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Title: Respondent- Driven Sampling to Assess Cumulative Lifetime Incidence of Abortion in Soweto, South Africa: A Methodological Assessment

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Running Head: Respondent Driven Sampling to Measure Abortion

Key words: respondent-driven sampling, abortion, induced abortion, incidence

Abbreviations: RDS, respondent-driven sampling; CI, confidence interval

Abstract

Respondent-driven sampling (RDS) is a potential strategy for addressing challenges in accurate abortion incidence estimation, but relies on often untested assumptions. We conducted an RDS study to estimate the cumulative lifetime abortion incidence in Soweto, South Africa, evaluate whether RDS assumptions were met, and compare RDS estimates of incidence to estimates adjusted for employment and age based on census data. A total of 849 participants were recruited from 11 seeds between April and December 2018. The assumptions that individuals can identify target population members and approximation of sampling with replacement was met. There were minor violations of the assumptions of seed independence from the final sample, and reciprocity of ties. Assumptions of accurate degree reporting and random recruitment were not met. Failure to meet assumptions yielded a sample with different employment characteristics than the target population, which was not resolved by standard RDS methods. The RDS estimate of cumulative lifetime abortion incidence was 12.1% (95% CI: 9.8%, 14.3%), and the employment-adjusted estimate was 16.9% (95% CI: 12.8%, 22.1%). We caution researchers in using RDS for representative estimates of abortion incidence. Post-survey weights to adjust for differences in characteristics between the sample and target population may yield more representative results.

Respondent- Driven Sampling to Assess Cumulative Lifetime Incidence of Abortion in Soweto, South Africa: A Methodological Assessment

Unsafe abortion is a completely preventable cause of maternal mortality and morbidity,(1) yet is responsible for 8-13% of global maternal deaths.(2) Understanding the proportion of abortions that happen outside of facility settings can help to identify gaps in the accessibility of clinic-based abortion services in settings where abortion is legally available. Accurate estimation of abortion incidence can also help facilitate the development of interventions to address access to and quality of care. However, there are substantial challenges to accurate estimation of abortion incidence.

Abortions that occur within health facilities are often incompletely or inaccurately recorded, and there is a lack of individual-level data on abortions that occur outside of health facilities. Indirect methods for estimating abortion incidence rely on difficult to test assumptions and extrapolations.(3, 4) Due to stigma and fear of legal consequences, people who have out-of-facility abortions may be reluctant to seek care in the event of complications, and are thus excluded from facility-based estimates of abortion incidence based on the rate of care-seeking. If they do seek care, people who have had out-of-facility abortions may be reluctant to disclose their abortion—or may intentionally report a miscarriage.(5-8)

Respondent-driven sampling (RDS) has been proposed as a potential solution to the above challenges in abortion incidence estimation.(9) RDS was developed to estimate prevalence and incidence of sensitive or illegal behaviors among populations lacking a valid sampling frame.(10-16). RDS leverages a small non-random sample of initial participants (known as *seeds*) to recruit others within their social network.(11-13) In

practice, representativeness of RDS samples may not hold because initial seeds are not randomly selected, well-connected participants may have more recruitment success, and individuals may be more likely to form social ties with those with similar characteristics (homophily). RDS estimation methods attempt to account for this potential selection bias by weighting participants with more contacts inversely proportional to the number of contacts in the network itself, limiting the number of participants that each participant can recruit, and having sufficient waves of recruitment.(12, 13, 17)

The validity of RDS relies on several assumptions around recruitment dynamics: all relationships between recruiters and their recruits are reciprocal, the final sample is independent of the initial seeds, the sampling process replicates sampling with replacement, participants can accurately estimate their degree (number of contacts in the target population), and recruiters randomly recruit from within their social network.(11, 12, 18) Despite the rapid proliferation of RDS as a sampling approach, these assumptions are rarely, if ever, rigorously assessed.(19) Furthermore, as these studies are typically conducted among hidden populations for which no sampling frame exists, validation of whether these estimation methods yield a representative sample is often impossible.

To address this research gap and above-identified measurement and recruitment challenges in abortion incidence estimation, we conducted an RDS study to estimate cumulative lifetime abortion incidence among women of reproductive age in Soweto, South Africa. While RDS has traditionally been used to measure outcomes among a stigmatized population, to our knowledge, this is the first study that uses RDS to measure abortion (a stigmatized outcome) among a general population. We believe this question is well-suited to RDS for several reasons. Population-representative surveys, such as household surveys,

may exclude young women, those who are living in informal settlements or inconsistent/variable living conditions, or refugees. Furthermore, those who participate in any study may be likely to underreport their abortion experiences.(7, 20) RDS may reach a broader population than traditional research methods, and the process of being recruited into the study by someone known to the participants may generate trust between the recruiter and the researcher and encourage disclosure of sensitive experiences.

The aim of this paper is to assess whether the above assumptions of RDS were met in a study of abortion incidence in Soweto, South Africa, and provides generalized information on the impact of failing to meet underlying assumptions on RDS estimates.

Methods

Study participants

The study was conducted from April 2018 – December 2018 in Soweto, South Africa. Participants were eligible if they were between the ages of 15-49, lived in Soweto, spoke English, Tswana, isiZulu, Sotho, or Xhosa, had not already participated, and had a valid recruitment coupon.

Procedures

With assistance from community partners, we identified eleven seeds. After providing verbal consent, seeds completed an interviewer-administered baseline questionnaire at the study site on sociodemographic characteristics, social network size and composition, and abortion experiences. Each seed was provided three recruitment coupons to recruit eligible members of their network.

Interested participants contacted study staff to confirm eligibility and schedule an interview. Eligible participants provided verbal consent, completed the baseline questionnaire, and were provided three recruitment coupons. Participants received an incentive of R75 (USD 6) for completing the baseline questionnaire, and a secondary reimbursement of R50 (USD 4) for each successfully recruited study participant.

All participants were instructed to contact study staff within 4 weeks of participation to schedule a follow-up questionnaire about their recruitment experiences and receive their secondary incentive. Study questionnaires were developed based on findings from formative qualitative work,(21) recommendations from the literature,(9, 18) and piloted prior to implementation.

Ethical approval for the study was obtained from the Human Sciences Research Council (Pretoria, South Africa).

Sample size

We determined the minimum required sample size based on the method proposed by Salganik.(22) In the absence of accurate data on abortion incidence in South Africa, we chose a maximally conservative estimate of 50%. In order to detect a 50% cumulative lifetime abortion incidence, with 80% power, absolute precision of 3%, 95% confidence intervals, and a design effect of 3, we aimed to recruit a sample size of 900 women, conditional on the distribution of selected socio-demographic characteristics becoming similar across waves (equilibrium).

Analysis

We assessed the following five assumptions of RDS based on methods proposed by Gile et al.(18) First, the participants must be able to identify those in their social network as members of the target population (women of reproductive age), and form reciprocal social ties on the basis of this shared characteristic (reciprocity of ties). Second, the final sample composition should be independent of the initial seeds. Third, the target population is sufficiently large to ensure selection probabilities do not meaningfully change over the study period (sampling should replicate sampling with replacement). Fourth, participants accurately report the number of eligible participants in their social network (degree). Fifth, participants randomly sample recruits from within this network (random referral).

To assess the first assumption, we assessed the reported relationship between participants and their recruiters, and whether the participant reported they knew their recruiter, and would have recruited them (reciprocity of network ties). If participants report being recruited by their friends, family members, or others in their social network, this would indicate individuals are able to identify members of their social network who are eligible for participation. Participants reporting being recruited by strangers or by those who they wouldn't have recruited would indicate this assumption was not met.

To assess the second assumption, we assessed homophily and bottleneck and convergence plots for key sociodemographic characteristics and abortion incidence. Homophily is a measure of preference for recruiting others who have a similar shared characteristic (i.e., age).(11) Homophily values of 1 indicate the number of recruiter-recruit pairs with the same characteristic are similar to expected by chance; a homophily value of 1.6 would indicate there are 60% more homophilius pairs than expected by chance. Homophily may indicate the initial selection of seeds influenced the final sample

composition. Bottleneck plots assess large differences in sample characteristics by seed. Convergence plots assess whether sociodemographic characteristics are converging on a stable estimate. Lack of convergence may indicate the initial selection of seeds may still be influencing the estimate, and would indicate need for additional data collection.

To assess the third assumption, we assessed failed recruitment attempts due to previous participation (potential recruits declined a coupon because they had already participated). We also assessed whether the number of other participants a participant reports knowing increased over time or study wave, which would indicate potential depletion of the target population. This was assessed by the question, "Not counting the person who recruited you, how many women do you know who have participated in this study?"

While it is impossible to validate accuracy of reported network size, we assessed *consistency* by asking participants to report their network size at baseline and follow-up, as well as plausibility of responses. As an assumed feature of RDS is that individuals with larger social networks are over-represented. We used Spearman's rank correlation to measure the association between self-reported degree at baseline and the following measures: estimated potential number of recruits, actual number of recruits, and self-reported degree at recruitment follow-up.

Finally, we assessed the fifth assumption by comparing the proportion of the sample employed to the average proportion of contacts in a network who are employed, as reported by participants. We measured employment status based on a previous RDS study among a non-hidden target population.(23)

We then assessed the impact of failing to meet these assumptions on estimated cumulative lifetime abortion incidence. We calculated the following cumulative lifetime abortion incidence measures: 1) unadjusted incidence, 2) RDS-II estimator (definition below), 3) RDS-II estimator excluding those without reciprocal network ties, 4) sample proportion with post-estimation weights for selected socio-demographic characteristics (based on results from homophily and random recruitment assessment).

The RDS-II estimator(24) is the proportion of respondents who report ever having had an abortion, weighted by the inverse of their network degree size (Equation 1). 95% confidence intervals are calculated over 500 bootstrapped samples.

$$\hat{p} = \frac{\sum_{j \in I} \frac{1}{d_j}}{\sum_{j \in S} \frac{1}{d_j}}$$

Equation 1: RDS-2 Estimator; where j indexes the respondent, $\boldsymbol{S}$ is the set of the full sample, $\boldsymbol{I}$ is the set of respondents who have ever had an abortion, d_j is the degree.

We used two different measures of degree for the RDS-II estimator: self-reported network size was measured as the number of eligible contacts the respondent saw in the past week, and *visibility*(25) as an alternative to self-reported degree. Visibility was imputed based on participant self-reported degree, number of recruits, and time spent recruiting, using the *impute.visibility_mle* function in RDS Analyst: Software for the Analysis of Respondent-Driven Sampling Data 0.65.(26) Differences in estimates were assessed using a two proportion Z-test.

All analyses were conducted using Stata 15(27) and RDS Analyst: Software for the Analysis of Respondent-Driven Sampling Data 0.65.(26)

Results

A total of 854 participants, including 11 seeds, completed the baseline questionnaire. Participant demographics are reported in Table 1. Data from five respondents were excluded from analysis due to participant ineligibility (age older than 49 years, duplicate enrollment) or missing survey data, resulting in an analytic sample of 849. A total of 15.7% were between the ages of 15 – 19. Nearly two-thirds (64.0%) reporting having a romantic partner, and the majority (83.7%) were either students or unemployed. The most commonly spoken home language was isiZulu (38.9%) and Sesotho (25.6%).

Among all participants, 358 successfully recruited at least one recruit (42.2%). Only one seed did not recruit any participants. Among remaining seeds, the maximum recruitment wave was 17 after 36 weeks of recruitment. Over half the sample came from one seed. Recruitment chains are in Web Figure 1.

A total of 289 participants participated in the follow-up survey on their recruitment experiences and their relationships to the 822 individuals to whom they gave coupons (Table 2), including 77% of participants who successfully recruited and 2.2% of those who did not successfully recruit other participants.

Assumption #1: Reciprocity of ties

When asked at baseline, "Would you have recruited your recruiter," 91.1% of respondents reported yes, indicating reciprocity (Table 2). Among those who reported "no" or "unsure," most reported they would not have recruited their recruiter because they don't see them very often, didn't think they would be interested, or didn't know them very well. A minority (n=5, 0.6%) reported they would not have recruited their recruiter because they were recruited by a stranger. At follow-up, among the 822 reported recruit – recruiter relationships, 84.1% of participants reported their recruit would have given them a coupon, while 10.5% said they were unsure and 5.5% said no. Commonly reported reasons for why they believed their recruit would not have recruited them included not being socially close to them, not seeing them very often, or being helped by others to identify them. The presence of participants who reported being helped by others to identify recruits not only violates the assumption of reciprocity of ties (as they are recruiting from outside of their social network), but also violates the assumption of accurate reporting of degree and random recruitment from within their network. While we could not validate the concordance of reported relationships, overall, the distribution of the relationships to their recruiters reported by participants was similar to the distribution of the relationships to their recruits reported at follow-up.

Assumption #2: Seeds independent of final sample

We found there was a significant tendency for in-group recruitment (homophily) based on age and employment status (Table 1). In the sample, recruitment homophily for employment was 1.11, indicating participants were 11% more likely to have the same employment status as their recruiter, compared to if there was no differential recruitment

based on employment status (Chi-square test for independence, P <.01). Participants were 68% more likely to be in the same age category as their recruiter, compared to if recruitment was random (Chi-square test for independence, P <.001), and were over two times more likely to have the same home language as their recruiter (homophily = 2.03, P <.001)

Figure 1 shows the convergence plot for the proportion of participants who reported ever having an abortion (cumulative lifetime abortion incidence). Cumulative lifetime abortion incidence was higher among initial participants, and converged on the stationary distribution around 500 participants. The convergence plot for employment similarly reaches equilibrium around 450 participants (Figure 2). There is no evidence of bottlenecks for abortion (Figure 3), age, or employment status (Figure 4), indicating there are no distinct sub-communities with respect to these characteristics within the sample. However, while home language appears to converge in the overall sample (Figure 5), there are bottlenecks by home language (Figure 6). This suggests the final sample is not independent of the initial seeds, at least with respect to home language.

Assumption #3: With-replacement sampling

The study team decided to end recruitment early due to the end of year holidays in South Africa. Thus, failure to attain sample size was not due to a global finite population effect; furthermore, our sample size calculation was based on a conservative estimate abortion incidence.

Among those who completed follow-up, 93.4% reported no coupon refusals. At baseline, nearly half (45.3%) reported not knowing any other study participants; most

(89.3%) reported knowing fewer than 5 study participants. These data are informative insofar as participants disclosed their participation to others in their social network. The number of contacts who participated did not increase meaningfully over the study period (data not shown).

Additionally, as the estimated target population size (~300,000) is much larger than participant median network size (20), it is unlikely our study of 849 faced issues with depletion of eligible participants.

Assumption #4: Respondents accurately report degree

At baseline, average degree (number of eligible participants in the respondent's social network who they have seen in the past week) was 72.3, with a range of 0 to 2500. Median degree was 20 (interquartile range (IQR) 10 – 50), 9.9% of participants reported a degree greater than 150, and 0.6% reported a degree greater than 1000. The distribution of reported degree (Web Figure 2) has peaks for degrees in multiples of 10, suggesting rounding. When asked, "How many coupons could you distribute by tomorrow if you were given unlimited coupons?" participants reported a mean of 32 coupons (median 10, IQR: 5-23, range: 0 – 2000). Rounding and implausible extreme outliers are suggestive of inaccurate reporting of degree. Imputed visibility ranged from 1 – 13, with a mean of 6.3 (IQR 5 – 7). Self-reported degree was strongly correlated with estimated potential number of recruits (Spearman's R = 0.68) and self-reported degree at recruitment follow-up (R = 0.52). However, self-reported degree was not correlated with actual success in recruiting (R = 0.02).

Median difference between reported degree at baseline and follow-up was 0, suggesting no systematic differences between the two visits that may influence reporting of degree; however, almost all individual responses (90.5%) varied by more than 10% between visits.

Assumption #5: Respondents randomly refer within their network

Participants at baseline reported 50.6% of eligible contacts they have seen in the past week are currently working (employed). In the overall sample, only 16.3% reported they were employed at baseline. At follow-up, participants reported 41.3% of eligible contacts they have seen in the past week are employed, but only 11.2% of those they distributed coupons to were employed. These results indicate over-recruitment of unemployed participants within individual's social networks. Furthermore, based on a 2018 national employment survey, estimated female workforce participation rate was 30%, suggesting participants' networks in the sample may not represent the total target population as it pertains to employment status.(28)

We did not ask participants about the age composition of their social network or their potential recruits. However, the age distribution of Soweto is approximately equal to the age distribution of the sample (Web Table 1).

Effect of assumptions on estimate of cumulative lifetime abortion incidence

We assessed the potential effect of failure to meet the above assumptions on estimated cumulative lifetime abortion incidence (Table 3). The crude estimate of cumulative lifetime abortion incidence in the overall sample was 12.5% (95% CI: 10.4%,

14.9%). The RDS-II estimate was 12.1% (95% CI: 9.8%, 14.3%) using imputed visibility and 10.5% (95% CI: 5.6%, 15.5%) using self-reported degree at baseline. After excluding participants who reported they would not have recruited their recruiter (no reciprocity of ties), the RDS-II estimate using imputed visibility was 11.7% (95% CI: 9.2%, 14.2%).

To assess the effect of self-reported degree (network size) on the estimate, we restricted to those who answered questions on degree at both baseline and follow-up. Among this sub-sample, crude cumulative lifetime abortion incidence was 18.3% (95% CI: 14.3%, 23.3%). The RDS-II estimate varied based on whether the weight variable was visibility, self-reported degree at baseline, and self-reported degree at follow-up, though differences were not significant (Table 3).

Finally, we estimated cumulative lifetime abortion incidence using post-survey weights to account for different probabilities of inclusion based on employment status and age (Table 3). Weights were calculated based on population proportions reported in the 2011 Census and 2018 Quarterly Labour Force Survey (see Web Table 1). The employment-adjusted estimate (16.9%, 95% CI: 12.8%, 22.1%) using weights based on the target population employment proportions was higher than all other adjusted point estimates in the full sample, though this difference was not significant. The age-adjusted estimate (13.1%, 95% CI 10.9%, 15.7%) was similar to the crude estimate (12.5%. 95% CI: 10.4%, 14.9%).

Discussion

This paper presents a rare and important opportunity to assess the theoretical assumptions of RDS in a study of reproductive age women, and finds several assumptions

were not met. Our findings suggest that RDS may not be an appropriate method for constructing a probability sample, at least among this target population. Re-weighting the RDS sample based on population weights yielded higher (and potentially less-biased) estimates of cumulative lifetime abortion incidence.

We found the assumption that sampling approximates sampling with replacement was met with strong certainty. There were minor violations of the assumption that seeds are independent of the final sample, and reciprocal ties. The following assumptions were violated: participants accurately report their degree, and random referral from within their network. Implications of violating these assumptions are discussed below.

Assumptions

Large and implausible reported network sizes, as well as evidence of rounding, suggest degree was not accurately measured. Importantly, self-reported degree was not correlated with recruitment success. This may be due to differences in persuasiveness, closeness to members of the network, or differences in motivation to participate. Visibility, an imputed measure, has been suggested as an alternative measure of degree.(25) However, visibility relies on self-reported degree, which we have shown may be inaccurate. Our findings suggest adjustment based on self-reported degree may be a poor proxy for addressing selection bias.

Unemployed participants were over-represented in this sample based on recent estimates on female workforce participation. Participants reported a higher unemployment rate in their network than the target population unemployment rate. RDS theory posits adjustment based on degree should account for over-representation of participants who

have networks with higher unemployment than the target population.(11, 12, 24) However, most RDS estimators do not account for differential recruitment. Prior research on RDS in a general population for which census data was available similarly found those of lower income and social status were more likely to participate.(23) Unemployed participants in this study may be more motivated to accept a coupon and participate due to the cash incentives, and likely had more time to travel to the study site and participate in a survey during traditional working hours.

Limitations

Given the lack of data on the true abortion incidence in this population, we are unable to assess which estimate is closest to the "truth." However, based on estimates of number of abortions in the Southern Africa region, and the low likelihood of over-reporting of abortion experiences, we believe the true cumulative lifetime abortion incidence is higher than estimates from in this study. As such, we assume the estimate generated by using post-survey weights based on census employment data are the least biased estimates.

Participants who successfully recruited were more likely to have completed a follow-up survey on their recruitment experiences; thus, it is likely our study did not capture recruitment experiences of participants who did not recruit, thereby underrepresenting coupon refusal rates. Future studies should offer additional incentives for recruitment follow-up, to encourage participation among those who did not successfully recruit, and use data collection methods such as Audio Computer-Assisted Self-Interview (ACASI) that do not require participants to directly disclose sensitive items to study interviewers.

Implications

This study has important implications for abortion incidence estimation. We believe our estimates suffered from under-reporting of abortion due to stigma and social desirability bias, and have concerns about the utility of RDS to construct a population representative sample to measure abortion incidence in a general population of women. However, peer-to-peer recruitment of those who have had an abortion may be a powerful recruitment (but not sampling) strategy to gather important information from those who have had abortion experiences. While not representative, this strategy may reach a broader population of individuals than may be reached via convenience sampling from facilities, or who would be included in probability-based sample. For example, RDS studies among a target population of those who have ever had an abortion could yield information about the proportion of successful out-of-clinic abortions, information about the rate of complications, or care-seeking rates among this population. Future research should explore leveraging such data from RDS studies on abortion along with external data sources to use analytic approaches such as population size estimation(29) or the Abortion Incidence Complications Methodology(3) to generate estimates of abortion incidence.

RDS offers a mechanism to construct a sample of participants from a target population that are often hard to reach, and for whom additional research is critical. However, researchers employing this method should take caution in interpreting results as representative of the target population, as several key assumptions underlying RDS may not be met. Importantly, the discrepancy between self-reported degree and successful recruiting, as well as non-random recruitment from within social networks, may have

outsize impacts that threaten representativeness of estimates under RDS assumptions. We believe adjustment via post-survey weights holds greater promise in correcting for selection bias when probabilities of selection can be estimated, as was possible in this study among a general population of reproductive aged women. If census level sociodemographic estimates of the target population are not available, adjustment based on probability of selection within individuals' social network may correct for bias, to some extent. Studies employing RDS methods should be preceded by rigorous formative qualitative work to identify key sociodemographic factors that might influence recruitment and the outcome of interest. Future studies should explore the extent to which these alternative adjustments may correct for bias in a population where validation against census estimates is possible.

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Table 1. Lifetime abortion incidence and socio demographic characteristics of women participating in a respondent-driven sampling survey, Soweto, South Africa, 2018 (N=849).

Sociodemographic characteristic	No.	Sample Proportion		RDS-II Estimated Population Proportion		Homophily [a]	Abortion incidence [b]
		%	95% CI	%	95% CI	Value	%
Total population	849	100		100			12.5
Age (categorical)	849					1.68[a]	
15 - 19	133	15.7	13.4, 18.3	16.1	14.2, 18	1.52	0.0
20 - 24	184	21.7	19, 24.6	22.2	19.5, 24.8	1.20	10.3
25 - 29	166	19.6	17, 22.4	19.2	17.5, 20.8	1.00	17.5
30 - 34	127	15.0	12.7, 17.5	14.9	11.8, 17.9	1.18	17.3
35 - 39	109	12.8	10.7, 15.3	12.6	9.8, 15.4	1.03	11.0
40 - 44	78	9.2	7.4, 11.3	9.0	6.8, 11.2	1.13	18.0
45 - 49	52	6.1	4.7, 8	6.1	3.6, 8.7	1.27	19.2
Marital Status[c]						1.01[a]	
Living with partner	207	24.6	21.8, 27.6	24.3	23.7, 24.9	0.97	16.9
Partner, not living together	332	39.4	36.1, 42.7	39.6	36.1, 43.1	0.99	10.8
Separated/Divorced	14	1.7	1, 2.8	1.6	0, 4.9	0.94	21.4
Single	290	34.4	31.3, 37.7	34.5	31, 37.9	1.04	10.7
Employment Status[c]						1.11[a]	
Employed	138	16.3	13.9, 18.9	16.9	14.4, 19.4	1.15	11.1
Unemployed/student	710	83.7	81.1, 86.1	83.1	80.6, 85.7	1.15	19.6
Home language[c]						2.03[a]	
Afrikaans	2	0.2	0.1, 0.9	0.2	0, 2.1	0.80	0.0
English	4	0.5	0.2, 1.3	0.5	0.3, 0.7	1.19	0.0
IsiXhosa	66	7.8	6.2, 9.8	7.7	7.7, 7.8	1.21	7.6
IsiZulu	329	38.9	35.7, 42.3	39.9	38.9, 40.8	1.48	15.5
Sepedi	20	2.4	1.5, 3.6	2.4	0.0, 6.0	1.19	0.0
Sesotho	216	25.6	22.7, 28.6	24.5	21.3, 27.8	1.41	13.4
Setswana	59	7.0	5.4, 8.9	7.2	6.9, 7.5	1.08	11.9
Tshivenda	35	4.1	3, 5.7	4.0	2.5, 5.5	1.77	8.6
Xitsonga	10	11.8	9.8, 14.2	12.	7.1, 17.1	2.13	10.0

	0			1			
Shona	13	1.5	0.9, 2.6	1.3	0.0, 3.5	3.91	7.7
Other	1	0.1	0, 0.8	0.1	0.0, 1.3	1.33	0.0

Abbreviations: RDS-II, respondent-driven sampling II estimator; CI, confidence interval

[a] Values indicated with [a] are recruitment homophily values, indicating the tendency of recruits to have the same characteristic as their recruiter. All other values are population homophily values, which refers to whether there are more homophilius pairs within each level of a characteristic than would be expected due to chance.

[b] Cumulative lifetime abortion incidence, row percentage (proportion of respondents in each category level who reported at least one abortion attempt during their lifetime).

[c] Subgroup n's do not sum to total due to missing data on marital status (n=6), employment status (n=1), and home language (n = 3).

Table 2. Recruitment dynamics among women participating a respondent-driven sampling survey, Soweto, South Africa (N = 849).

Recruitment Dynamics by Stage	N	%
Baseline[a]		
Non-seeds who completed Baseline[a]	**838**	**100.0**
Relationship to recruiter		
Friend	393	46.9
Neighbor/Church member/Community member	169	20.2
Other female relative	64	7.6
Cousin	61	7.3
Sister	46	5.5
Coworker/Colleague/Customer/Classmate	26	3.1
Friend of friend	26	3.1
Mother	21	2.5
Daughter	13	1.6
Stranger	5	0.6
Other	4	0.5
Missing	10	1.2
Would you have recruited your recruiter?		
Yes	763	91.1
No	45	5.4
Not sure	20	2.4
Missing	10	1.2
Follow-Up[b]		
Total number of relationship reported on	822	100
Relationship to potential recruit		
Friend	441	53.6
Neighbor/Church member/Community member	159	19.3
Sister	54	6.6
Cousin	54	6.6
Coworker/Colleague/Customer/Classmate	27	3.3
Daughter	13	1.6
Mother	8	1.0
Friend of friend	5	0.6
Other	61	7.4
Would your recruit have recruited you?		
Yes	691	84.1
No	45	5.5
Not sure	86	10.5

[a] Recruitment dynamics in baseline completed by 838 recruited participants (11 seeds excluded)

[b] Follow-up completed by 289 participants, reporting on 822 relationships

Table 3. Cumulative lifetime abortion incidence among women participating in a respondent-driven sampling survey, Soweto, South Africa, 2018 (N=849).

Estimate of Cumulative Lifetime Abortion incidence	No.	Weight Variable	Point Estimate (%)	95% CI[a]
Crude Estimate	849	None	12.5	10.4, 14.9
RDS-II	849	Imputed visibility	12.1	9.8, 14.3
RDS-II	849	Degree at baseline	10.5	5.6, 15.5
RDS-II (Excluding those with no reciprocal ties)	763	Imputed visibility	11.7	9.2, 14.2
Employment-adjusted based on network structure	849	Employment	15.3	12.1, 19.1
Employment-adjusted based on population structure	849	Employment	16.9	12.8, 22.1
Age-adjusted based on population structure	849	Age	13.1	10.9, 15.7
Among those who completed follow-up (*n* = 289)				
RDS-II	289	Imputed visibility	19.1	14.2, 24.1
RDS-II	289	Degree at baseline	20.3	10.8, 29.8
RDS-II	289	Degree at follow-up	21.2	11.2, 31.1

Abbreviations: RDS-II, respondent-driven sampling II estimator; CI, confidence interval

[a] 95% Confidence Intervals for RDS-II estimates constructed via bootstrapping procedures.

Figure Titles and Legends

Figure 1. Convergence plot for cumulative lifetime abortion incidence from a respondent-driven sampling study of women aged 15 - 49, Soweto, South Africa (n = 849). Legend**:** The solid line shows the change in the cumulative sample proportion of abortion with increasing number of study participants; the dashed line shows the final overall cumulative lifetime abortion incidence among all participants in the study. Equilibrium is reached when the cumulative proportion (solid line) converges on a stable estimate and does not change with successive waves of participants.

Figure 2. Convergence plot for employment status from a respondent-driven sampling study of women aged 15 - 49, Soweto, South Africa (n = 849). Legend: A) Convergence plot for proportion of student participants; B) Convergence plot for proportion of unemployed participants; C) Convergence plot for proportion of employed participants.

Figure 3. Bottleneck plot for cumulative lifetime abortion incidence from a respondent-driven sampling study of women aged 15 - 49, Soweto, South Africa (n = 849). Legend**:** The solid lines show the cumulative proportion of abortion with increasing number of study participants, by seed (each separate line represents a different recruitment chain). The dashed line indicates the cumulative lifetime abortion incidence in the overall sample at the end of the study. The solid dot indicates the cumulative lifetime abortion incidence in each recruitment chain at the end of the study. Bottlenecks are present if the dots do not appear to converge on the dashed line, which would indicate that the overall estimate may be affected by the initial selection of seeds.

Figure 4. Bottleneck plot for employment status from a respondent-driven sampling study of women aged 15 - 49, Soweto, South Africa (n = 849). Legend: A) Bottleneck plot for proportion of student participants; B) Bottleneck plot for proportion of unemployed participants; C) Bottleneck plot for proportion of employed participants.

Figure 5. Convergence plot for home language from a respondent-driven sampling study of women aged 15 - 49, Soweto, South Africa (n = 849). Legend: A) Convergence plot for proportion of isiZulu speaking participants; B) Convergence plot for proportion of Sesotho speaking participants; C) Convergence plot for proportion of Xitsonga speaking participants; D) Convergence plot for proportion of participants speaking other languages.

Figure 6. Bottleneck plot for home language from a respondent-driven sampling study of women aged 15 - 49, Soweto, South Africa (n = 849). Legend: A) Bottleneck plot for proportion of isiZulu speaking participants; B) Bottleneck plot for proportion of Sesotho speaking participants; C) Bottleneck plot for proportion of Xitsonga speaking participants; D) Bottleneck plot for proportion of participants speaking other languages.