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Individual and Network Factors Associated with HIV Care Continuum Outcomes Among Nigerian MSM Accessing HealthCare Services

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Abstract

Background and setting—As data on the determinants of the HIV care continuum from key populations such as men who have sex with men (MSM) in resource-limited, settings (RLS) are limited, the study aimed to characterize HIV care continuum outcomes and assess individual and network barriers to progression through the HIV care continuum among MSM in Abuja and Lagos, Nigeria.

Methods—TRUST/RV368 study used respondent-driven-sampling to accrue MSM into community-based clinics in Nigeria. Participants received HIV testing at enrollment. HIV-infected

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participants were offered antiretroviral therapy (ART) with HIV RNA testing every three months (Abuja) or six months (Lagos). Multiple logistic regression models were used to calculate adjusted odds ratios for factors associated with each point in the HIV care continuum, including HIV testing, ART initiation, and six-month viral suppression.

Results—A total of 1506 MSM were recruited, 1178 (78.2%) tested for HIV and 369 (31.3%) were HIV positive newly diagnosed. Of these, 188 (50.1%) initiated ART, 136 (72.3%) completed six months and 96 (70.6%) were virally suppressed. Larger network size and stronger social network support were positively associated with HIV testing uptake. Factors associated with ART initiation were higher education and stronger social network support. Having stronger social network support was associated with increased odds of viral suppression at six months.

Conclusions—Social determinants of health potentiated increased HIV Care Continuum outcomes. Integration of HIV prevention, HIV Counselling and Testing services and universal coverage of ART into a community-based clinic is critical in achieving better hig HIV Care Continuum outcomes.

Keywords

Men who have Sex with Men; Sexual network; HIV testing; ART initiation; Viral suppression

Introduction

The UNAIDS 90-90-90 targets challenge healthcare systems to diagnose 90% of people living with HIV (PLHIV), link 90% of those diagnosed to care and treatment, and to achieve viral suppression in 90% of those in care[1]. Data on the determinants of the HIV care continuum from key populations such as men who have sex with men (MSM) in resource-limited settings (RLS) are needed to inform targeted interventions in these populations in order to achieve the UNAIDS targets.

Prior studies focused on individual characteristics associated with HIV testing, ART initiation and viral suppression [2–7]. Besides individual characteristics, sexual network factors may affect HIV testing and downstream engagement in health services[8]. MSM face challenges in accessing health care that may be alleviated by culturally competent care providers, peer health navigators, and/or integrated healthcare services [9,10]. For example, in Nigeria, same-sex practices are criminalized and MSM are highly stigmatized [11,12]. For this reason, it remains challenging to effectively engage MSM living with HIV in Nigeria given that they are less likely to access health care services and are at risk of uncontrolled viral load. MSM are disproportionately affected by HIV with prevalence of HIV among Nigerian MSM ranging from 44% to 66 % compared to 3.2% in general population[13,14]. Similarly, incidence and prevalence of sexually transmitted infections (STI) among Nigerian MSM are high [13,15], posing the risk of adverse clinical outcomes and also onward HIV transmission. Understanding the multi-level barriers and enhancers is key to designing and implementing more effective treatment and prevention programs. In this study, we characterized the HIV care continuum within the context of test and treat among MSM in Nigeria.

Methods

Study design and population

MSM were recruited into a prospective combination HIV prevention and treatment study (TRUST/RV368) using respondent driven sampling (RDS) in two clinics in Abuja and Lagos, Nigeria as previously described[16,17]. 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. Through community based convenient sampling, 12 individuals (seeds) who are highly connected within the target population were recruited. Seeds recruited up to three of their social and/or sexual eligible partners through the distribution of coupons. Recruitment chains ranged in length from 0 to 28 waves as of August 2017. Seeds and subsequent recruits were included in these analyses. 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.

Data collection

In these analyses, study participants (egos) provided information on up to 5 of their partners (alters) from the past year. Face-to-face interviews using a structured questionnaire were administered to each ego at baseline and every 3 months for up to 18 months. The questionnaire captured demographic characteristics as well as other information such as, receiving information about HIV prevention and participation in HIV prevention meetings in the past 12-months, sexual orientation, fear of seeking health care, avoiding seeking care, blackmail, network size, network density, and disclosure of MSM status to family or health care workers. Information collected about alters included age, education, marital status, socio economic status, HIV status, regular or casual partnership, and sexual orientation.

Clinical data and blood samples 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]. Plasma viral load (VL) tests were conducted every three months (Abuja) or six months (Lagos) using COBAS TaqMan HIV-1 Test (Roche Molecular Diagnostics, California).

Definition of Variables

The outcome variables of interest were HIV testing, ART initiation, and viral suppression. HIV diagnosed participants underwent HIV treatment preparation counselling and initiated ART. Those who initiated ART and had HIV-RNA ≤1000 copies/ml at 6-months post ART initiation were considered virally suppressed in accordance with WHO guidelines[19].

Network size was defined as the number of MSM the study participant knew and/or had seen or communicated with in the last six months. Network density was defined as degree of connection in the network and was calculated as the total number of actual ties divided by the total number of potential ties[20]. Network density scores were dichotomized; < 50% indicating smaller network density and ≥ 50% indicating larger network density. To understand the effect of social support on HIV Care Continuum, participants answered the

following five questions: “Can you count on other MSM in your group of friends if you need to borrow money”, “Can you count on other MSM in your group of friends to accompany you to a doctor or hospital”, “Can you count on other MSM in your group of friends if you need to talk about your problems”, “Can you count on other MSM in your group of friends if you need somewhere to stay” and “Can you count on other MSM in your group of friends to help deal with a violent or difficult situation”. Responses were measured using a Likert scale ranging from (0) strongly disagree to (3) strongly agree. Scores were summed (score range: 0–15) and the Cronbach’s alpha was 0.82. Scores were dichotomized at the median, < 10 indicating weaker social support and ≥ 10 indicating stronger social support. Strength of partner’s information was based on the ego’s rating from 0 (not sure at all) to 10 (100% sure) about the information he provided on his alter. Rating scores were dichotomized at the median, < 8 indicating weaker strength of partner’s information and ≥ 8 indicating stronger strength of partner’s information. Strength of partner’s relationship was based on the ego’s rating of his friendship with his alter on a scale of 0 to 10. Rating scores were dichotomized at the median, < 6 indicating weaker relationship and ≥ 6 indicating stronger relationship.

Statistical analysis

Frequencies of categorical variables were calculated as the proportions of participants sampled. At the ego level, correlates of HIV testing were assessed using bivariate and multiple logistic regression models. From the list of alters we created ego-alter pair data which consisted of one data record for each sexual partner that included participant characteristics and ART initiation and viral suppression outcomes. For the paired data analysis, logistic regression with generalized estimating equations were used to account for the correlations of the ego in each ego-alter relationship. Since participants who did not test for HIV did not have alters’ information collected, logistic regression models using paired data were fit to assess ego and alter predictors of ART initiation and viral suppression. For the analyses of paired data, three hierarchical models were performed. Model 1 included only ego characteristics. In model 2, alter characteristics were added to model 1. The final model, model 3, cross level differences and interaction terms were added to model 2. Akaike’s information criterion (AIC), − 2Log likelihood (–2LL) and likelihood ratio test were used to assess the fitness of hierarchical models. Multivariate models included pre-specified, biologically plausible factors of interest and variables with p-value of less than 0.2 in bivariate models. In hierarchical models, variables were sequentially added in a stepwise manner while checking the model fit. Dummy variables were created for the missing data. All associations were presented as adjusted odds ratios (aORs) with 95% confidence intervals (CIs). Statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC).

Results

Study population

Between March 2013 and August 2017, a total of 2024 MSM were recruited and those who had a known HIV positive status were excluded (n=518). Of the remaining 1506 MSM with unknown HIV status, 1178 (78.2%) were tested for HIV and 369 (31.3%) were HIV-infected (figure 1). Of these newly diagnosed individuals, 188 (50.9%) initiated ART. Of 136

individuals who reached 6 months in care after ART initiation, 96 (70.6%) achieved viral suppression. Table 1 presents baseline ego and alter characteristics.

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=1033, 68.6%), had senior secondary school education (n=765, 50.8%), were Christian (n = 983, 65.3) and were bisexual (n=971, 64.5%). One hundred and ninety four (12.9%) received information about HIV prevention in the past 12-months and participated in HIV prevention meetings (n=345, 22.9%). Most, (n =1028, 68.3%) had a network size between 1–10 partners, had a network density ≥ 50% (n=478, 31.7%) and reported avoiding seeking health care (n=431, 28.6%). Nearly a quarter (24.2%) reported disclosing sexual orientation to health care providers and never had a prior HIV test (n = 519, 34.5%). The median social support score was 10 (IQR, 8 –11) and nearly a third had social support score ≥ median (n = 436, 29.0%).

Alter characteristics

The median age of alters was 25 (IQR, 22–30) years. Of 3370 alters, 1930 (57.3%) were between 20 and 29 years old and 1671 (49.6%) had more than senior secondary school education. Based on the egos' responses, 1839 (54.6%) alters had social economic status higher than ego's and 1817 (53.9%) were bisexual. Eight seven alters (2.6%) were HIV positive and 2107 (62.5%) were casual relationships. The median score measuring egos' confidence in alters information was 8 (IQR, 6–9).

HIV testing

Multivariate analyses of ego characteristics (Table 2) showed that higher education, senior secondary school vs. < senior secondary school (aOR =2.4; 95% CI, 1.7 – 3.4), > senior secondary school vs. < senior secondary school (aOR = 2.6; 95% CI, 1.7 – 4.0) and having a large network density ≥ 50% vs. < 50% (aOR = 1.8; 95% CI, 1.1 – 3.0) were significantly associated with increased odds of HIV testing. Having a large network size, 11–20 vs. 1–10 (aOR =1.7; 95% CI, 1.1 – 2.5), 21–30 vs.1–10 (aOR = 3.5; 95% CI, 1.5 – 7.8) and disclosing being an MSM to health care workers (aOR =1.5; 95% CI, 1.1 – 2.2) were also associated with increased odds of HIV testing. Furthermore, participants who have stronger social support from friends within their networks (aOR = 6.4.; 95% CI, 1.1 – 37.2) and those who reported prior HIV test (aOR = 1.5.; 95% CI, 1.1 – 2.0) had increased odds of HIV testing. Younger age, ≤ 19 vs. ≥ 30 years (aOR =0.7; 95% CI, 0.5 – 0.9), 20 – 29 vs. ≥ 30 years (aOR =0.6; 95% CI, 0.4 – 1.0), religion, Moslem vs Christian (aOR =0.4; 95% CI, 0.3 – 0.6) and blackmail (aOR = 0.9, 95% CI, 0.8 – 1.0) were associated with decreased odds of HIV testing.

Multilevel modelling

Ego characteristics and ART Initiation (Model 1): Having higher education, > senior secondary school vs. < senior secondary school (aOR = 2.4; 95% CI, 1.5 – 4.0) was associated with increased odds of ART Initiation (Table 3). Participants having stronger social network support (aOR = 1.4; 95% CI, 1.0 – 1.8) also had increased odds of ART

Initiation. Younger partcipants, 20 – 29 vs. ≥ 30 years (aOR =0.5; 95% CI, 0.3 – 0.9) and Moslems (aOR = 0.5; 95% CI, 0.3 – 0.6) had decreased odds of ART initiation.

Alter characteristics and ART Initiation (Model2): Compared to participants whose sex partners have less than senior secondary school education, those whose partners have more than senior secondary school (aOR = 2.0; 95% CI, 1.0 – 4.1) were significantly associated with increased odds of ART Initiation. The odds of participants initiating ART is higher when alters and ego have similar level of social economic status compared to when alters have lower social economic status relative to ego (aOR = 1.9; 95% CI, 1.2 – 3.0).

Cross level differences/Interactions and ART initiation (Model 3): Participants with larger network size and stronger social support had increased odds of ART initiation compared to those with smaller network size and weaker social support (aOR = 1.4; 95% CI, 1.0 – 2.2).

Ego characteristics and viral suppression (Model 1): Multivariate associations of ego and alter characteristics and six months viral suppression are presented in table 4. Younger age, 20 – 29 vs. ≥ 30 years (aOR =0.3; 95% CI, 0.1 – 0.8) and having a large network size 11–20 vs. 0–10 (aOR = 0.6; 95% CI, 0.3 –0.9) were associated with decreased odds of viral suppression. Moslems (aOR = 1.8; 95% CI, 1.0 – 3.1), those who disclosed MSM status to health care workers (aOR = 1.8; 95% CI, 1.1 – 3.2) and participants with stronger social support from other friends within their networks (aOR = 2.8; 95% CI, 1.9 – 4.2) had increased odds of viral suppression.

Alter characteristics viral suppression (Model 2): The odds of participants achieving viral suppression is higher when alters and ego have similar level of social economic status compared to when alters have lower social economic status relative to ego (aOR =2.3; 95% CI, 1.1 – 4.5).

Cross level differences/Interactions and viral suppression (Model 3): Participants with larger network size and stronger social support had increased odds of achieving viral suppression compared to those with smaller size density and weaker social support (aOR = 3.0; 95% CI, 1.1 – 8.2).

Discussion

The provision of MSM friendly health care services by integrating universal coverage of ART into community-based clinics facilitated the achievement of moderate levels of the HIV Care Continuum outcomes in this population. Approximately 78% of the study participants tested for HIV, and of those infected, slightly over half initiated ART. These proportions are far less than the UN targets suggesting more work is needed in order to achieve the UN goals. Achieving moderate level of viral suppression at 6-months of follow up is promising, suggesting high level of medication adherence among those retained in care. Our findings also indicate having stronger social network support is an important factor in succeeding in all points in the HIV Care Continuum pathway.

There is consistent evidence that social networks exert strong social influence on the engagement of network members in the HIV Care Continuum [21–23]. In addition to stigma affecting HIV infection, MSM often are affected by stigma related to sexual practices and sexual orientation [24,25]. Stigma is a fundamental barrier to engagement into HIV care and negatively impacts patient outcomes [11,12]. Social support systems reduce stigma, improve individual acceptability of HIV infection, as well as successful navigation throughout the HIV Care Continuum pathway [23,26]. Instrumental support such as provision of financial assistance, emotional support such as comfort, and informational support such as advice on dealing with difficult situation may have facilitated the uptake of HIV testing, initiation of ART and eventual viral suppression in this cohort. Previous research among Ghanaian MSM demonstrated that family and friend's social support and positive experiences at the health care setting facilitated HIV care[27]. We observed an interaction between network size and social support in that, those with both a larger network and higher social support were more likely to initiate ART and achieve viral suppression compared to participants with smaller network size and social support. The larger the network size the higher the likelihood of receiving social support to positively influence HIV care outcomes. Structured social support systems tailored to key population (KP) are critical to engaging MSM into care, improving health and prevention of HIV infection.

Younger MSM were less likely to test for HIV compared to older participants. Globally, adolescents and young MSM are at increased risk for HIV due to the many developmental, psychological, social, and structural transitions that converge in this period of the lifespan[28]. The starting point for all interventions must still be HIV counseling and testing. Innovative ways to promote testing have shown promise including incentivization, self-testing, and mobile health [29,30] but more evaluation to show effectiveness in this age group is required. Comparison of those who tested and those who did not test demonstrated that a higher proportion of those who did not test 36% had less than senior secondary school education compared to 12% for those who tested, suggesting the importance of education on HIV testing. Furthermore, among those who did not test for HIV at study entry and never sought HIV testing before, 34% were 19 years or younger compared to 6% who were 30 years or older, emphasizing the need to improve HIV testing and engagement in care among young MSM.

These analyses demonstrated that a fair proportion of participants did not initiate treatment. As previously documented, the shock of new HIV diagnosis, fear of being discriminated by the peer or family [18,31] may explain the moderate rate of ART initiation. Because of marginalization and high mobility, approximately one-third of HIV newly diagnosed MSM who did not initiate ART in this study moved to a different location. Interventions to alleviate stigma and strengthening of drop-in centers with culturally competent health care providers to better serve mobile KP is critical.

The achieved moderate level of viral suppression in this cohort of MSM suggests that provision of MSM friendly clinical services is effective. Although viral load suppression rate among MSM is lacking in Nigeria, prior data among heterosexual individuals showed suppression rates that are comparable to our data [32,33]. Younger MSM had a decreased odds of achieving viral suppression. Successful viral suppression requires optimal adherence to

ART. Prior data on MSM showed levels of ART adherence ranging from 16 to 74% with younger MSM having lower adherence rates [34,35]. Interventions to improve adherence among young MSM such as treatment support and reminders from network members [36] are essential in order to improve sustained viral suppression.

Religion was a significant predictor at all points of HIV care cascade. Compared to Christians, Muslims had decreased odds of HIV testing and ART initiation. Prior research showed overwhelming opposition of homosexuality by Islamic society[37], which could explain the low uptake of HIV testing and treatment among Muslim gay men in this study. Although Muslim lag behind Christians in HIV testing and treatment, a few of those engaged in care tended to have better viral suppression outcome, indicating that with better support, good health care outcomes could be achieved among Muslim gay men.

The main strength of these analyses is the characterization of HIV Care Continuum using a well-established cohort of MSM as opposed to the use of cross sectional data. However, our study is not without limitations. Alter sexual behaviors data were reported by the ego, reporting bias cannot be eliminated although we assessed the confidence in egos' recall on information about alters. In addition, lost to follow is high. Since participants who were lost to follow up tended to have lower level of education and less exposure to HIV education, our effects size on HIV care cascade outcomes might be underestimated. It is also important to acknowledge that the time period following HIV diagnosis may entail restructuring of social support networks, and these dynamics may vary. Our ongoing research will establish a baseline understanding of these dynamics and patterns.

Conclusions

In conclusion, this report represents a rigorous multi-level characterization of the HIV Care Continuum for MSM from a sub-Saharan Africa, where information have been limited thus far. Our finding underscores that, within the context of achieving epidemic control through universal coverage of ART, MSM still lag behind other men and women of similar reproductive age. However, integration of HIV prevention, HIV Counselling and Testing services and universal coverage of ART into a community-based setting is necessary and critical in achieving high levels of HIV Care Continuum outcomes. Interventions that harness the social support network, especially of the young MSM to improve HIV care outcomes, offer promise for long-term efficacy for the 90-90-90 targets.

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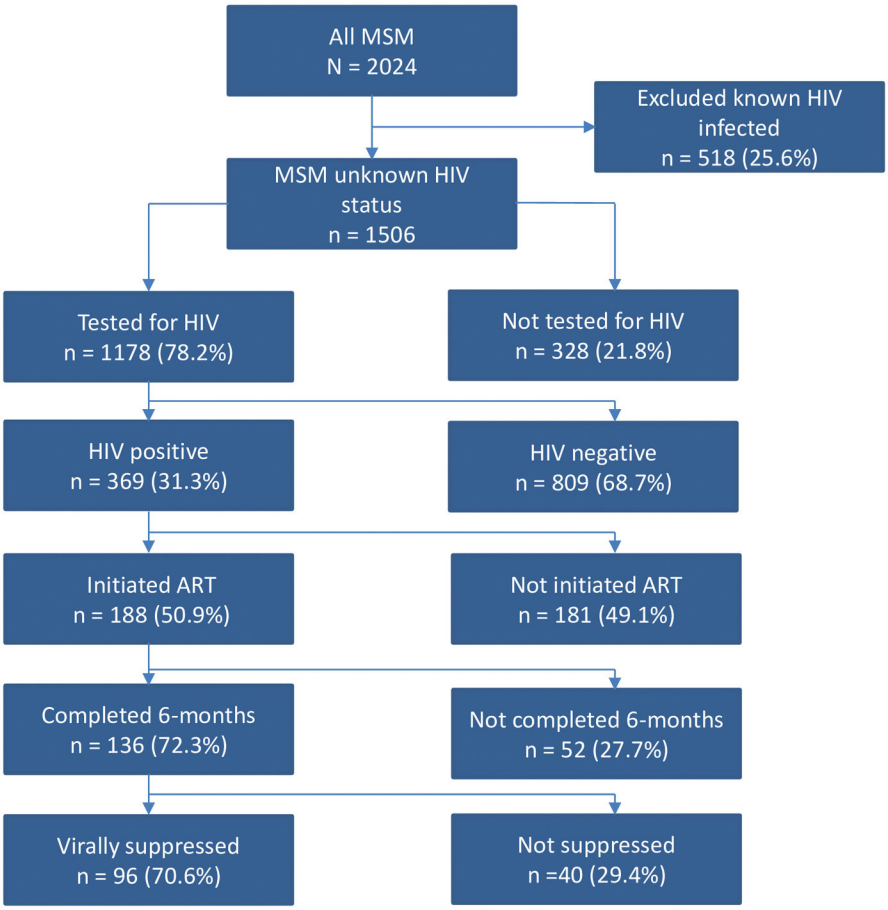

Figure 1.

HIV testing, ART initiation and six-month viral suppression among MSM in Abuja and Lagos, Nigeria

Table 1

Individual and Network Characteristics at various stages of HIV Cascade among MSM at HIV Prevention Clinics, Abuja and Lagos, Nigeria 2013 – 2017

	Ego (n = 1506)		Alter (n = 3370)	
Characteristic	**N**	**%**	**n**	**%**
Age				
≤ 19 years	259	17.2	359	10.7
20 – 29 years	1033	68.6	1930	57.3
≥ 30 years	214	14.2	776	23.0
Missing/ Don't know	0	0.0	305	9.0
Education				
< Senior secondary school	264	17.5	224	6.6
Senior secondary school	765	50.8	1153	34.2
> Senior secondary school	451	30.0	1671	49.6
Missing / Don't know	26	1.7	322	9.6
Religion				
Christian	983	65.3		
Moslem	497	33.0		
Missing	25	1.7		
Marital status				
Single	1308	86.8	2708	80.4
Married	104	6.9	528	15.7
Divorced/separated/ widow	31	2.1	38	1.1
Missing/ Don't know	63	4.2	96	2.9
SES of Alters compared to that of Ego's				
Lower			779	23.1
Same			682	20.2
Higher			1839	54.6
Do not know			70	2.1
Sex orientation				
Bisexual	971	64.5	1817	53.9
Homosexual	507	33.7	1356	40.2
Missing / Don't know	28	1.9	197	5.8
Sexual relationship				
Regular			1255	37.2
Casual			2107	62.5
Missing			8	0.2
HIV status				
Negative	809	53.7	1599	47.4
Positive	369	24.5	87	2.6
Missing / Don't know	328	21.8	1684	50.0
Received information about HIV prevention for MSM				

	Ego (n = 1506)		Alter (n = 3370)	
Characteristic	**N**	**%**	**n**	**%**
No	710	47.1		
Yes	194	12.9		
Missing/Defaulted/Non response	602	40.0		
Participate in HIV prevention meetings				
No	557	37.0		
Yes	345	22.9		
Missing/Defaulted/Non response	604	40.0		
Network size				
1 – 10	1028	68.3		
11 – 20	208	13.8		
21 – 30	83	5.5		
31+	153	10.2		
Missing	34	2.3		
Network density				
< 50 %	369	24.5		
≥ 50 %	478	31.7		
Missing/Defaulted/Non response	659	43.8		
Have fear of seeking health care				
No	1034	68.7		
Yes	431	28.6		
Missing	40	2.7		
Ever being blackmailed				
No	1179	78.2		
Yes	305	30.3		
Missing	22	1.5		
Ever tested for HIV				
No	519	34.5		
Yes, once	944	62.7		
Missing	43	2.8		
Disclosed MSM to family				
No	1291	85.7		
Yes	195	13.0		
Missing	20	1.3		
Disclosed MSM to health care workers				
No	1142	75.8		
Yes	364	24.2		
Missing	0	0.0		
Social support score				
< Median	378	25.1		
≥ Median	436	29.0		
Missing/Defaulted/Non response	692	46.0		

	Ego (n = 1506)		Alter (n = 3370)	
Characteristic	**N**	**%**	**n**	**%**
Can count on friends to get money				
Disagree/strongly disagree	278	18.5		
Agree/strongly agree	586	38.9		
Missing/Defaulted/Non response	314	42.6		
Can count on friends to accompany to the hospital				
Disagree/strongly disagree	241	16.0		
Agree/strongly agree	645	42.8		
Missing/Defaulted/Non response	620	41.2		
Can count on friends to talk about your problems				
Disagree/strongly disagree	212	14.1		
Agree/strongly agree	675	44.8		
Missing/Defaulted/Non response	619	41.1		
Wave				
0 – 12	890	59.1		
13 – 27	616	40.9		
Site				
Lagos	433	28.7	1093	32.4
Abuja	1073	71.3	2277	67.6
Strength of partners information				
<Median			1607	47.7
≥Median			1733	51.4
Missing			30	0.9
Partners strength of relationship with ego				
<Median			1296	38.5
≥Median			2055	61.0
Missing			19	0.5

Abbreviations: HIV, Human immune deficiency Virus; SES, Socio economic status; MSM, Men who have sex with men.

Table 2

Association Between Ego Characteristics and HIV testing among MSM at HIV Prevention Clinics, Abuja, and Lagos, Nigeria 2013 – 2017.

	Tested N = 1178	Bivariate		Multivariate	
Characteristics	**n (%)***	**OR**	**95% CI**	**aOR**	**95% CI**
Age					
≤ 19 years	172(56.3)	**0.5**	**(0.4 – 0.7)**	**0.7**	**(0.5 – 0.9)**
20 – 29 years	823(79.7)	**0.3**	**(0.2 – 0.5)**	**0.6**	**(0.4 – 1.0)**
≥ 30 years	183(85.5)	**1.0**		**1.0**	
Education					
< Senior secondary school	145(54.9)	**1.0**		1.0	
Senior secondary school	620(81.0)	**3.5**	**(2.6 – 4.7)**	**2.4**	**(1.7– 3.4)**
> Senior secondary school	392(86.9)	**5.4**	**(3.8 – 7.9)**	**2.6**	**(1.7 – 4.0)**
Missing	21(80.8)				
Religion					
Christian	806(82.0)	1.0		1.0	
Moslem	347(69.8)	**0.5**	**(0.4 – 0.6)**	**0.4**	**(0.3 – 0.6)**
Missing	25(96.2)				
Sex orientation					
Bisexual	778(80.1)	1.0		1.0	
Homosexual	373(73.6)	**1.4**	**(1.1 – 1.7)**	1.1	(0.9 – 1.5)
Missing / Don't know	27(396.4)				
Participate in HIV prevention meetings					
No	480(86.2)	**1.0**		**1.0**	
Yes	335(97.1)	**3.4**	**(1.9 – 7.4)**	**4.1**	**(2.7 – 6.2)**
Missing	363(60.0)				
Received information on HIV prevention					
No	618(87.0)	**1.0**		**1.0**	
Yes	169(96.0)	**3.4**	**(1.7 – 7.3)**	**4.9**	**(2.9 – 8.2)**
Missing	374(62.1)				
Network size					
1 – 10	771(75.0)	1.0		1.0	

Characteristics	Tested N = 1178 n (%)*	Bivariate OR	Bivariate 95% CI	Multivariate aOR	Multivariate 95% CI
11 – 20	171(82.2)	**1.5**	**(1.0 – 2.2)**	**1.7**	**(1.1 – 2.5)**
21 – 30	76(91.6)	**3.5**	**(1.6 – 7.8)**	**3.5**	**(1.5 – 7.8)**
31+	130(85.0)	**1.8**	**(1.2 – 2.9)**	**1.9**	**(1.1 – 3.1)**
Missing	30(88.2)				
Network density					
< 50 %	332(90.1)	**1.0**		**1.0**	
≥ 50 %	450(94.2)	**1.8**	**(1.1 – 3.0)**	**2.1**	**(1.2 – 3.7)**
Missing	396(60.0)				
Ever being blackmailed					
No	935(79.3)	**1.0**		**1.0**	
Yes	223(73.1)	**0.7**	**(0.5 – 0.9)**	**0.9**	**(0.8 – 1.0)**
Missing	20(9.1)				
Disclosed MSM to family					
No	991(76.7)	1.0		1.0	
Yes	168(86.2)	**1.8**	**(1.2 – 2.8)**	1.2	(0.9 – 2.0)
Missing	19(95.0)				
Disclosed MSM to health care workers					
No	858(75.1)	1.0		1.0	
Yes	320(87.9)	**2.4**	**(1.7 – 3.4)**	**1.5**	**(1.1 – 2.2)**
Missing	0(0.0)				
Social support score					
< Median	368(97.1)	1.0		1.0	
≥ Median	434(99.5)	**5.9**	**(1.3 – 27.1)**	**6.4**	**(1.1 – 37.2)**
Missing	376(54.3)				
Ever tested for HIV					
No	337(34.5)	**1.0**		**1.0**	
Yes	799(84.6)	**2.7**	**(2.1 – 3.4)**	**1.5**	**(1.1 – 2.0)**
Missing	42(97.7)				
Wave					
0 – 12	709(79.7)	1.0		1.0	

	Tested N = 1178	Bivariate		Multivariate	
Characteristics	**n (%)***	**OR**	**95% CI**	**aOR**	**95% CI**
13 – 27	469(76.1)	0.8	(0.6 – 1.0)	1.0	(0.8 – 1.4)

Abbreviations: OR, Odds ratio; aOR, adjusted odds ratio; CI, Confidence intervals; HIV, Human immune deficiency Virus;

*Percentage denote proportion of HIV testing using n from this table with N from Table 1.

Bolded denotes $p < 0.05$

Table 3

Association Between Individual, Structural and Network Characteristics and ART Initiation Among MSM at HIV Prevention Clinics, Abuja and Lagos, Nigeria 2013 – 2016: Multilevel Logistic Regression Models Using Paired Data

	Model1		Model2		Model3	
Characteristic	**aOR**	**95% CI**	**aOR**	**95% CI**	**aOR**	**95% CI**
Ego factors						
Age						
≤ 19 years	1.1	(0.6 – 2.0)	1.5	(0.6 – 3.1)	0.9	(0.5 – 1.8)
20 – 29 years	**0.5**	**(0.3 – 0.9)**	**0.5**	**(0.3 – 0.8)**	**0.5**	**(0.3 – 0.8)**
≥ 30 years	1.0		1.0		1.0	
Education						
< Senior secondary school	1.0		**1.0**		**1.0**	
Senior secondary school	1.3	(0.8 – 2.2)	**2.0**	**(1.2 – 3.6)**	**1.9**	**(1.1 – 3.6)**
> Senior secondary school	**2.4**	**(1.5 – 4.0)**	**4.3**	**(2.4 – 7.6)**	**4.2**	**(2.3 – 7.9)**
Religion						
Christian	**1.0**		**1.0**		**1.0**	
Moslem	**0.5**	**(0.3 – 0.6)**	**0.4**	**(0.3 – 0.7)**	**0.5**	**(0.3 – 0.7)**
Participate in HIV prevention meetings						
No	1.0		1.0		1.0	
Yes	1.1	(0.8 – 1.5)	1.2	(0.8 – 1.7)	1.1	(0.7 – 1.5)
Network size						
1 – 10	1.0		1.0		1.0	
11 – 20	**0.6**	**(0.3 – 0.9)**	**0.8**	**(0.2 – 0.6)**	**0.5**	**(0.3 – 0.7)**
21 – 30	1.5	(0.8 – 3.1)	1.8	(0.9 – 3.7)	1.3	(0.8 – 2.1)
31+	0.8	(0.5 – 1.3)	0.9	(0.5 – 1.4)	0.8	(0.5 – 1.3)
Disclosed MSM to health care workers						
No	1.0		1.0		**1.0**	
Yes	1.2	(0.9 – 1.8)	1.4	(0.9 – 2.2)	**1.4**	**(1.0 – 2.3)**
Social support score						
< Median	1.0		1.0		1.0	
≥ Median	**1.4**	**(1.0 – 1.8)**	**1.4**	**(1.1 – 1.9)**	**1.3**	**(1.1 – 1.9)**

	Model1		Model2		Model3	
Characteristic	**aOR**	**95% CI**	**aOR**	**95% CI**	**aOR**	**95% CI**
Missing						
Wave						
0 – 12	1.0		1.0		1.0	
13 – 27	1.1	(0.8 – 1.5)	1.0	(0.8 – 1.4)	0.9	(0.7 – 1.3)
Alter factors						
Partner education						
< Senior secondary school			1.0		1.0	
Senior secondary school			1.5	(0.7 – 3.2)	1.4	(0.5 – 3.9)
> Senior secondary school			**2.0**	**(1.0 – 4.1)**	**1.9**	**(1.1 – 3.3)**
Partner HIV status						
No			1.0		1.0	
Yes			1.2	(0.6 – 2.8)	1.3	(0.6 – 3.0)
Don’t know			1.3	(0.9 – 1.7)	**1.5**	**(1.1 – 2.0)**
Social economic status of the alters relative to the ego						
Lower			1.0		1.0	
The same			**1.9**	**(1.2 – 3.0)**	**1.8**	**(1.1 – 3.0)**
Higher			1.4	(0.9 – 2.1)	**1.7**	**(1.1 – 2.8)**
Cross level differences/Interaction						
Age difference						
Same age					1.0	
Ego older					1.6	(0.9 –3.0)
Alter older					1.3	(0.7 –2.4)
Network size*social support						
Smaller network size and social support					1.0	
Large network size and social support					**1.4**	**(1.0 – 2.2)**
Site						
Lagos					**1.0**	
Abuja					**2.2**	**(1.1 – 4.4)**
Model Fit						
AIC	1463.4		1342.7		1225.7	

Characteristic	Model1		Model2		Model3	
	aOR	95% CI	aOR	95% CI	aOR	95% CI
− 2LL	1461.4		1340.7		1223.7	
p Value likelihood ratio test			Model 2 vs. 1: $p < 0.01$		Model 3 vs. 2: $p < 0.01$	

Abbreviations: aOR, adjusted Odds ratio; CI, Confidence Intervals.

HIV, Human immune deficiency Virus;

Bolded denotes $p < 0.05$

Table 4

Association Between Individual and Network Characteristics and Six Months Viral Suppression Among MSM at HIV Prevention Clinics, Abuja and Lagos, Nigeria 2013 – 2017: Multilevel Logistic Regression Models Using Paired Data

	Model1		Model2		Model3	
Characteristics	**aOR**	**95% CI**	**aOR**	**95% CI**	**aOR**	**95% CI**
Ego factors						
Age						
≤ 19 years	0.7	(0.3 – 1.5)	0.6	(0.3 – 1.7)	0.7	(0.2 – 2.1)
20 – 29 years	**0.3**	**(0.1 – 0.8)**	**0.3**	**(0.1 – 0.9)**	**0.2**	**(0.0 – 0.9)**
≥ 30 years	**1.0**		**1.0**		**1.0**	
Education						
< Senior secondary school	1.0		1.0		1.0	
Senior secondary school	0.8	(0.3 – 1.9)	0.8	(0.3 – 3.3)	0.6	(0.2 – 2.5)
> Senior secondary school	0.6	(0.2 – 1.4)	0.7	(0.2 –2.4)	0.5	(0.1 – 1.8)
Religion						
Christian	**1.0**		**1.0**		**1.0**	
Moslem	**1.8**	**(1.0 – 3.1)**	**3.4**	**(1.5 – 7.8)**	**2.4**	**(1.0 – 5.9)**
Participate in HIV prevention meetings						
No	1.0		1.0		**1.0**	
Yes	1.5	(0.9 – 2.5)	1.9	(0.9 – 2.9)	**2.2**	**(1.1 – 4.2)**
Network size						
1 – 10	1.0		1.0		1.0	
11 – 20	**0.6**	**(0.3 – 0.9)**	**0.4**	**(0.2 – 0.7)**	0.7	(0.4 – 1.9)
21 – 30	1.9	(0.7 – 5.0)	1.1	(0.3 – 3.6)	0.9	(0.2 – 3.8)
31+	0.7	(0.3 – 1.3)	**0.2**	**(0.1 – 0.4)**	**0.4**	**(0.2 – 1.0)**
Disclosed MSM to family						
No	1.0		1.0		1.0	
Yes	1.5	(0.8 – 3.0)	1.3	(0.6 – 2.8)	2.1	(0.9 – 5.1)
Disclosed MSM to health care workers						
No	**1.0**		**1.0**		**1.0**	
Yes	**1.8**	**(1.1 – 3.2)**	**2.0**	**(1.0 – 4.3)**	**2.0**	**(1.0 – 4.2)**

	Model1		Model2		Model3	
Characteristics	**aOR**	**95% CI**	**aOR**	**95% CI**	**aOR**	**95% CI**
Social support score						
< Median	1.0		1.0		1.0	
≥ Median	**2.8**	**(1.9 – 4.2)**	**2.9**	**(1.5 – 5.8)**	**5.8**	**(2.6 – 13.2)**
Alter factors						
Partner HIV status						
No			1.0		1.0	
Yes			2.7	(0.9 – 8.1)	2.5	(0.5 – 14.0)
Don’t know						
Social economic status of the alters relative to the ego						
Lower			1.0		1.0	
The same			**2.3**	**(1.1 – 4.5)**	**3.4**	**(1.4 – 8.0)**
Higher			1.1	(0.1 – 9.6)	1.4	(0.7 – 3.5)
Cross level differences/Interaction						
Age difference						
Same age					1.0	
Ego older					0.4	(0.1 – 1.8)
Alter older					0.4	(0.1 – 1.7)
Network size*social support						
Smaller network size and social support					1.0	
Large network size and social support					**3.0**	**(1.1 – 8.2)**
AIC		823.1		614.2		553.6
− 2LL		823.1		612.2		551.6
p Value likelihood ratio test			Model 2 vs. 1: p < 0.01		Model 3 vs. 2: p < 0.01	

Abbreviations: aOR, adjusted Odds ratio; CI, Confidence Intervals

Bolded denotes p < 0.05

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