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Application of Respondent Driven Sampling to Collect Baseline Data on FSWs and MSM for HIV Risk Reduction Interventions in Two Urban Centres in Papua New Guinea

William Yeka, Geraldine Maibani–Michie,
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ABSTRACT *The need to obtain unbiased information among hard-to-reach and hidden populations for behavioural and biological surveillance, epidemiological studies, and intervention program evaluations has led researchers to search for a suitable sampling method. One method that has been tested among IDU and MSM recently is respondent-driven sampling (RDS). We used RDS to conduct a behavioural survey among FSWs and MSM in two urban centres in Papua New Guinea (PNG). In this paper we present the lessons learned implementing RDS in a developing country setting. We also present comparisons of RDSAT-adjusted versus unadjusted crude estimates of some key socio-demographic indicators as well as comparisons between the estimates from RDS and a hypothetical time–location sample (TLS). Overall, the use of RDS among the MSM and FSWs in PNG had numerous advantages in terms of collecting a required sample size in a short time period, minimizing costs and maximising security for staff and respondents. Although there were a few problems these were easily remedied and we would recommend RDS for other similar studies in PNG and other developing countries.*

KEYWORDS *Female sex workers, Men who have sex with men, Papua New Guinea, Respondent-driven sampling, Sampling.*

INTRODUCTION

Papua New Guinea is currently experiencing a major generalized HIV epidemic driven by high rates of unprotected sex, multiple sexual partners, early age of sexual debut, and high rates of STIs. Sexual violence and aggression is also widespread.¹ PNG's HIV surveillance system has limited capacity, and valid scientific information is needed to guide community prevention efforts.²

Female sex workers (FSWs) and men who have sex with men (MSM) have been identified as groups at high-risk for HIV throughout the world. There have been few published studies about FSWs in PNG.^{3,4} No previous quantitative research has been conducted with MSM in PNG, but qualitative research and unpublished reports indicate that MSM behaviour is prevalent in some areas of the country.⁵

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Moreover, numerous anthropological studies indicate that many tribes in PNG have practised male–male sexual behaviour in traditional rites and rituals.^{6–8}

The major challenge in studying HIV–risk behaviours and developing prevention efforts among high risk populations is gathering information from non–biased samples.⁹ Members of population groups such as men who have sex with men (MSM), injecting drug users (IDU) and female sex workers (FSWs) are involved in stigmatized or illegal behaviour, leading individuals to hide their identity and to be reluctant to participate in research studies. No sampling frame exists for these groups, and the fact that creating one may be difficult and very costly makes them hard to sample with traditional probability–based sampling methods.

Respondent driven sampling (RDS) is a relatively new adaptation of chain–referral sampling, where subsequent respondents are recruited by previous respondents through their network of acquaintances.^{9–11} It has several features that overcome the limitations of other sampling methods that allow it to provide unbiased and representative population–based estimates. RDS has therefore been recommended as an alternative sampling approach for “hidden” populations that do not congregate in identifiable or accessible locations.^{12–14} Because RDS relies on participants from the target population to recruit subsequent respondents, it has the advantages that it requires less detailed formative research, is less costly, can be completed in a shorter amount of time, and has greater external validity than other methods.

This paper presents lessons learned from applying RDS in a study to collect baseline behavioural data for HIV prevention programming among two high risk populations in two urban centres in Papua New Guinea. The research among FSWs in Goroka and Port Moresby and MSM in Port Moresby was linked to the Poro Sapot Project (PSP), which is an HIV prevention initiative of Save the Children in PNG (SCiPNG). The Papua New Guinea Institute of Medical Research (PNGIMR) partnered with SCiPNG and Family Health International (FHI) to conduct the research.

REASONS FOR CHOOSING RDS

The first phase of the research project was a qualitative evaluation of the two target populations. Qualitative research methods included field observations, focus group discussions, in–depth interviews, and key informant interviews. In addition, a literature review of research studies on these populations in PNG was carried out.

Our formative research showed that there was a relatively large and socially well connected population of MSM in Port Moresby, the capital and largest city of PNG. Although there were a number of commercial and public spaces where MSM met and socialised, none of them catered to a primarily MSM clientele. There were no formal community–based or social organizations of gay or homosexual men. Due to social stigma and discrimination, the vast majority of MSM kept their sexual orientation hidden from their family, friends and co–workers. The lack of MSM–identified sites and the hidden nature of homosexuality in PNG meant that it would be difficult to use time–location sampling (TLS) as the recruitment methodology.^{13,14}

The decision to use RDS for the survey of FSWs came about following formative assessments in both locations. FSWs in PNG were found to be very mobile. Although a few illegal brothels did exist, only a small number of women

worked in those locations. Most FSWs frequented formal establishments such as disco bars, hotels, motels, and guest houses in search of potential clients. In most locations FSWs mixed with the general population in a way that would have made it difficult to differentiate sex workers from other females.

In addition, security for the research staff and participants was a major concern. MSM informants had complained of physical and verbal abuse due to social stigmatization. The crime rate in Port Moresby was very high and had steadily deteriorated in the time period before the research was conducted. Since most MSM and FSWs went out at night to socialise or meet clients, it would have been difficult to ensure the security of research staff members if they had to contact potential respondents in public areas. RDS provided a safer alternative in this regard because respondents were not actively recruited by study interviewers but were instead referred by their peers to be interviewed at a safe study facility during a convenient time of the day.

RESEARCH METHODS

The field work in Port Moresby began in February 2005 and was completed at the beginning of April 2005. Data collection in Goroka began in April 2005 and was completed in 2 weeks. The interviewers were all FSWs and MSM who received 1 and 1/2 weeks of intensive training prior to the starting of field work.

The research teams at each site were comprised of a coupon manager, a research assistant and a group of peer interviewers. In Port Moresby we trained and used six MSM interviewers and four FSWs interviewers. In Goroka we trained and used five FSWs interviewers.

THE COUPON MANAGEMENT SYSTEM

A coupon management system was developed in Microsoft FoxPro 2.6 and was used to track the relationships between the recruiters and their recruits. The same program was used to record biometric measurements (circumference of both wrists and length of both forearms), which were used to check for and prevent duplication of recruitment. The latter was done through the calculation of the index of differences between the candidate and all of the other biometric measures already entered.¹⁵

RECRUITMENT OF SEEDS AND STUDY PARTICIPANTS

The FSWs seeds for the RDS sample were drawn from distinct geographic areas within Port Moresby and Goroka. The areas chosen in each location were the coverage areas that were mapped out and targeted for the intervention programs. Therefore eight seeds were chosen who lived and worked in five different areas of the city of Port Moresby, and six seeds were chosen from six different areas in Goroka. These areas and the number of seeds drawn for Port Moresby and Goroka are shown in Tables 1 and 2, respectively.

In some areas of Port Moresby two seeds were chosen: one seed was a younger FSWs while the other was an older one. Formative research had shown that the younger and older FSWs in some locations did not mix socially and therefore could be considered as separate populations. In other areas only one seed was used as in these areas the younger and older FSWs mixed together socially.

TABLE 1. Socio-demographic characteristics of FSWs in Port Moresby

	Seeds		Sample			
	(<i>n</i> = 8)	Percent	(<i>n</i> = 245)	Crude (%)	RDSAT-adjusted (%)	Absol. diff (%)
Age						
16–19	1	12.5	48	19.6	25.0	5.4
20–24	1	12.5	38	15.5	18.6	3.1
25–29	1	12.5	54	22.0	22.7	0.7
30+	5	62.5	105	42.9	33.5	9.4
Marital status						
Ever married	6	75.0	185	75.5	66.9	8.8
Currently married	1	12.5	58	23.7	17.2	6.5
Currently married cohabiting with spouse	0	0.0	7	2.9	3.9	1.0
Education level						
No formal education	0	0.0	58	23.7	26.6	7.9
Primary	3	37.5	121	49.4	47.5	1.9
Secondary	5	62.5	61	24.9	22.2	2.7
Other (eg. vocational)	0	0.0	5	2.0	3.2	1.2
Region of birth						
Highlands	2	25.0	113	46.1	42.7	3.4
Southern	5	62.5	116	47.3	51.2	3.9
Others	1	12.5	16	6.5	5.9	0.6
Place of residence						
Town/Koki area	2	25.0	62	25.3	18.4	6.9
Boroko area	1	12.5	100	40.8	23.6	17.2
7-mile/airport	2	25.0	15	6.1	4.6	1.5
Gordons/Hohola	2	25.0	19	7.8	8.8	1.0
Waigani/Gerehu	1	12.5	46	18.8	43.2	24.4
Others	0	0.0	3	1.2	1.1	1.2

The eligibility criteria for the selection of FSWs seeds as well as their subsequent recruits were defined as “a female over the age of 16 who has exchanged sex for money or other goods and services in the last 12 months and is not drunk at the time of the interview.”

For the MSM study in Port Moresby we also attempted to recruit a diverse set of seeds based on self-identified sexual orientation and region of origin.

Seeds were recruited through SCiPNG, which had recently initiated a peer education program with MSM. The peer educators in the project also worked as interviewers for the research. These men tended to recruit MSM seeds from their own social group. As a result, eight of the ten seeds used were self-identified as homosexual, and seven of the ten were from the southern region, which was the site of the research. As we will report later, the biases inherent within the initial group of MSM seeds were not present in the final sample population, in line with RDS theory.

The eligibility criteria for the selection of the MSM seeds as well as their subsequent recruits were defined as “a man over the age of 16 who has had sex with another man in the last 12 months and is not drunk at the time of the interview.”

TABLE 2. Socio-demographic characteristics of FSWs in Goroka

	Seeds		Sample			
	(<i>n</i> = 6)	Percent	(<i>n</i> = 249)	Crude (%)	RDSAT-adjusted (%)	Absol. diff (%)
Age						
16–19	1	16.7	45	18.1	16.6	1.5
20–24	1	16.7	80	32.1	35.3	3.2
25–29	1	16.7	62	24.9	23.9	1.0
30+	3	50.0	62	24.9	24.0	0.9
Marital status						
Ever married	3	50.0	164	65.9	65.8	0.1
Currently married	0	0.0	27	10.8	12.4	1.6
Currently married cohabiting with spouse	0	0.0	0	0.0	0.0	0.0
Education level						
No formal education	2	33.3	87	34.9	35.8	0.9
Primary	2	33.3	108	43.4	43.2	0.2
Secondary	2	33.3	53	21.3	22.0	0.7
Other (eg. vocational)	0	0.0	2	0.8	1.0	0.2
Region of birth						
Highlands	6	100.0	238	95.6	96.4	0.8
Momase	0	0.0	8	3.2	2.7	0.5
Others	0	0.0	3	1.2	0.8	0.4
Place of residence						
Seigu/fish Wara	1	16.7	73	29.3	31.2	1.9
Asariyufa	1	16.7	62	24.9	26.3	1.4
North Goroka	1	16.7	35	14.1	11.1	3.0
Kama	1	16.7	12	4.8	2.6	2.2
Lofi/Faniyufa	1	16.7	23	9.2	7.1	2.1
Waterise	1	16.7	32	12.9	15.5	2.6
Others	0	0.0	12	4.8	5.7	0.9

In none of the three study groups was it found necessary to add additional seeds during the course of the study.

INCENTIVES

Seeds and their recruits were offered monetary incentives as well as gift bags containing pamphlets, posters, free condoms and lubricant. Participants in Port Moresby were given 20 PNG Kina (K20, equal to U.S. \$6.00) for successfully participating in the study and K10 (U.S. \$3.00) each for every successfully recruited peer. The FSWs in Goroka were given K10 (U.S. \$3.00) for participating and K5 (U.S. \$1.50) for every successful recruitment made. The amount for incentive was less in Goroka because of the lower cost of living there compared to Port Moresby.

INTERVIEWS AND SETTING

As part of the RDS field work in Port Moresby, the research team rented two private properties situated in secluded locations of the city. The FSWs study in

Goroka was also carried out at a private property in a residential part of town. Data was collected by trained interviewers who were MSM and FSWs themselves and was directly supervised by the principal investigators. All interviews took place in private rooms with only the interviewer and subject present. The secure nature of the locations used also allowed the research staff to exclude non-participants from the sites while recruitment and interviews were taking place.

Participants gave witnessed verbal consent to be part of the study. Interviews were conducted using a structured questionnaire. Information obtained included demographics, sexual behaviour, drug and alcohol use, knowledge and use of male and female condoms, knowledge and attitudes towards HIV/AIDS and STI, history and treatment seeking behaviour of STI, experience with stigma and discrimination, and exposure to intervention programs. The MSM interviews included information about their sexual orientation. Additional information was collected that was specifically required for RDS methodology: personal network size, relationships to recruiters, and the number of recruitment refusals encountered.

SAMPLE SIZES

A total of 245 and 249 FSWs were interviewed in Port Moresby and Goroka, respectively. For the MSM study in Port Moresby, a total of 225 MSM participants were interviewed.

A total of 471 and 621 coupons were given out to 157 and 207 FSWs in Port Moresby and Goroka, respectively, while 603 coupons were given out to 201 MSM. Participants in all sites were told in advance that recruitment would stop when the desired sample size was reached. Participants who had lost a coupon were not given any additional ones.

Failure to meet the eligibility criteria resulted in 15 females (four from Goroka) and 35 males being refused participation in the study. Half of the women who were excluded in Port Moresby were under 16 years of age, while the other half were excluded because they reported that they had never sold sex. The four FSWs that were excluded in Goroka were all under 16 years of age. The bulk of the men that were excluded from the MSM study (33) did not meet the criteria of having had sex with another man in the previous 12 months, while two others were excluded for trying to repeat the interview.

DATA ANALYSIS METHODS

Data was double entered using Microsoft FoxPro 2.6 and analysed using Stata 8.0 (Stata Corporation, Texas, USA), RDS Analysis Tool (RDSAT, Cornell University, NY, USA) and EpiInfo 6.04 (CDC, USA and WHO, Geneva). Adjusted analysis was carried out using RDSAT on single categorical variables whereas bivariate and multivariate analysis was done using EpiInfo and Stata. RDSAT adjusts the analysis of population estimates by taking into consideration the links between the recruiters and their recruits as well as their reported personal network sizes.^{11,12} A detailed description of the methods of calculation is beyond the scope of this paper.

SOME KEY RESULTS

Of the 157 and 207 FSWs in Port Moresby and Goroka that were given coupons, 56.7% and 42.0%, respectively, recruited one or more of their peers into the study.

For the MSM study, 57.2% of the 201 participants that were given coupons recruited one or more peers. Two questions were asked with regards to the number of coupons given out and the number of refusals encountered by each recruiter to determine refusal rates. However, the research assistants did not consistently record the answers to these questions. Nevertheless, the refusal rates appeared to be very low as indicated by the fact that 74.2% and 85.1% of the FSWs recruiters who successfully recruited other participants in Port Moresby and Goroka returned all three coupons. Of the successful MSM recruiters, 52.2% of them had all three coupons returned, 35.6% had two coupons returned and 12.2% had one coupon returned. Half of the MSM seeds (five) did not recruit any peers while three FSWs seeds (two from Port Moresby) did not recruit any peer.

It took a median of 4 days (Range = 1–12) and 3.5 days (Range = 1–10) for a coupon to be returned by FSWs in Port Moresby and Goroka, respectively. MSM returned the coupon at a median of 3 days (range = 1–18). For both the FSWs and MSM, however, recruitment occurred at a much faster rate than had been anticipated and recruits presented to the study locations faster than they could be interviewed. It became necessary to slow down recruitment by scheduling interviews each day on a first-come first-served basis. Those that could not be interviewed the day they first presented were scheduled for the next day. Eventually the recruiters were told to bring their recruits in on specified dates in order to control the flow of new subjects to the study sites. The fast rate of recruitment for the three subpopulations enabled the sample sizes for FSWs in Port Moresby and Goroka to be reached in 17 and 20 days, respectively, while the sample size for MSM was reached in 22 days.

The main sociodemographic characteristics of the seeds and the overall samples for the three studies are presented in Tables 1, 2 and 3. Comparisons between the RDSAT-adjusted and crude analyses are given as well.

The results for the FSWs study in Port Moresby show that, while the seeds were roughly comparable to the overall sample, there were still some major differences with regard to educational status and region of birth.

For the FSWs study in Goroka, there was less variation between the seeds and final sample (Table 2), although the seeds tended to be older than overall sample.

The most striking differences between the initially selected seeds and the final sample were found for the MSM study in Port Moresby (Table 3). The final sample was younger, less educated, and more often unemployed. In addition, while the majority of the seeds (80%) were gay identified, less than a third of the final sample self-identified as homosexual and the majority of the final sample self-identified as bisexual.

For all three studies (Tables 1, 2 and 3), a common pattern in the findings that emerged with regard to comparisons of the characteristics of seeds and final samples, was that the overall sample was of lower socioeconomic status (especially for the MSM study). This suggests that RDS is able to penetrate “hidden” populations that are often very different from the initially selected seeds.

In terms of the comparisons between the RDSAT-adjusted and crude analysis in Tables 1, 2 and 3, the greatest variations between the two analyses (as measured by the percent of absolute difference) were found for FSWs in Port Moresby. This was especially true with regard to place of residence, where up to 24.4% differences were found for the ones that reside in one part of the city (Table 1). For FSWs in Goroka, considerably less variation was found with absolute differences ranging from 0 to 3.2% (Table 2). For the MSM study, some considerable differences were also seen and absolute differences ranged from 0 to 10.8%.

TABLE 3. Socio-demographic characteristics of MSM in Port Moresby

	Seeds		Sample			
	(<i>n</i> = 10)	Percent	(<i>n</i> = 225)	Crude (%)	RDSAT-adjusted (%)	Absol. diff (%)
Age						
16–19	2	20.0	49	21.8	20.8	1.0
20–24	1	10.0	81	36.0	38.1	2.1
25–29	6	60.0	60	26.7	27.7	1.0
30+	1	10.0	35	15.6	13.2	2.4
Education level						
No formal education	0	0.0	12	5.3	6.7	1.4
Primary	0	0.0	87	38.7	49.5	10.8
Secondary	6	60.0	69	30.7	40.4	9.7
Secondary	4	40.0	15	6.7	3.1	3.6
Employment status						
Unemployed	2	20.0	120	54.0	52.0	2.0
Employed	3	30.0	29	13.0	11.0	2.0
Self-employed	5	50.0	69	31.0	35.0	4.0
Students	0	0.0	4	2.0	2.0	0.0
Region of birth						
Highlands	2	20.0	33	14.7	23.9	9.2
Southern—gulf only	1	10.0	114	50.7	54.1	3.4
Southern—others	6	60.0	48	21.3	10.7	10.6
New Guinea islands	0	0.0	10	4.4	4.8	0.4
Momase	1	10.0	20	8.9	6.3	2.6
Sexual orientation						
Heterosexual	1	10.0	29	12.9	10.0	2.9
Gay/homosexual	8	80.0	65	28.9	23.0	5.9
Bisexual	1	10.0	131	58.2	67.0	8.8
Paid by man for sex						
Yes	9	90.0	169	75.1	70.7	4.4
No	1	10.0	56	24.9	29.2	4.3

The results presented in Tables 4 and 5 were an attempt to understand the potential differences in respondent characteristics that would have existed between RDS and TLS, had this latter sampling method been used instead of RDS. The hypothetical TLS group for this analysis included FSWS and MSM respondents who reported that they ‘always’ looked for and met their sexual partners in visible locations that would have been likely included in a TLS sampling frame (i.e., nightclubs, bars, hotels, guesthouses and identifiable public venues). The results shown in Table 4 indicate that the RDS samples for FSWS in both Port Moresby and Goroka were younger and less educated than the hypothetical TLS group. While reported condom use with clients was similar between the RDS and TLS groups, reported condom use with non-paying partners was substantially lower among the RDS group. On the other hand, forced sex, knowledge, and reported STI symptoms were higher in the TLS group. Analysis of the key program exposure variable, contacted by peer educator, also revealed that program exposure was substantially lower among the RDS sample than hypothetical TLS sample. The analysis of the MSM study population in Port Moresby (Table 5) showed striking differences in

TABLE 4. RDS versus hypothesized TLS estimates of key indicators for FSWs

Key indicators	Port Moresby (%)		Goroka (%)	
	RDS ^a (<i>n</i> = 235)	TLS (<i>n</i> = 103)	RDS ^a (<i>n</i> = 227)	TLS (<i>n</i> = 165)
Age				
16–24	43.6	36.9	51.9	49.7
25+	56.2	63.1	47.9	50.3
Education level				
No formal education	26.6	21.4	35.8	30.1
Primary	47.5	53.3	43.2	44.6
Secondary	22.2	24.3	22.0	24.1
Used condom with client at last sex	86.0	88.2	79.0	77.7
Used condom consistently with client ^c	62.6	61.2	31.3	31.3
Used condom with non-paying partner at last sex	48.3	75.7	43.0	62.0
Used condom consistently with non-paying partner ^c	33.5	48.7	16.0	26.0
Forced to have sex ^b	58.4	66.7	66.5	70.5
Thinks mosquitos can transmit HIV	37.1	50.0	30.7	36.1
Had vaginal discharge ^b	43.2	53.4	28.6	37.4
Had sore in/around vagina ^b	20.5	24.3	12.1	19.4
Never contacted by peer ^b educator	24.4	18.5	40.9	39.6

^aRDSAT adjusted^bIn the last 12 months^cIn the last 4 weeks

almost all variables examined. In comparison to the hypothetical TLS group, the RDS group was older, less educated, more likely to be unemployed, more likely to identify their sexual orientation as heterosexual or bisexual and less likely to use condoms for partnerships examined. This group was also less likely to use lubricant during anal sex and less likely to have been exposed to HIV prevention programming. On the other hand, the hypothetical TLS group was more likely to report forced sex, incidents of discrimination and symptoms of STIs.

It is important to note that the observed differences between the two groups in Tables 4 and 5 would have been even more pronounced if the comparisons had been made between the mutually exclusive categories—the hypothetical TLS group and the RDS group restricted to respondents who would likely not have been sampled using TLS.

DISCUSSION OF THE LESSONS LEARNED

Sampling procedures should be capable of reaching all members of the population or subpopulation under surveillance in order to produce unbiased estimates of trends in HIV behavioural risks.¹² In this respect, RDS was chosen to study the three subpopulations of interest in PNG after carefully considering its advantages and disadvantages for each target group. Many factors prompted us to opt for RDS instead of other sampling methods. For MSM, the main reasons why other sampling methods would not be adequate were that most of them were hidden due to social stigma and that no public venues existed to use as a sampling frame

TABLE 5. RDS versus hypothesized TLS estimates of key indicators for MSM

Key Indicators	RDS [£] (n=223)	TLS (n=52)
Age - 16-24	58.9	66.7
- 25 +	40.9	33.3
Education level - No formal education	6.7	0.0
- Primary	49.5	55.6
- Secondary +	43.5	44.4
Employment status - Unemployed	52.0	46.2
- Employed	11.0	9.6
- Self employed	35.0	38.5
Sexual orientation - Heterosexual	10.0	7.7
- Gay/homosexual	23.0	36.5
- Bisexual	67.0	55.8
Used condom with one-time client at last anal sex	57.6 (n=126)	69.2 (n=39)
Used condom consistently with one-time client [£]	32.5 (n=126)	46.2 (n=39)
Used condom with non-paying partner at last anal sex	46.3 (n=203)	58.3 (n=48)
Used condom consistently with non-paying anal partner [£]	16.3 (n=203)	27.1 (n=48)
Ever used lubricant when having anal sex	61.6	74.5
Forced to have sex [¥]	58.5	69.2
Discriminated against [¥]	37.3	63.3
Self perception of HIV risk as high risk	29.0	28.8
Thinks mosquitos can transmit HIV	29.4	22.0
Had urethral discharge [¥]	27.9	39.2
Had genital ulcer [¥]	23.9	26.5
Never contacted by peer educator [¥]	21.1	13.5

[£]RDSAT adjusted only shaded[¥]In the last 12 months[£]In the last 4 weeks

for TLS. For the FSWs, creation of a sampling frame for random sampling or TLS would be difficult and costly given their very high mobility and the illegal nature of sex work in PNG.

For all three target groups in both locations, security for both the subjects and the research staff was a major concern. This is an issue specific to PNG, but may also be an important issue in other developing countries with unstable economic and political situations. The ability to conduct interviews in a private and secure location during the daytime and have potential subjects come directly to the study location after being recruited by previous respondents was a major advantage of RDS in this study. In PNG, it would have been difficult to have ensured the safety of the research staff if they had to go out into the field at night time or may have required hiring security guards at considerable expense.

RDS has been described by those studying more the difficult sub-population of illicit drug users as a flexible and robust method that can produce a sample representative of the heterogeneity of the target population.¹⁶ We had a similar experience in implementing RDS among FSWs and MSM in a developing country. Although our original seeds were not as diverse as we intended them to be, a comparison of the seeds versus the final sample (Tables 1, 2 and 3) shows that by

using RDS, the characteristics of the final samples were often quite different from the initially selected seeds. Particularly striking was our finding that the overall samples in all three subpopulations were mainly lower socio-economic status. A comparison of the RDSAT-adjusted versus the crude estimates of the various socio-demographic characteristics (Tables 1, 2 and 3) showed mostly little variation.

The rapid rate of recruitment among all subpopulations suggests that the dual incentive system did work exceptionally well. We observed that the majority of the recruiters accompanied their recruits to the interview site. The reason for this was most likely that the recruiters wanted to collect their recruitment incentives immediately, but it also ensured that many of the recruited persons did in fact show up at the study sites in a relatively short amount of time.

Not one FSWs or MSM subject used the phone number printed on the coupon to make an appointment. Telephone charges are relatively expensive, and mobile phones are not widespread among the general population in PNG. Therefore, it may have been easier and less expensive for recruits to simply show up at the research site than to have called ahead for an appointment. Thus the use of a telephone call to make appointments may not be necessary in this country in any future application of RDS for these or similar populations.

The results of the comparisons between the RDS and hypothetical TLS samples (Tables 4 and 5) suggest that RDS allowed for greater penetration and representation of more vulnerable segments of the FSWs and MSM target populations. The use of dual financial incentives associated with RDS is also believed to have been important for reaching less educated and unemployed segments of the FSWs and MSM populations because they were more likely to find this a motivating factor for participation. During the RDS field work, it was observed anecdotally that the more economically desperate participants with ample disposable time were more likely to try to recruit individuals who did not meet the study eligibility criteria.

Careful planning, staff training, and preparation for the field work enabled us to handle the onslaught of recruits and ensure the smooth implementation of RDS among FSWs and MSM in Papua New Guinea. The procedures checklist¹³ and practicing with the coupon management system were particularly important in preparing for the research. We agree with the view expressed by others that RDS is relatively easy to implement and less costly in that it did not require exhaustive mapping exercise to construct sampling frames.^{2,16} In our experience, the dual incentive system of RDS helped to reduce non-response rates and fuelled recruitment.¹³

Finally, in this study we relied on others to help select the original seeds. Some of the seeds failed to recruit any additional subjects. Half of the MSM seeds recommended to us simply did not recruit any other MSM, indicating that the recruitment of initial seeds in this study was not very effective. Problems were also encountered with potential recruits who misrepresented themselves in attempts to participate in the study in order to earn money. This was especially true in the MSM study, where many men who were not really MSM tried to participate. Similarly, a number of underage girls were refused entry into the study. This problem most likely resulted from the dual incentive system, in which a participant could potentially earn up to U.S. \$15.00, a significant sum in a poor country like PNG. However, the screening and interview process in place was sufficient to track and preclude repeat participation or recruitment of individuals who did not meet the inclusion criteria.

For this study among FSWs and MSM in PNG, using RDS as the sampling methodology had numerous advantages in terms of collecting the required sample size in a short time period, minimizing study costs, and resulting in representative estimates of the target populations. Although there were a few problems in implementing a new research method in a resource-poor setting, these were easily remedied, and we would recommend RDS for similar studies in PNG and other developing nations.

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REFERENCES

1. UNAIDS. *AIDS Epidemic*. UNAIDS, in Geneva, Switzerland, Update: 2004.
2. Semaan S, Lauby J, Liebman J. Street and network sampling in evaluation studies of HIV risk-reduction interventions. *AIDS Rev*. 2002;4:213-223.
3. Mgone CS, Passey M, Anang J, et al. Human immunodeficiency virus and other sexually transmitted diseases among female commercial sex workers in two major cities in Papua New Guinea. *Sex Transm Dis*. 2002;29(5):265-270.
4. Gare J, Lupiwa T, Suarkia D, et al. High prevalence of sexually transmitted infections among female sex workers in the eastern highlands province of Papua New Guinea: correlates and recommendations. *Sex Transm Dis*. 2005;32(6):466-473.
5. National Sex and Reproduction Research Team, Jenkins C. National study of sexual and reproductive knowledge and behaviour in Papua New Guinea. PNG Institute of Medical Research Monograph No.10. Goroka, Papua New Guinea Institute of Medical Research, 1994.
6. Herdt GH. Ritualized homosexual behaviour in the male cults of Melanesia, 1962-1983: an introduction. In: Herdt GH, ed. *Ritualized Homosexuality in Melanesia*. Berkeley and Los Angeles: University of California Press; 1984:1-82.
7. Schwimmer E. Male couples in New Guinea. In: Herdt GH, ed. *Ritualized Homosexuality in Melanesia*. Berkeley and Los Angeles: University of California Press; 1984:248-291.
8. Herdt GH. Semen transactions in Samba culture. In: Herdt GH, ed. *Ritualized Homosexuality in Melanesia*. Berkeley and Los Angeles: University of California Press; 1984:167-210.
9. Ramirez-Valles J, Heckathorn D, Vazquez R, et al. From networks to populations: the development and application of respondent-driven sampling among IDUs and Latino gay men. *AIDS Behav*. 2005;19:1-16.
10. Heckathorn D. Respondent-driven sampling: a new approach to the study of hidden populations. *Soc Probl*. 1997;44(2):174-199.
11. Heckathorn D. Respondent-driven sampling II: deriving valid population estimates from chain-referral samples of hidden populations. *Soc Probl*. 2002;49(1):11-34.

12. Salganick M, Heckathorn D. Sampling and estimation in hidden populations using respondent driven sampling. *Sociol Method*. 2004;34(1):193–240.
13. Magnani R, Sabin K, Saidel T, Heckathorn D. Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS*. 2005;19(Suppl 2):S67–S72.
14. Mills S, Saidel T, Magnani R, Brown T. Surveillance and modelling of HIV, STI, and risk behaviours in concentrated HIV epidemics. *Sex Transm Infect*. 2004;80(Suppl II):ii57–ii62.
15. Heckathorn D, Broadhead RS, Sergeyev B. A methodology for reducing respondent duplication and impersonation in samples of hidden populations. *J Drug Issues*. 2002;31(2):543–564.
16. Wang J, Carlson RG, Falck RS, et al. Respondent-driven sampling to recruit MDMA users: a methodological assessment populations. *Drug Alcohol Depend*. 2005;78:147–157.