.5	2.4	(1.4 - 4.0)	1.9	(1.0 - 3.7)
Network size 1 year before enrollment						
1 - 3	34	21.4	1.0		1.0	
4 - 5	104	31.2	1.4	(1.1 - 1.8)	1.5	(1.1 - 2.0)
Interactions						
HIV negative/network size(1-3)					1.0	
HIV negative/network size(3-4)					1.2	(0.5 - 2.6)
HIV positive previously diagnosed/networksize(1-3)					1.7	(0.7 - 4.1)
HIV positive previously diagnosed/networksize(4-5)					3.9	(1.9 - 8.1)
HIV positive currently diagnosed/network size(1-3)					1.4	(0.3 - 5.1)
HIV positive currently diagnosed/network size(4-5)					3.2	(1.5 - 6.8)

Abbreviations: RR, Risk ratio; aRR, Adjusted risk ratio; CI, Confidence Intervals; RAS, receptive anal sex; HIV, Human Immune deficiency Virus.

* Percentage denote incidence of GC and/or CT using n from this table with N from Table 1.

Bolded denotes $p < 0.05$

Table 3

Bivariate analyses on alters characteristics and incident rectal infections among MSM at HIV prevention care at treatment clinics in Abuja and Lagos, Nigeria, 2013 – 2015.

Characteristic	Casual alters			Regular alters		
	STI n (%)	RR	95% CI	STI n (%)	RR	95% CI
Age						
19 years	10 (11.5)	0.3	(0.1 – 0.7)	23 (17.3)	0.6	(0.3 – 0.9)
20 – 29 years	126 (34.8)	0.9	(0.6 – 1.3)	214 (31.7)	0.9	(0.7 – 1.2)
30 years	58 (35.6)	1.0		128 (32.3)	1.0	
Don't know	5 (16.7)	0.5	(0.2 – 1.4)	28 (22.2)	0.7	(0.3 – 1.2)
Education						
< Senior secondary school	10 (23.3)	1.0		13 (14.8)		
Senior secondary school	68 (29.7)	1.2	(0.7 – 2.4)	138 (28.1)	2.6	(1.3 – 5.0)
> Senior secondary school	118 (35.2)	1.5	(0.8 – 3.0)	215 (35.4)	3.2	(1.6 – 6.3)
Don't know	3 (2.7)	0.4	(0.0 – 1.1)	21 (15.8)	1.7	(0.7 – 4.2)
Partner HIV status						
No	108 (31.9)	1.0		158 (28.5)	1.0	
Yes	19 (39.6)	1.2	(0.8 – 2.0)	30 (44.8)	1.6	(1.1 – 2.4)
Don't know	72 (28.2)	0.2	(0.6 – 1.3)	201 (28.6)	1.0	(0.7 – 1.4)
Sex under influence of alcohol						
No	97 (28.8)	1.0		179 (25.6)	1.0	
Yes	75 (36.8)	1.3	(0.9 – 1.8)	130 (38.5)	1.5	(1.1 – 2.0)

Characteristic	Casual alters			Regular alters		
	STI n (%)	RR	95% CI	STI n (%)	RR	95% CI
Don't know	27 (26.5)	0.9	(0.5 – 1.5)	83 (28.3)	1.1	(0.7 – 1.6)
Condom use on RAS 1 year prior to enrolment						
Never	45 (47.4)	1.0		62 (43.1)	1.0	
About half the time	51 (32.3)	0.6	(0.5 – 0.9)	76 (35.3)	0.8	(0.7 – 1.1)
Always	62 (26.8)	0.5	(0.4 – 0.7)	125 (30.2)	0.7	(0.5 – 0.9)
Did not have receptive sex	41 (15.4)	0.3	(0.2 – 0.5)	129 (23.3)	0.5	(0.3 – 0.8)
Received money/favor in exchange for sex						
No	86 (29.3)	1.0		158 (30.0)	1.0	
Yes	63 (32.8)	1.2	(0.8 – 1.7)	122 (30.5)	1.0	(0.8 – 1.4)
Don't know	50 (31.8)	1.1	(0.7 – 1.7)	112 (27.9)	0.9	(0.7 – 1.3)
Partner had > 1 regular sex partners						
No	49 (30.8)	1.0		46 (22.1)	1.0	
Yes	117 (31.2)	1.0	(0.7 – 1.4)	285 (32.3)	1.5	(1.0 – 2.5)
Don't know	33 (30.0)	1.1	(0.6 – 1.6)	60 (25.4)	0.9	(0.5 – 1.5)

Abbreviations: RR, Risk ratio; HIV, Human immune deficiency Virus; CI, Confidence Intervals; RAS receptive anal sex.

* Percentage denote incidence of GC and/or CT using n from this table with N from Table 1.

Bolded denotes $p < 0.05$

Table 4

Multivariate analyses on alter characteristics and incident *Neisseria gonorrhea* and *Chlamydia trachomatis* infections among MSM at HIV prevention care at treatment clinics in Abuja and Lagos, Nigeria, 2013 – 2015.

Variable	Casual alters		Regular alters	
	aRR	95 % CI	aRR	95 % CI
Age				
19 years	0.3	(0.2 – 0.6)	0.6	(0.4 – 1.0)
20 – 29 years	0.9	(0.8 – 1.3)	0.9	(0.8 – 1.2)
30 years			1.0	
Don't know	0.5	(0.2 – 1.2)	0.8	(0.6 – 1.2)
Education				
< Senior secondary school				
Senior secondary school	0.9	(0.5 – 1.5)	2.3	(1.2 – 4.4)
> Senior secondary school	1.0	(0.5 – 1.6)	2.6	(1.4 – 5.0)
Don't know	0.3	(0.1 – 0.9)	1.4	(0.7 – 2.9)
Partner HIV status				
No			1.0	
Yes	1.4	(1.1 – 1.8)	1.5	(1.1 – 2.0)
Don't know	0.9	(0.7 – 1.0)	0.9	(0.8 – 1.1)
Sex under influence of alcohol				
No			1.0	
Yes	1.2	(1.0 – 1.4)	1.4	(1.1 – 1.7)
Don't know	0.7	(0.5 – 1.1)	1.1	(0.8 – 1.4)
Condom use on RAS 1 year prior to enrollment				
Never	1.0		1.0	
About half the time	0.8	(0.5 – 1.3)	0.6	(0.3 – 1.2)
Always	0.8	(0.6 – 1.1)	0.7	(0.4 – 1.2)
Did not have receptive sex	0.6	(0.3 – 1.2)	0.5	(0.3 – 0.8)
Received money/favor in exchange for sex				
No			1.0	

Variable	Casual alters		Regular alters	
	aRR	95 % CI	aRR	95 % CI
Yes	1.2	(0.9 – 1.6)	0.9	(0.7 – 1.1)
Don't know	0.9	(0.9 – 1.7)	1.1	(0.8 – 1.4)
Partner had sex with anonymous person				
No			1.0	
Yes	1.6	(1.2 – 2.3)	1.0	(0.8 – 1.3)
Don't know	0.9	(0.9 – 1.7)	0.9	(0.6 – 1.2)

Abbreviations: aRR, Adjusted risk ratio; HIV, Human Immune deficiency Virus; CI, Confidence Intervals; RAS, receptive anal sex.; RAS, receptive condom use. Bolded denotes $p < 0.05$