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Respondent-Driven Sampling as a Recruitment Method for Men Who Have Sex with Men in Southern Sub-Saharan Africa: A Cross-Sectional Analysis by Wave

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Abstract

Objectives—Respondent-driven sampling (RDS) is a popular method for recruiting men who have sex with men (MSM). Our objective is to describe the ability of RDS to reach MSM for HIV testing in three southern African nations.

Methods—Data collected via RDS among MSM in Lesotho (N=318), Swaziland (N=310), and Malawi (N=334) were analyzed by wave in order to characterize differences in sample characteristics. Seeds were recruited from MSM-affiliated community-based organizations. Men were interviewed during a single study visit and tested for HIV. Chi-square tests for trend were used to examine differences in the proportions across wave category.

Results—A maximum of 13–19 recruitment waves were achieved in each study site. The percentage of those who identified as gay/homosexual decreased as waves increased in Lesotho (49% to 27%, $p<0.01$). In Swaziland and Lesotho, knowledge that anal sex was the riskiest type of sex for HIV transmission decreased across waves (39% to 23%, $p<0.05$, and 37% to 19%, $p<0.05$).

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The percentage of participants who had ever received more than one HIV test decreased across waves in Malawi (31% to 12%, $p<0.01$). In Lesotho and Malawi, the prevalence of testing positive for HIV decreased across waves (48% to 15%, $p<0.01$ and 23% to 11%, $p<0.05$). Among those living with HIV, the proportion of those unaware of their status increased across waves in all study sites although this finding was not statistically significant.

Conclusions—RDS that extends deeper into recruitment waves may be a promising method of reaching MSM with varying levels of HIV prevention needs.

Keywords

Africa; HIV; male homosexuality; sampling studies; intervention studies; social stigma

INTRODUCTION

Southern Sub-Saharan Africa is one of the most affected regions for HIV/AIDS worldwide, with the adult prevalence of HIV in 2012 ranging from nearly 11% in Malawi, 23% in Lesotho, and nearly 27% in Swaziland.¹ Even in the context of these broadly generalized HIV epidemics, there is increasing recognition of the enhanced risk for HIV among men who have sex with men (MSM), primarily due to the efficient transmission of HIV through unprotected anal intercourse.^{2–4} However, high levels of sexual orientation-related stigma directed towards MSM can impede the ability to access MSM for HIV-related studies and to disseminate HIV prevention interventions and treatment.^{5, 6} As a result, several methods to recruit hard-to-reach and marginalized populations, including MSM, have been developed. Arguably, one of the most popular methods developed thus far is respondent-driven sampling (RDS).^{7, 8}

RDS methods have been widely described. Briefly, a group of initial recruits or “seeds” are identified in the target population in the initial wave of recruitment (wave 0). These seeds recruit their peers in the first wave, who then recruit additional peers in the second wave, and so forth, until the desired sample size is reached. At the end of this process, mathematical adjustments are used to weight the sample to compensate for the non-random sampling methodology and unbiased population-level estimates can be derived. RDS networks, which can be characterized as peer-driven referral chains, may also be of special utility for implementing and disseminating HIV interventions.^{9, 10} For example, previous research has indicated that network-level HIV prevention interventions are most effective when they are deployed into the same social and sexual networks that facilitate spread of HIV.⁹ Because HIV is transmitted within sexual networks,¹¹ MSM RDS networks may serve as promising intervention delivery routes, as information/behaviors diffuse through peer-to-peer interaction.¹² In addition, although RDS has not been used extensively in the context of community-level interventions, there are currently ongoing community-based HIV interventions using RDS to recruit MSM in Sub-Saharan Africa for interventions, including Nigeria and Malawi.^{13–16}

Several RDS studies have relied on local MSM-based organizations to recruit seeds,^{15, 17–20} potentially due to time and feasibility constraints. Because seeds are supposed to be selected purposively based on a variety of factors,²¹ the use of seeds selected from MSM community

based organizations (CBOs) may potentially induce an initial bias of MSM who are more likely to be aware of services and have better knowledge about health care and HIV. This is because in stigmatizing environments MSM CBOs often serve jointly as HIV service providers for MSM.²² If seeds are selected based on a specific trait, for instance connection to an MSM CBO, the early-wave recruits will likely share characteristics similar to those of the seeds. Because of this, earlier- as compared with later-recruited participants may have varying levels of sexual orientation-related stigma and engagement in the HIV care continuum, and therefore may also have different intervention needs upon presentation to a study site.¹⁴ Making use of RDS recruitment to reach MSM who are less exposed to intervention programs could be beneficial for improving MSM-related program outreach, particularly if these men are less likely to know their HIV status or less likely to be previously engaged in care. However, there is little existing empirical evidence to demonstrate the changes in sample characteristics by recruitment wave among MSM RDS networks in Sub-Saharan Africa.

The objective of these analyses is to describe the ability of RDS to reach MSM for survey administration and HIV testing in southern Sub-Saharan Africa by recruitment wave. Given that MSM seeds in these analyses were recruited through CBOs, we hypothesized that individuals recruited in later waves would be less likely to have disclosed their sexual practices to healthcare providers, less likely to be engaged in HIV testing, and less likely to know whether they were living with HIV. We analyzed data collected via RDS among MSM in Lesotho, Swaziland, and Malawi that were initially collected in order to estimate the prevalence of HIV and size of the local MSM population.

METHODS

Study population and sampling methods

Participants were recruited from February to June 2014 in Maseru, Lesotho, from July 2011 to March 2012 in Blantyre, Malawi, and from July to December 2011 in Manzini, Swaziland using RDS.^{16, 23} Seeds were recruited from local MSM-affiliated CBOs (although not all seeds were CBO members). During the study visit, participants were administered a structured survey instrument that included measures of socio-demographics, sexual orientation, engagement in MSM community activities, social and health care related stigma, disclosure of sexual practices to family members and health care providers, sexual risk behaviors, and HIV testing and diagnoses.²⁴

MSM were eligible to participate if they were aged 18 years or older, assigned male sex at birth, reported having receptive or insertive anal intercourse with a man in the past 12 months, and provided informed oral consent. No exclusions were made on the basis of ethnicity, gender identity, or history of HIV testing and diagnosis. Participants were reimbursed the equivalent of US\$1 to 10 for their time and travel to the study site (in Swaziland this was dependent on distance traveled to and from the study site). In addition, recruiters were compensated the equivalent of up to US\$2 for each eligible participant they recruited into the study.

Data collection was approved by the Lesotho National Health Research Ethics Committee (IRB00005243), the Malawi College of Medicine Ethics and Research Committee (IRB00002895), and the Ministry of Health Scientific Ethics Committee in Swaziland (IRB00003508). All studies were also approved by the Johns Hopkins School of Public Health Institutional Review Board.

Data collection and key measures

For these analyses, measures of interest included disclosure of sexual practices, engagement in the MSM community, social and health care related stigma, sexual risk behaviors, and history of HIV testing and diagnosis. Disclosure of sexual practices was measured by asking participants if they had ever told any member of their family or any health care worker that they have sex with other men. For MSM community engagement, participants were asked, “In the past 12 months, how often have you participated in a meeting, march, rally, or gathering to promote the rights of MSM?” as well as “In the last 12 months, have you received information on prevention of HIV infection from sex between men?” We assessed participants’ level of social stigma by asking whether they had ever felt scared to walk around in public places because of their gender identity or sexual orientation. Similarly, we assessed health care stigma by asking participants whether they ever felt afraid to go to health care services because they were worried that someone may learn that they have sex with men.

For sexual risk behaviors, we assessed the participant’s reported number of male anal sex partners within the past 12 months and current condom use frequency with main and casual male partners. Frequency of condom use was dichotomized to “*always*” vs “*less than always*”. HIV knowledge was assessed by asking participants what type of sex puts them most at risk for HIV, what type of anal sex (i.e., insertive or receptive) puts them most at risk for HIV, and what is the safest lubricant to use during anal sex (during anal sex “with latex condoms” was specified in Lesotho but not in Swaziland or Malawi). In Lesotho and Malawi, participants were asked whether they had ever received an HIV test and in Swaziland they were asked whether they had received an HIV test within the past 12 months. Response options included *no*, *yes - once*, and *yes - more than once*. All participants were asked if they had ever been told by a doctor or health care provider that they have HIV.

After completing the questionnaire, trained nurse counselors performed blood draws to test for HIV using the Determine Rapid Test (Alere, Waltham, MA, USA or Inverness Medical, Chiba, Japan). If tested positive, the sample was then tested using the Unigold Rapid Test (Trinity Biotech, Bray, Ireland). Confirmatory testing was performed for discrepant or indeterminate HIV rapid tests in accordance with national guidelines. For these analyses, variables for currently living with HIV and being aware of one’s HIV status were created based on participants’ self-reported HIV status and laboratory test result.

Statistical Analysis

To characterize measures of interest across study recruitment waves, we collapsed the waves into equally spaced groups of waves at each study site, and allowed for additional waves in the final group in order to include a large enough sample size in a given category. Missing

data for variables of interest were excluded from analyses. Convergence, also referred to as equilibrium, was assessed by calculating the cumulative sample proportions as participants enrolled in the survey. Convergence is defined as the point at which sample proportions come within 2% of final sample proportions during the enrollment of participants and is an indication that the sample is becoming random.²⁵ In a supplementary analysis, convergence plots were used to assess the possible lingering effect of seed selection. RDS-adjusted total prevalence for variables of interest were calculated using RDS Analyst (RDS-II estimator).²⁶ Chi-square tests for linear trend of log odds were used to examine differences in the proportion of dichotomous characteristics across wave category and a non-parametric test for trend was used to examine differences in ordinal and interval variables. Statistical analyses were conducted using Stata 13.1 (College Station, Texas).

RESULTS

Recruitment

In Lesotho, 9 out of 10 initial seeds recruited 318 participants and resulted in 13 waves of recruitment. In Swaziland, 4 of 5 seeds accrued 326 men through up to 14 waves, and in Malawi, 10 seeds recruited 338 participants and reached 19 waves of recruitment. A few participants in Swaziland (n=16) and Malawi (n=4) could not be traced back to valid seeds and were excluded *post-hoc*. Characteristics of the seeds are presented in supplementary appendix 1. Sample size calculations were powered based on the ability to estimate local HIV prevalence. Lesotho and Swaziland achieved their targeted sample size and Malawi achieved 96% of their sample size. Convergence plots indicated stabilization for most estimates of interest; however, some plots indicated possible bottlenecks and a need for enrollment of additional participants (supplementary appendix 2).

Socio-demographic characteristics

Participants had a median age of 22 years in Lesotho and Swaziland and 24 years in Malawi (Tables 1–3). The majority in each study site reported a secondary/high school education and being single/never married. Age and education level remained relatively constant across waves in all study sites. However, the percentage of participants who were single/had never married increased as waves increased in Malawi ($p<0.01$). Further, the mean MSM network size of participants decreased as recruitment waves increased in Lesotho ($p<0.01$) and Malawi ($p<0.01$), although there were some participants who reported large network sizes during later waves in Swaziland.

Openness of sexual orientation

The percentage of those who identified as gay/homosexual decreased as recruitment waves increased in Lesotho ($p<0.01$) but remained relatively stable across waves in Swaziland and Malawi. In Lesotho, participants in earlier waves were more likely to have received MSM-specific HIV prevention information ($p<0.05$) and to have participated in a gathering to promote the rights of MSM ($p<0.01$) within the past 12 months. Participants in earlier waves in Lesotho were more likely to have disclosed having sex with men to their families ($p<0.01$), whereas in Malawi and Swaziland there were no clear trends detected by wave.

The percentages of those who disclosed their sexual practices to health care workers remained relatively constant across waves for each study site.

HIV-related knowledge and behaviors

For sexual risk behaviors, number of reported male anal sex partners decreased across recruitment waves in Lesotho ($p=0.01$), but remained somewhat constant in Malawi and Swaziland. In addition, frequency of condom use with casual or main male partners did not differ by recruitment wave across any of the study sites. In Swaziland and Lesotho, participants in the earlier waves were more likely than those in the later waves to know that anal sex is the riskiest type of sex for HIV transmission ($p<0.05$ in both Lesotho and Swaziland) and that water-based lubricant is the safest type of lubricant to use during anal sex ($p<0.05$ in Lesotho).

The percentage of participants who had received one or more than one HIV test decreased as recruitment waves increased in Malawi ($p<0.01$) and remained relatively consistent as recruitment waves increased in Lesotho and Swaziland. The percentage of participants living with HIV decreased in Lesotho ($p<0.01$) and Malawi ($p<0.05$) as recruitment waves increased. Among participants who tested positive for HIV, the proportion who were unaware of living with HIV increased as recruitment waves increased in each study site; however, this was not statistically significant ($p>0.05$).

DISCUSSION

In this study of MSM in Lesotho, Malawi, and Swaziland recruited using RDS, the self-reported social network sizes of MSM, knowledge about HIV transmission, exposure to MSM-related HIV prevention information, participation in the MSM community, frequency of HIV testing, likelihood of testing positive for HIV, number of male sex partners reported within the past 12 months, and likelihood of disclosing sexual practices to family members decreased as recruitment waves increased in some but not all study sites. The variation in results across study sites is not surprising given that the sites are located in different countries with different network characteristics. As hypothesized, the proportion of those who were unaware of living with HIV increased as recruitment waves increased although this was not statistically significant in any study site. Contrary to our hypothesis, disclosure of sexual practices to health care providers did not change significantly across waves. Despite heterogeneity and incompatibility with some of our original hypotheses, these results suggest that RDS can be used effectively to reach MSM with varying levels of HIV prevention and treatment needs even when seeds are accessed through MSM-based CBOs.

Interventions aimed at increasing levels of HIV testing and HIV transmission knowledge might consider RDS as a suitable recruitment strategy because MSM recruited from CBOs using convenience-based methods may not be the population who would benefit most from the intervention. For example, in some study sites respondents in later recruitment waves reported less knowledge about HIV transmission and less frequent HIV testing, which is consistent with findings from MSM in Nigeria.¹⁴ RDS could potentially be used as a peer-driven intervention to disseminate HIV prevention knowledge and testing behaviors from earlier to later waves of MSM. For example, RDS as a peer-driven intervention has been

shown to increase AIDS clinical screening rates among persons living with HIV/AIDS²⁷ and to increase HIV-related risk behaviors among people who inject drugs.¹⁰ Given the low proportions of HIV transmission knowledge and HIV testing, participants in later waves could benefit by receiving positive peer influences from those in the earlier waves. Effective use of RDS for these intervention purposes would likely require dual incentives and a limited distribution of coupons (i.e., less than four) for recruiters in order to produce more recruitment waves and penetrate “deeper” into MSM networks.

For social stigma, participants in early recruitment waves were more likely to report feeling scared to walk around in public due to their sexual identity, which may result from their being more easily as recognized as gay in the broader community. Lesotho participants in the earlier waves were also more likely to have disclosed their sexual practices to family members. These findings are similar to the results from a previous study conducted in the Netherlands, which found that participants recruited from lesbian, gay, and bisexual (LGB) venues were more likely to be open about their sexual orientation and to encounter more social stigma related to their sexual orientation, as compared with LGB individuals recruited from a general research panel.²⁸ In particular, stigma may be greater for MSM who are open about their sexual orientation because they may display mannerisms less aligned with traditional male gender roles.^{29, 30} However, there was a high level of fear of seeking health care reported by participants across all recruitment waves, suggesting that perceived stigma in health care is a barrier to HIV care for all MSM and not just those who may be more recognized as being MSM in the wider community. Based on these results, RDS might be a useful recruitment strategy for HIV interventions seeking to reach stigmatized MSM who are not open about their sexual orientation.

Although these studies provide specific insight into the network and recruitment structures of three countries, results may not be generalizable to the Southern Sub-Saharan Africa region as a whole. Differences related to sexual orientation-related stigma, culture, healthcare services, social desirability bias, and MSM social networks likely affected findings in each of the countries presented here. Although network size decreased as the number of waves increased, which is a positive indication that RDS assumptions are being met, this does not practically indicate that men with smaller MSM networks are harder to reach for HIV testing or other HIV prevention interventions. In addition, we did not possess the data required for estimating HIV treatment engagement across wave. Although many of our variables of interest reached convergence, convergence for some variables was not reached long before recruitment ended. This indicates that some estimates should be interpreted with caution as some variables may have encountered bottlenecks or required additional enrollment of participants. However, given that there were ample numbers of waves and evidence from convergence plots that most variables converged in advance of reaching the final sample size, it is likely that bias from seed dependence was substantially eliminated.²⁵

Overall, these data suggest that RDS is a feasible implementation tool for reaching MSM with varying HIV intervention needs in Sub-Saharan African settings that rely on CBOs for seed selection. In particular, men recruited in later waves of RDS may be missed through traditional programmatic accrual processes such as convenience sampling from MSM-based

CBOs. Notably, RDS that extends deeper into recruitment waves may be a promising method of reaching MSM who are less involved with the MSM community, less likely to be aware of living with HIV, and less likely to be knowledgeable about MSM-related HIV transmission.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key messages

- Respondent-driven sampling (RDS) is a feasible implementation tool for reaching MSM for HIV testing in highly stigmatized settings
- RDS that extends deeper into recruitment waves may be a promising method of reaching MSM who are further marginalized from the HIV prevention dialogue
- Men recruited in later waves of RDS may be missed through traditional programmatic recruitment processes such as convenience sampling

Table 1

Characteristics of MSM in Maseru, Lesotho by RDS accrual wave

	% Characteristics within each wave category				p-value	Total % (n/N)	RDS-Adjusted Total % (95% CI)	Convergence wave no.
	0–3	4–7	8–13					
Total % (n)	30 (94)	51 (162)	20 (62)	--		100 (318)	--	--
Median age in years (IQR) ^a	22 (20–27)	22 (19–25)	23 (21–27)	0.31		22 (20–26)	21 (19–24)	3
Education completed ^a								
Primary school or less	21.3	9.9	32.3	0.19		17.6 (56/318)	21.9 (18.2–25.6)	10
Secondary/High School	60.6	69.1	56.5			64.2 (204/318)	67.2 (59.2–75.3)	9
More than high school	18.1	21.0	11.3			18.2 (58/318)	10.9 (2.9–18.8)	7
Marital status								
Single/never married	78.7	87.7	69.4	0.30		81.5 (259/318)	73.2 (65.7–80.6)	9
Ever cohabited	21.3	12.4	30.7			18.6 (59/318)	26.9 (19.4–34.3)	
Sexual orientation ^a								
Gay or Homosexual	48.9	47.5	26.7	0.004**		44.0 (138/314)	29.7 (20.1–39.3)	10
Bisexual	48.9	49.4	61.7			51.6 (162/314)	63.6 (55.0–72.1)	9
Heterosexual	2.1	3.1	11.7			4.5 (14/314)	6.7 (2.3–11.2)	4
Median network size (IQR) ^a	16 (7–25)	10 (6–20)	9 (5–17)	0.002*		11 (6–20)	5 (3–10)	10
Received MSM-specific HIV prevention information, past 12 months	62.8	52.8	45.2	0.03*		54.3 (172/317)	42.3 (34.8–49.7)	9
Participation in gathering to promote the rights of MSM, past 12 months	21.3	15.4	0.0	<0.001***		14.2 (45/318)	10.2 (2.9–17.5)	9
Disclosed sexual practices to family	48.4	38.5	24.6	0.003**		38.7 (122/315)	31.7 (23.7–39.7)	9
Disclosed sexual practices to health care worker	14.9	13.0	6.6	0.14		12.3 (39/316)	7.4 (3.6–11.3)	7
Afraid to seek health care due to sexual orientation	20.2	17.9	11.3	0.17		17.3 (55/318)	13.8 (5.9–21.6)	7
Scared to be in public due to sexual orientation	20.1	18.5	19.4	0.86		19.2 (61/318)	16.9 (9.9–23.8)	6
Median number of male sexual partners, past 12 months (IQR) ^a	3 (2–5)	3 (1–4)	2 (1–4)	0.01*		3 (1–4)	2 (1–3)	10
Always/often uses condoms with main male partner(s)	68.8	70.2	77.4	0.32		71.2 (193/271)	71.9 (63.2–80.6)	6
Always/often uses condoms with casual male partner(s)	75.4	80.8	66.7	0.48		76.4 (162/212)	74.4 (65.0–83.7)	10
Knowledge about HIV transmission								

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	% Characteristics within each wave category				p-value	Total % (n/N)	RDS-Adjusted Total % (95% CI)	Convergence wave no.
	0-3	4-7	8-13					
Anal sex is the riskiest type of sex	37.2	26.7	19.4		0.01*	28.4 (90/317)	20.5 (13.6–27.5)	8
Receptive anal sex is the riskiest type of anal sex	44.7	47.2	42.6		0.88	45.6 (144/316)	38.6 (32.0–45.2)	6
Water-based lubricant is the safest to use during anal sex with latex condoms	23.4	19.9	8.1		0.02*	18.6 (59/317)	12.0 (3.1–20.8)	8
Ever tested for HIV ^a								
Never	19.2	21.0	14.5		0.96	19.2 (61/318)	20.9 (14.1–27.8)	3
Once	21.3	25.3	27.4			24.5 (78/318)	25.3 (18.7–31.9)	7
More than once	59.6	53.7	58.1			56.3 (179/318)	53.8 (45.8–61.7)	5
Living with HIV	47.9	27.3	15.0		<0.001***	31.1 (98/315)	18.0 (12.8–23.2)	9
Among those living with HIV								
Aware of status	52.5	37.1	33.3		0.16	44.1 (37/84)	53.7 (35.8–71.6)	7
Unaware of status	47.5	62.9	66.7			56.0 (47/84)	46.3 (28.4–64.2)	7

* p<0.05;

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p<0.01;

p<0.001;

P-values derived by test for linear trend of the log odds against wave categories

^aP-values derived by nonparametric test for trend

Table 2

Characteristics of MSM in Manzini, Swaziland by RDS accrual wave

	% Characteristics within each wave category				p-value	Total % (n)	RDS-Adjusted Total % (95% CI)	Convergence wave no.
	0-3	4-7	8-14					
Total % (n)	22.9 (71)	49.0 (152)	28.1 (87)	--	--	100 (310)	--	--
Median age in years (IQR) ^a	22 (20-25)	22 (20-26)	22 (20-26)	0.83	0.83	22 (20-25)	22 (19-26)	3
Education completed ^a								
Primary school or less	1.4	2.6	6.9	0.59	0.59	3.6 (11/310)	3.4 (0.3-6.6)	6
Secondary/High School	73.2	79.0	67.8			74.5 (231/310)	78.8 (72.1-85.5)	9
More than high school	25.4	18.4	25.3			21.9 (68/310)	17.8 (11.6-23.9)	4
Marital status								
Single/never married	94.3	98.7	93.1	0.58	0.58	96.1 (295/307)	96.4 (91.6-100)	2
Ever cohabited	5.7	1.3	6.9			3.9 (12/307)	3.7 (0-8.4)	
Sexual orientation ^a								
Gay or Homosexual	63.4	61.8	62.1	0.84	0.84	62.3 (193/310)	58.3 (49.3-67.4)	7
Bisexual	36.6	35.5	36.8			36.1 (112/310)	39.0 (30.0-48.0)	7
Heterosexual	0.0	2.6	1.2			1.6 (5/310)	2.7 (0-5.5)	0
Median network size (IQR) ^a	15 (6-40)	10 (5-20)	15 (6-30)	0.92	0.92	11 (6-25)	5 (3-8)	7
Received MSM-specific HIV prevention information, past 12 months	28.6	25.0	28.7	0.94	0.94	26.9 (83/309)	20.3 (11.3-29.2)	5
Participation in gathering to promote the rights of MSM, past 12 months	23.9	16.5	16.1	0.22	0.22	18.1 (56/310)	15.3 (9.6-21.0)	5
Disclosed sexual practices to family	67.6	48.0	51.7	0.07	0.07	53.6 (166/310)	43.5 (35.1-51.8)	6
Disclosed sexual practices to health care worker	25.4	34.9	26.4	0.98	0.98	30.3 (94/310)	29.0 (21.0-37.0)	5
Afraid to seek health care due to sexual orientation	54.9	54.7	60.5	0.46	0.46	56.4 (173/307)	59.7 (51.0-68.3)	6
Scared to be in public due to sexual orientation	59.2	36.8	46.5	0.16	0.16	44.7 (138/309)	39.6 (31.4-47.7)	6
Median number of male sexual partners, past 12 months (IQR) ^a	2 (1-3)	2 (1-3)	1 (1-2)	0.11	0.11	2 (1-3)	2 (1-2)	9
Always/often uses condoms with main male partner(s)	66.7	63.4	62.5	0.61	0.61	63.9 (184/288)	61.3 (52.5-70.1)	6
Always/often uses condoms with casual male partner(s)	61.5	64.9	70.9	0.31	0.31	65.7 (132/201)	66.1 (55.6-76.6)	7
Knowledge about HIV transmission								

	% Characteristics within each wave category			p-value	Total % (n)	RDS-Adjusted Total % (95% CI)	Convergence wave no.
	0-3	4-7	8-14				
Anal sex is the riskiest type of sex	39.4	17.2	23.0	0.03*	24.0 (74/309)	24.0 (16.3-31.8)	7
Receptive anal sex is the riskiest type of anal sex	35.2	30.3	25.3	0.18	30.0 (93/310)	27.6 (20.7-34.4)	7
Water-based lubricant is the safest to use during anal sex	51.4	34.7	43.5	0.40	41.1 (124/302)	29.2 (20.7-37.7)	6
HIV test, past 12 months ^a							
Never	43.7	51.3	37.9	0.58	45.8 (142/310)	47.7 (38.9-56.5)	8
Once	31.0	27.0	37.9		31.0 (96/310)	28.4 (20.0-36.8)	9
More than once	25.4	21.7	24.1		23.2 (72/310)	23.9 (16.9-31.0)	5
Living with HIV	15.7	19.2	11.5	0.42	16.2 (50/308)	12.8 (7.1-18.5)	9
Among those living with HIV							
Aware of status	45.5	32.0	10.0	0.09	30.4 (14/46)	42.9 (0-90.8)	9
Unaware of status	54.6	68.0	90.0		69.6 (32/46)	57.1 (9.2-100)	9

^{*} p<0.05; P-values derived by test for linear trend of the log odds against wave categories

^a P-values derived by nonparametric test for trend

Table 3

Characteristics of MSM in Blantyre, Malawi by RDS accrual wave

	% Characteristics within each wave category					p-value	Total % (n)	RDS-Adjusted Total % (95% CI)	Convergence wave no.
	0-3	4-7	8-11	12-19					
Total % (n)	25.8 (86)	21.9 (73)	23.4 (78)	29.0 (97)	--	--	100 (334)	--	--
Median age in years (IQR) ^a	24 (21-27)	23 (21-27)	24 (21-28)	25 (21-28)	0.79	0.79	24 (21-28)	23 (21-27)	2
Education completed ^a									
Primary school or less	3.5	15.1	12.8	11.3	0.19	0.19	10.5 (35/334)	9.8 (4.1-15.4)	7
Secondary/High School	73.3	71.2	68.0	71.1			71.0 (237/334)	74.0 (66.3-81.8)	7
More than high school	23.3	13.7	19.2	17.5			18.6 (62/334)	16.2 (9.4-23.0)	4
Marital status									
Single/never married	76.7	76.7	87.2	92.8	0.001**	0.001**	83.8 (280/334)	83.9 (77.7-90.0)	13
Ever cohabited	23.3	23.3	12.8	7.2			16.2 (54/334)	16.1 (10.0-22.2)	
Sexual orientation ^a									
Gay or Homosexual	60.0	53.4	60.3	71.1	0.09	0.09	61.9 (206/333)	60.4 (52.8-68.0)	13
Bisexual	40.0	46.6	38.5	27.8			37.5 (125/333)	37.1 (29.9-44.4)	14
Heterosexual	0.0	0.0	1.3	1.0			0.6 (2/333)	2.5 (0-6.6)	0
Median network size (IQR) ^a	10 (5-20)	9 (5-15)	8 (5-17)	6 (4-10)	<0.001***	<0.001***	8 (5-15)	4 (3-7)	16
Received MSM-specific HIV prevention information, past 12 months	24.4	21.4	24.7	19.6	0.53	0.53	22.4 (74/330)	18.5 (11.6-25.4)	11
Participation in gathering to promote the rights of MSM, past 12 months	26.7	27.4	28.2	26.8	0.97	0.97	27.3 (91/334)	25.7 (18.6-32.7)	3
Disclosed sexual practices to family	23.3	15.1	19.2	22.7	0.89	0.89	20.4 (68/334)	17.6 (12.8-22.4)	4
Disclosed sexual practices to health care worker	17.4	26.4	20.5	19.6	0.96	0.96	20.7 (69/333)	20.2 (13.8-26.6)	4
Afraid to seek health care due to sexual orientation	25.6	17.8	20.5	17.5	0.25	0.25	20.4 (68/334)	24.1 (16.7-31.4)	6
Scared to be in public due to sexual orientation	29.1	6.9	15.6	12.4	0.02*	0.02*	16.3 (54/334)	13.7 (8.9-18.5)	9
Median number of male sexual partners, past 12 months (IQR) ^a	2 (1-4)	2 (1-3)	2 (1-4)	3 (1-4)	0.14	0.14	2 (1-4)	2 (1-4)	12
Always/often uses condoms with main male partner(s)	50.6	55.2	46.6	43.3	0.22	0.22	48.5 (150/309)	46.2 (37.7-54.7)	12
Always/often uses condoms with casual male partner(s)	57.4	58.5	47.5	53.4	0.44	0.44	54.2 (137/253)	50.3 (41.7-59.0)	10
Knowledge about HIV transmission									

	% Characteristics within each wave category				p-value	Total % (n)	RDS-Adjusted Total % (95% CI)	Convergence wave no.
	0-3	4-7	8-11	12-19				
Anal sex is the riskiest type of sex	13.6	15.9	16.2	12.4	0.85	14.4 (43/299)	15.0 (8.5–21.5)	5
Receptive anal sex is the riskiest type of anal sex	32.1	27.4	35.1	38.1	0.26	33.5 (111/331)	38.0 (31.4–44.7)	15
Water-based lubricant is the safest to use during anal sex	48.1	50.7	38.2	36.1	0.05	43.1 (130/302)	39.3 (30.5–48.0)	13
HIV test, ever ^a								
Never	29.4	34.3	42.3	51.0	<0.001***	39.8 (132/332)	43.4 (36.9–49.9)	15
Once	40.0	34.3	33.3	37.5		36.5 (121/332)	34.2 (27.5–40.8)	7
More than once	30.6	31.5	24.4	11.5		23.8 (79/332)	22.4 (16.6–28.2)	13
Living with HIV	23.3	17.8	10.3	11.3	0.02*	15.6 (52/334)	12.6 (8.0–17.2)	11
Among those living with HIV								
Aware of status	15.0	7.7	0.0	9.1	0.44	9.6 (5/52)	3.0 (0–17.4)	8
Unaware of status	85.0	92.3	100.0	90.9		90.4 (47/52)	97.0 (82.6–100)	8

* p<0.05;

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p<0.01;

p<0.001; P-values derived by test for linear trend of the log odds against wave categories

^a P-values derived by nonparametric test for trend