

The Effectiveness of Respondent Driven Sampling for Recruiting Males Who have Sex with Males in Dhaka, Bangladesh

Lisa Grazina Johnston · Rasheda Khanam · Masud Reza ·
Sharful Islam Khan · Sarah Banu · Md. Shah Alam ·
Mahmudur Rahman · Tasnim Azim

© Springer Science+Business Media, LLC 2007

Abstract This paper evaluates the effectiveness of respondent driven sampling (RDS) to sample males who have sex with males (MSM) in Dhaka, Bangladesh. A major objective for conducting this survey was to determine whether RDS can be a viable sampling method for future routine serologic and behavioral surveillance of MSM as well as other socially networked, hard to reach populations in Bangladesh. We assessed the feasibility of RDS (survey duration; MSM social network properties; number and types of initial recruits) to recruit a diverse group of MSM, the efficacy of an innovative technique (systematic coupon reduction) to manage the implementation and completion of the RDS recruitment process and reasons why MSM participated or did not participate. The findings provide useful information for improving RDS field techniques and demonstrate that RDS is an effective sampling method for recruiting diverse groups of MSM to participate in HIV related serologic and behavioral surveys in Dhaka.

Keywords Respondent-driven sampling · Males who have sex with males · HIV/AIDS · Surveillance · Bangladesh

Introduction

Over the past 5 years, respondent driven sampling (RDS) has cautiously been adopted by many countries with years of experience using cluster, targeted and institutional sampling to conduct large scale HIV serologic and behavioral surveys among hard to reach populations (Magnani et al. 2005). The Government of Bangladesh has gathered data for the National Surveillance System since 1998 to assess HIV prevalence and risk behaviors among vulnerable populations (injection drug users, female and male sex workers, males who have sex with males [MSM] and bridge population groups, including rickshaw drivers, truckers, and dock workers) following the UNAIDS/WHO guidelines of second generation surveillance (Government of Bangladesh 2005; UNAIDS/WHO 2000).

In Bangladesh, past serologic and behavioral data were gathered using time location sampling, and serologic surveillance data were gathered using convenience sampling of individuals within intervention programs. Both systems access individuals whose behaviors are 'visible' because of where they gather (e.g., cruising spots for MSM) and potentially miss those who are 'hidden' or less accessible (Johnston et al. 2006; Magnani et al. 2005; Ramirez-Valles et al. 2005; Semaan et al. 2002). This is problematic since data from such surveillance methods, which are used to plan and fund prevention programs, are not representative of the entire sub-population of interest (Government of Bangladesh 2003, 2005). Surveys using RDS methods have been shown to reach both visible and hidden segments of

L. G. Johnston (✉)
13 Via Plaza Nueva, Santa Fe, NM 87507, USA
e-mail: lsjohnston@comcast.net

L. G. Johnston
Independent Consultant, Family Health International, Dhaka,
Bangladesh

R. Khanam · M. Reza · S. I. Khan · Md. S. Alam · T. Azim
International Centre for Diarrhoeal Disease Research, Dhaka,
Bangladesh

S. Banu · M. Rahman
Institute of Epidemiology, Disease Control and Research,
Dhaka, Bangladesh

the population and allow for easy integration of serologic and behavioral surveillance systems (Johnston et al. 2006; Ramirez-Valles et al. 2005).

RDS uses a chain referral sampling approach, but incorporates social network theories to gather a sample representative of the target population by mitigating the biases commonly found in chain referral sampling (Heckathorn 1997, 2002; Erickson 1979). Unlike traditional random sampling methods, RDS does not require a sampling frame to calculate the probability of selecting a sampling unit. RDS is particularly useful for studying HIV risk populations who practice illegal and/or stigmatized behaviors (e.g., same sex intercourse, selling sex, injecting drugs, etc.), which often lack sampling frames (Abdul-Quader et al. 2006; Johnston 2007; Johnston et al. 2005, 2006; Ramirez-Valles et al. 2005; Stromer et al. 2006; Yeka et al. 2006).

Basically, RDS starts with a non-randomly selected group of participants (seeds) from the target population. Seeds that complete the survey protocol receive a set number of recruitment coupons which they use to recruit members of the target population who are members of their social network. Seeds' recruits redeem coupons to enroll in and complete the survey, thereby becoming first wave participants. First wave participants receive recruitment coupons to recruit members of their social network (second wave participants). This recruitment process continues for numerous waves, until the pre-determined sample size is reached. Participants receive an incentive for participating in the survey (primary incentive) and for recruiting their peers (secondary incentive).

Testing new and innovative sampling approaches is a considerable challenge for countries with limited HIV surveillance budgets and the financial and social cost of failure can be high (Ogunnaik-Cooke and Bombereau 2007; Simic et al. 2006). This is true especially since RDS' success relies on several factors that have not been previously established. For example, the incentive must be appropriate, not too high or too low, to motivate economically and socially diverse members of the target population; target population members must be connected through dense social network ties (Johnston 2007; Platt et al. 2006; Simic et al. 2006); and there must be an adequate number of initial recruits (seeds) to ensure that recruitment chains are long enough to mitigate biases while reaching the pre-determined sample size.

As RDS is tested in new locations and among different populations, new field innovations are being evaluated to improve the data collection process. In most RDS studies each participant receives three recruitment coupons over the course of waves throughout the survey. One modification is the implementation of a systematic coupon reduction process which is hypothesized to assist with the

flow of participants, especially when recruitment is fast. Coupon reduction involves reducing the number of coupons from three to two, and then from two to one at specific waves in the recruitment chain.

In 2006, the government of Bangladesh conducted a survey of MSM in Dhaka city to test whether RDS would be a viable sampling option for future serologic and behavioral surveillance surveys. MSM were selected as the target population since they were the most likely group to have the dense social network properties necessary for conducting RDS. By the nature of their behaviors, MSM must know other (at least one other) MSM to be in that population. We initiated this survey having conducted minimal in-depth formative research (used to identify seeds, select a survey site, design the coupon, and set the incentive) and not knowing whether RDS would be effective in recruiting this hidden and stigmatized population in Dhaka.

In this paper, we examine whether RDS methods are effective at recruiting a calculated sample size of MSM ($n = 530$) into an HIV serologic and behavioral surveillance survey in the large urban environment of Dhaka. And, if so, whether MSM have sufficiently dense network ties to attain a sample with sufficient socio-metric depth, and to attain an equilibrium distribution of participants by self-identified MSM type, occupation (sources of income), and age. An equilibrium distribution is the point at which characteristic proportions remain stable even if recruitment continues for several more waves. We also describe the level of homophily (the measurement of contact between people based on characteristics) among self-identified MSM types to understand their network ties. Furthermore, we explore the effects of a systematic reduction of coupons and coupon expiration periods to gradually reduce the number of valid coupons in the community at the end of the survey and to slow down the flow of participants during data collection. Finally, we examine reasons why some MSM accepted a coupon, and others did not, to participate in this survey.

Methods

Participants

We sampled MSM at a fixed site in Dhaka city between March 5 and May 15, 2006. Eligible participants were males who had sex with another male (and who had not sold sex) in the past 1 year, 18 years or older and living in Dhaka City Corporation.

Recruitment used eight non-randomly selected MSM, known as seeds, five of whom were interviewed at the start of data collection. Two seeds were interviewed 2 weeks

later and a final seed was interviewed 1 week after that. After completing a face-to-face interview and providing blood for HIV and syphilis screening, each seed received three coupons to use in recruiting their peers. Seeds, identified through a local organization working on MSM issues and a voluntary counseling and testing (VCT) center, were selected based on their ability to recruit other MSM (large social network sizes) and their differences in self-identified MSM type, occupation and age (Table 1).

Participants received a primary incentive of 150 Taka (~2.14 US Dollars) and those who recruited other MSM into the survey received 100 Taka (~1.43 US Dollars) for each successful recruit. Trained Bangladeshi MSM interviewed participants about their background and HIV risk behaviors and asked why they accepted a coupon and enrolled into the survey. When participants returned to the survey site to receive their secondary incentive for recruiting other MSM, they completed a questionnaire addressing whether they tried to give a coupon to someone who refused to accept it, and why a potential recruit refused to accept it.

Lab technicians collected 5 ml of venous blood from participants to test for HIV antibodies and syphilis. HIV samples were unlinked and anonymous while those for syphilis were linked to the individuals so that results and treatment, if needed, could be provided. Participants were eligible to receive their syphilis results by returning to the survey site 2 weeks after providing a sample. As HIV testing was unlinked, participants were not provided their HIV results. Rather, they were referred to a nearby HIV VCT Unit of ICDDR, B to receive pre- and post-HIV counseling with free HIV testing and results. Interviews and serological specimens were linked through a unique number, located on the coupon brought in by the

participant. Participants were also offered a free medical consultation with a physician, consisting of minor diagnostic tests (e.g., blood pressure), screening for visible STIs and genital abnormalities, and feedback about any medical ailments or concerns the participant had.

The RDS staff consisted of one screener (completing eligibility and consent forms, and explaining the survey), five interviewers, two coupon managers (who provided coupons, explained the recruitment process, completed non-response questionnaires, and distributed primary and secondary incentives) and two supervisors who managed participant flow and filled in for the screener and coupon managers when needed. In addition, there were two lab technicians who took serological specimens, and two clinicians. Three data management assistants and one statistician were assigned to data entry and analysis, respectively.

The survey sample size of 530 was calculated based on a 10% change over time on 'condom use while buying sex from males in last 1 month' with a design effect of 1.25. This type of sample size calculation was used with the expectation that RDS would become a standard sampling method to measure change over time as part of Bangladesh's annual HIV serologic and behavioral surveillance activities (Salganik 2006; Family Health International 2000).

Measures

During data collection we tested a systematic coupon reduction process to control exponential sample growth. The number of recruitment coupons was decreased from three to two for the fifth wave, and from two to one for the

Table 1 Seed characteristics and recruitment success, Dhaka, Bangladesh, 2006

Seed number	Network size	Self-identified MSM type ^a	Age	Past month occupation/income source	Maximum number of waves	Maximum number of recruits (except seed)	Percent recruited
1	7	Pantheri	27	Family	7	29	6
2	30	Kothi	31	Dancing/singing (performer)	8	111	21
3	17	Kothi	33	Dancing/singing (performer)	7	29	6
4	65	Male	53	From property	9	141	27
5	30	Male	27	Service (in an NGO)	9	68	13
6	20	Gay	20	University student	9	105	20
7	30	Male	26	University student	7	35	7
8	498	Gay	37	Service (in a multinational company)	2	5	1
					Total	523	100

^a 'Kothi' are feminized males who play the part of 'female' in their emotional, physical and social interactions with other males. 'Pantheri,' the name given by *kothi*, are the sex partners of *kothi* and are usually insertive partners. 'Male' refers to MSM who do not have a self-perceived MSM identity-most *pantheri* will identify themselves as *male*, rather than *pantheri*. 'Gays' identify themselves as westernized homosexuals, engaging in emotional and sexual relationships with other men

sixth and all sub-sequent waves, until we stopped giving out coupons at the end of the survey. Providing participants who are efficient recruiters (likely to distribute all or most of the coupons) with three coupons in each wave throughout the survey can cause the sample to grow exponentially. This may result in difficulties with participant flow at the survey site when too many coupons are redeemed at once (Johnston 2007). Exponential sample growth can also lead to an abrupt end to recruitment once the pre-established sample size is reached, resulting in numerous unredeemed coupons remaining in the community and participants wanting to redeem coupons once the survey has already ended (Johnston 2007).

A systematic coupon reduction process is more closely suited to the theoretical principles of linear recruitment (a first-order Markov chain as a random walk on a directed graph) upon which RDS is designed (Goel and Salganik 2007; Heckathorn 1997, 2002; Klodahl 1989). Basically, this means that beginning with a particular state (e.g., the characteristic mix of seeds), RDS recruitment will involve a random walk of states, whereby the transition from state to state (e.g., cross-sectional characteristics of each wave, such as the percentage of those who are HIV positive versus those who are HIV negative) is independent from the previous or past state. Eventually, a stationary probability distribution of characteristics (states) is reached. In RDS this stationary distribution is known as the equilibrium distribution. It supports the theorem that a final RDS sample of recruits will eventually be attained that is independent of the characteristics of the participants (seeds) from which recruitment began (Heckathorn 1997, 2002). RDS statistical rationale depends on the sample characteristics reaching equilibrium (Heckathorn 2002; Salganik and Heckathorn 2004).

A systematic coupon reduction process can benefit RDS recruitment by encouraging the production of long, rather than short and wide, recruitment chains (Heckathorn 2002). Wide chains resulting from multiple recruitments can increase homophily biases related to clustering. As a result, within-group associations (those in the same wave) are stronger than between-group associations (those from one wave to the next), leading to high variance around the RDS population estimator and effectively requiring a larger sample size (Goel and Salganik 2007). Long chains are essential to ensure that the final sample comprises an equilibrium distribution of recruits with diverse characteristics that reflects the mix of characteristics in the survey population.

The use of three coupons throughout RDS recruitment has a practical, rather than theoretical, rationale. The principal network theories underlying RDS are based upon a linear recruitment process, best achieved through the use of only one recruitment coupon. However, in RDS this is

not feasible because using only one coupon, rather than three, could result in recruitment chains dying out before producing a sufficient number of waves to reach an equilibrium distribution (Heckathorn 2002). Multiple recruitment coupons in a sample process that relies on participants as recruiters resolves attrition and ensures that a recruitment chain grows even though some recruits fail to recruit other people, in turn prematurely ending the recruitment process (Heckathorn 2002).

Systematic coupon reduction does not bias RDS samples, since even when recruits are provided with three coupons, not all coupons are distributed to and/or accepted by others. Nor is differential recruitment impacted, since RDS data analysis depends on the proportional distribution of each group's recruits, rather than the absolute number of recruits within each group or type; the probabilities remain the same whether all groups recruit equally or some groups recruit more or less than others (Heckathorn 2002).

As coupons are reduced based on wave rather than on a pre-set time frame, any impact of one chain recruiting faster than another is effectively eliminated. In fact, reducing coupon quotas at a set wave ensures that slower chains can catch up to faster chains, thereby allowing each chain to reach socio-metric depth. Recruitment rates were also controlled with expiration dates (the time during which the recruiter had to distribute his coupon and the recruit had to redeem it by enrolling in the survey) of 2 weeks on each dated coupon. To ensure the gradual end of the survey and to discourage participants from redeeming coupons once the survey ended, we reduced the expiration period to 1 week as the survey approached completion.

Equilibrium distributions are calculated based on self-identified MSM type, occupation and age; homophily was also calculated on self-identified MSM type. Self-identified MSM types are defined in the following manner: '*Kothi*' are feminized males who play the part of 'female' in their emotional, physical and social interactions with other males. *Kothi* prefer to be penetrated; some cross-dress or use feminine make up. '*Panthei*,' the name given by *kothi*, are the sex partners of *kothi* and are usually insertive partners. '*Male*' refers to MSM who do not have a self-perceived MSM identity; most *panthei* will identify themselves as *male*, rather than *panthei*. '*Parik*' are the male lovers of *kothi*, and all *parik* are *panthei*, but not all *panthei* are *parik*. '*Do-parata*' are MSM who practice insertive sex roles with *kothi*, as well as receptive roles with other *panthei* or even with *kothi*. '*Gays*' identify themselves as westernized homosexuals, engaging in emotional and sexual relationships with other men; '*Bisexual*' is someone who has sex with both men and women (Dowset et al. 2006; Khan et al. 2005a, b).

Data Analyses

Proportion estimates, 95% confidence intervals, equilibrium and homophily proportions are calculated using the Respondent Driven Sampling Analysis Tool (RDSAT), Version 5.4.0. Data are weighted based on participants' recruitment patterns (who recruited whom, tracked by each participant's unique coupon number) and the size of their MSM social networks (measured as the number of other MSM they know, who are 18 years or older, live in Dhaka and whom they have seen in the previous 3 months). These data are used to derive weights for proportion and variance estimates (Heckathorn 2002; Salganik and Heckathorn 2004). Unadjusted means and proportions are calculated from the actual sample. RDSAT adjusted proportions refer to the broader population of MSM in Dhaka.

Equilibrium distributions are set at the RDSAT default to fall within 2% of the sample distribution. The convergence of equilibrium and sample distributions within 2% indicates no bias due to the non-random selection of seeds. The homophily scale is between 1 and -1 . One indicates that everyone with a certain characteristic recruited someone with the same characteristic and -1 indicates that everyone with a certain characteristic recruited someone with the opposite or different characteristic (McPherson et al. 2001). Zero is the point at which contacts recruited others randomly from the population of all possible recruits.

Results

Beginning with a Small Set of Seeds, RDS Recruited 531 MSM into an HIV Serologic and Behavioral Survey Over 11 weeks

Data from 531 MSM, including eight seeds, were collected over a period of ~ 11 weeks (March 5–May 15) or 49 working days. The survey site was open 5 days a week from the hours of 10:30 until 19:30. The average number of daily participant interviews completed was 11 (minimum = 1; maximum = 30). Enrollment wait times were usually within 10–20 min, but as long as 2 h; wait times to see the clinicians were no longer than 15 min. Up to five interviews could be conducted at the same time. Apart from the enrollment wait time, a participant spent ~ 85 min in the survey site, from the time he was screened (15 min), interviewed (40 min), examined and tested by the clinician (15 min), taught the coupon recruitment process, and received his primary incentive (15 min). The average time it took participants to distribute coupons and for recruits to enroll in the survey was 5.8 days.

In total we distributed 1,053 coupons, with 614 (58.3%) returned. Of the returned coupons, 88 (14.3%) were screened as non-eligible, 3 (0.5%) refused to participate and 523 (85.2%) participated in and completed the survey; 439 (41.7%) never redeemed their coupons.

Each seed effectively recruited other MSM, producing a maximum recruitment chain of 141 recruits and a minimum chain of five recruits. Regardless of seed type, all but one of the recruitment chains were diverse, with respect to six types of MSM self-identification (male, kothi, panthi, parik, gay, do-parata, and bisexual). In Fig. 1, the recruitment chain consisted of 105 recruits. Beginning with a gay seed, this chain comprised up to nine waves of each identified type of MSM.

MSM in Dhaka are Sufficiently Networked to Attain a Sample with Sufficient Socio-metric Depth (Dense Network Ties) to Reach an Equilibrium Distribution of Participants by Self-identified MSM Type, Age, and Occupation

Equilibrium distribution for self-identified MSM type was reached by the eighth wave (Fig. 2) for current age by the fourth wave and for occupation by the sixth wave. Equilibrium proportions for MSM identity was 31.1% gay, 26.6% parik, 12.4% kothi, 12.1% do-parata, 11.7% manly, 5.2% panthi, and 1.0% bisexual.

Equilibrium proportions for age were 26.3% under 20 years, 11% 20–24 years, 43% 25–29 years, 2.1% 30–34 years, 11% 35–39, and 6.3% over the age of 40 years. Equilibrium proportions for occupation was 3.6% unemployed participants, 7.1% students, 14.8% hard labor, 8.1% low income business ($\leq 5,318$ Taka; ~ 76.00 US dollars), 38.6% high income business ($> 5,318$ Taka), 5.3% low income service ($\leq 5,318$ Taka), 10.5% high income service ($> 5,318$ Taka), and 12.1% acquired income from family.

The final sample comprised MSM with large average social network sizes (> 13), indicating numerous network ties to other MSM based on self-identified MSM type. Self-identified bisexuals, panthi, and gay MSM had the largest average social network sizes (29.8, 25.3, and 28.6, respectively). Kothi had average social network sizes of 18.9, do-parata 17.4, male 14.8, and parik 13.5.

Low Homophily Demonstrates Random Recruitment Among Most Groups of MSM as Measured by Self-identified MSM Type

Self-identified bisexuals ($n = 6$) were completely heterophilous (-1), indicating that bisexuals only recruited other types of MSM and no other bisexuals into the sample.

Fig. 1 Example of a recruitment chain on self-identified MSM type starting with a gay seed (seed no. 6, $n = 105$), Dhaka, Bangladesh, 2006

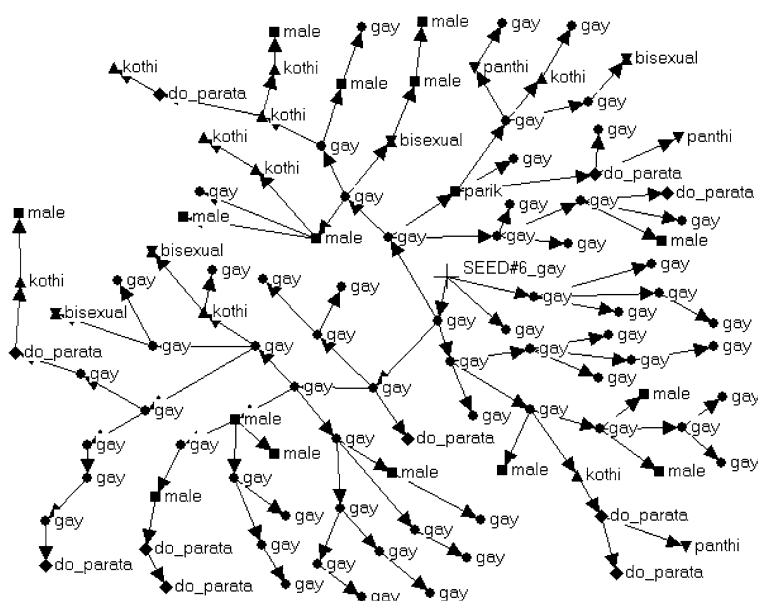
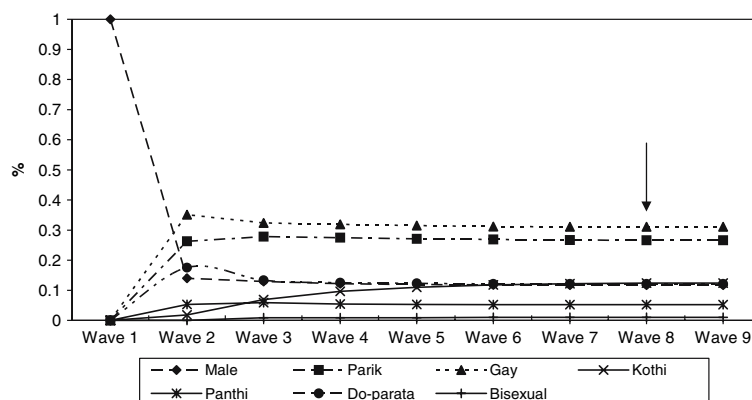


Fig. 2 Equilibrium by self-identified recognized MSM type ($n = 529$), Dhaka, Bangladesh, 2006. The arrow indicates the wave at which equilibrium was reached



Gays ($n = 85$) demonstrated insularity, recruiting 56% of the time from among other self-identified gays and 44% of the time recruiting randomly from the population of all MSM types. Kothi ($n = 145$) recruited other kothi 40% of the time and 60% of the time recruited randomly from the population of all MSM types. The remaining groups demonstrated low homophily, indicating random recruitment from among all types of MSM. Male ($n = 149$) demonstrated a homophily of 0.12, parik ($n = 24$) 0.05, panthi ($n = 61$) 0.02, and do-parata ($n = 59$) 0.09.

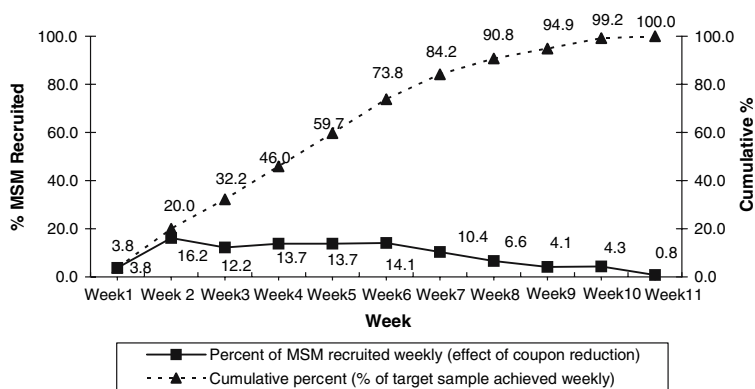
The Systemized Reduction of Recruitment Coupons and Coupon Expiration Dates as the Survey Progresses Helps with the Flow of Participants and to Reduce the Number of Coupons in the Community Near the End of the Survey

Figure 3 shows participants' flow (level of enrolment) as the survey progressed toward sample size. As recruitment

progressed beyond week 6, the percentage of participants coming to the survey site started to decrease. By the 11th week, the survey reached its sample size of 530. When the sample size reached 520, no more recruitment coupons were distributed to participants and the expiration date was gradually reduced from 2 to 1 weeks and then to shorter time periods to ensure that few active and unredeemed coupons remained in the community once sample size was reached. Among the 531 participants who enrolled in the survey, 215 received three coupons, 127 received two coupons, 147 received one coupon, and the remainder did not receive any coupons.

The number of waves needed to reach equilibrium changed as coupons were reduced. For instance, for the variable self-identified MSM type, those who received three coupons needed 11 waves to reach equilibrium. This remained true for those receiving 3 + 2 coupons, as well as those receiving 3 + 2 + 1 coupons. It was not until the final sample (those who received 3 + 2 + 1 + 0 coupons), that eight waves were needed to reach equilibrium. This pattern

Fig. 3 Flow of study participants over the course of 11 weeks, Dhaka, Bangladesh, 2006



of equilibrium was similar for age. However, the number of waves needed for occupation to reach equilibrium varied greatly as coupons were reduced. For three coupons the number of waves needed to reach equilibrium was 327, for 3 + 2 coupons 580 waves were needed, 3 + 2 + 1 coupons, seven waves were needed and for the full sample, six waves were needed.

Homophily distributions fluctuated for all categories within self-identified MSM type, age and occupation as coupons were reduced. For self-identified MSM type, homophily rose for all categories at the point when participants received 3 + 2 coupons. When participants received 3 + 2 + 1 coupons, homophily attained a distribution that remained fairly stable until sample size was reached (Table 2). This pattern also occurred in the categories for age and occupation.

As is common in most RDS surveys, many participants did not distribute all recruitment coupons provided to them. Among those participants receiving three coupons, 34% of them distributed all three of them and 34.9% distributed none of them. Among those receiving two coupons starting at wave five, 38.6% distributed two coupons, 26.8% distributed one coupon, and 34.6% did not distribute any coupons. Among those receiving one coupon starting at wave six, 55.8% distributed one coupon.

MSM Accept Coupons to Participate in an RDS Survey to Receive Health Benefits and Incentives

To understand motivation for participating in the survey, participants were asked, ‘Why did you accept a coupon to participate in this survey?’ The majority (57.9%) reported their primary reason for accepting a coupon was to receive the ‘clinical consultation and blood test’ (Table 3). Only 28.5% of MSM stated ‘receiving money’ as their primary reason for accepting a coupon.

Coupon Non-acceptance (Those Who Refuse to Accept a Coupon and why They Refused to Accept a Coupon) and Other Sources of Bias Among MSM

Participants returning to the survey site to collect a secondary incentive and/or to receive syphilis results were asked, ‘Did anyone refuse to accept a coupon from you?’ Twenty-nine participants reported that 50 persons to whom they tried to give a coupon refused to accept the coupon. The majority of those who refused to accept a coupon were either acquaintances (44%) or close friends (42%). The main reason cited by recruiters why someone did not accept a coupon was that they were either too busy (56%) or afraid of being identified as an MSM (28%) (Table 3).

Table 2 Homophily estimates over the course of systematic coupon reduction for self-identified MSM type, Dhaka, Bangladesh, 2006

Self-identified MSM type	3 coupons (n = 213)	3, 2 coupons (n = 340)	3, 2, 1 coupons (n = 487)	Full sample (n = 529 ^a)
Male	0.015	0.494	0.055	0.115
Parik	-1.000	0.555	0.058	0.049
Gay	0.660	0.754	0.592	0.560
Kothi	0.407	0.642	0.415	0.402
Panthi	-0.371	0.422	0.028	0.019
Do-parata	0.036	0.300	0.066	0.092
Bisexual	0.132	0.136	-1.000	-1.000

^a Two observations are missing for self-identified MSM type

Table 3 Reasons for accepting a coupon (adjusted RDSAT estimates), for ineligibility (unadjusted), and for refusing to accept a coupon (unadjusted), Dhaka, Bangladesh, 2006

Indicator	MSM	
	<i>n</i>	% (95% confidence interval)
Reasons given by participants for accepting a coupon (<i>n</i> = 523 seeds not asked)		
For clinical consultation and blood test	334	57.9 (51.7, 64.8)
For receiving money (transport costs)	102	28.5 (21.4, 33.9)
Interesting and useful study	52	6.2 (4.1, 9.5)
To respect friends request	34	7.0 (3.9, 11.5)
To while away my time	1	0.1 (0.0, 0.3)
Reasons recorded by RDS staff for ineligibility (<i>n</i> = 88)		
Not MSM	26	29.5 (20.3–40.2)
MSM but sold sex in last year	27	30.7 (21.3–41.4)
<18-years old	9	10.2 (4.8–18.5)
Live outside of Dhaka city	9	10.2 (4.8–18.5)
Already participated in this study	2	2.3 (0.3–8.0)
MSM, but no past year sex with other male	5	5.7 (1.9–12.8)
Had sex only with Hijra (transgender) or female in last year	7	8.0 (3.3–15.7)
Coupon expired	2	2.3 (0.3–8.0)
Never had penetrative sex in life	1	1.1 (0.03–6.2)
Relationship to the person who rejected coupon (<i>n</i> = 50)		
Acquaintance	22	44.0 (30.0, 58.7)
A close friend	21	42.0 (28.2, 56.8)
A sexual partner	6	12.0 (4.5, 24.3)
A stranger, someone met for the first time	1	2.0 (0.1, 10.6)
Reasons for not accepting a coupon (<i>n</i> = 50)		
Too busy	28	56.0 (41.3, 70.0)
Fear of being identified as MSM	14	28.0 (16.2, 37.7)
Not interested	5	10.0 (3.3, 21.8)
Already had a coupon	2	4.0 (0.5, 13.7)
Site is too far away	1	2.0 (0.1, 10.6)

Among the recruitment coupons presented at the RDS survey site, 88 recruits (14.3%) were ineligible to participate in this survey. Reasons for ineligibility included that the recruit had sold sex in the past year (30.7%) and that some recruits did not practice sex with other males (29.5%) (Table 3).

Discussion

Using a small set of seeds, RDS recruited a final sample of 531 MSM in Dhaka over 11 weeks (49 working days), demonstrating that MSM in Dhaka form dense social networks. Not only do MSM socially interact within their self-identified type but with a variety of MSM who self-identify as other types (Fig. 1). MSM have strong network ties to other MSM as demonstrated by their large average social network sizes calculated on MSM type. The fact that many MSM in Dhaka do not remain socially connected in

self-contained groups (e.g., self-identified ‘gays’ only socially interact with other self-identified ‘gays’), indicates that these network compositions could be useful in spreading HIV and STI prevention information through the dense social pathways that exist between different types of MSM in Dhaka.

All variables of interest reported here, as well as all other variables, reached equilibrium, prior to the maximum number of nine waves attained in the entire sample. The final sample was comprised of long recruitment chains, only achieved in populations that are socially well connected. Reaching equilibrium also indicates that any bias introduced by the initial non-randomly selected seeds was eliminated.

Among all self-identified MSM types, bisexuals were not well connected to other bisexuals as demonstrated by their complete heterophily. Gays, and to some extent kothi, were the most insular as demonstrated by a moderately high homophily distribution. Perhaps bisexuals know other

types of MSM with whom they have sex or interact socially, but do not interact with other bisexuals who may have stronger ties to their heterosexual relationships and other men who do not have sex with men. These may be the type of men that other sampling methods do not capture as they may tend to be more hidden and less forthcoming about their behaviors. Gays and kothi would tend to be insular in Dhaka since it is known that they form strong social ties within their own groups. For instance kothi exhibit strong insular network ties through the use of a special language with which to communicate with one another and gays exhibit strong insular network ties through their creation of an active gay Internet chat site (www.boysonlyboysbangladesh.com).

The implementation of an innovative field technique, systematic coupon reduction, resulted in the smooth implementation of RDS and did not affect the sample eventually reaching equilibrium. Homophily distributions fluctuated as coupons were reduced, indicating some variation in recruitment patterns, but attained moderate to low levels (hovering around zero), except for a few categories, as the sample size was reached. However, regardless of how coupons are distributed and redeemed, there will often be some type of differential recruitment in the final sample. This is precisely why RDS is no more than a good chain-referral sample unless analyzed with RDSAT, or some other specialized software, that adjusts the biases due to differential recruitment patterns and the self-described sizes of participants' social networks.

Coupon reduction helped maintain a manageable flow of participants by encouraging linear recruitment growth. This mitigated the difficulties encountered in other surveys when large numbers of participants with valid coupons redeem their coupons simultaneously. In these situations RDS staff become overwhelmed and are forced to ask potential participants to return at a later date and time, sometimes leading to situations in which participants become angry and aggressive after arriving (some having traveled long distances) at the survey site with a valid coupon (personal observations by first author-Northeastern India, 2005; Vietnam, 2004). Furthermore, many participants who are asked to wait for long time periods or to return to the survey site at a later date never return (personal observations by first author-Northeastern India, 2005; Belgrade, Serbia, 2005; Vietnam, 2004).

RDS relies on participants having positive experiences during the survey process so that they will be more likely to encourage their peers to participate (Heckathorn 1997). Past experience shows that negative experiences during an RDS survey, such as having to wait a long time for an interview, will lead to participants sharing their dissatisfaction with others and potentially dissuading them from enrolling (personal observation by first author-Vietnam

2004; Tanzania, 2007). Follow-up interviews with RDS staff indicated that MSM who enrolled in the survey were pleased with the survey and clinical examination process and felt comfortable about telling their peers to participate.

The number of ineligible men who showed up at the survey site with a valid coupon was high. This is most likely due to an insufficient explanation of the coupon recruitment process from RDS staff to recruiters, especially given that recruiters will most likely give their coupon to someone they know will enroll in the survey so that they can get the secondary incentive for having recruited someone (Heckathorn 1997). RDS staff was provided with extra training during the course of the survey to ensure that the explanation of the coupon recruitment process was as clear as possible. However, information about the coupon recruitment process, usually given at the end of the survey process, can sometimes be too technical or burdensome for participants to remember, especially after they have completed a 1-h interview, given blood and met with the clinician. It may be better to explain the coupon recruitment process at the beginning of the survey process and then to offer follow up information once participants complete all of the survey steps.

The majority of MSM stated that their main motivation for enrolling in the survey was to receive a medical examination and syphilis test. This indicates that MSM are interested in their own health care and curious about STI examinations and treatment and that there is a need for such services to become more available. It is not known whether the medical exam and HIV and syphilis tests hindered some types of participants from attending the survey. It appears that the provision of a clinical exam and testing were viewed as an incentive to enroll in the survey. Among those who refused to accept a coupon, no recruiters mentioned fear of HIV and syphilis testing as a reason.

Participants reported that few MSM refused to accept a recruitment coupon when it was offered. This information was collected only from those who returned to the survey site to collect their secondary incentive and does not reflect true non-response bias. The most common reason that MSM provided for refusing a coupon was being too busy; given the amount of time to complete the survey, this is understandable. However, it is concerning that several recruiters reported that MSM refused to accept a coupon because they were afraid of being identified as MSM. This is an indication of the level of stigmatization felt by MSM in Dhaka.

A strong limitation to this survey was that VCT services were not available at the RDS survey site. Although MSM provided a serological specimen for HIV testing, they did not receive their HIV test results, but were

provided a voucher for free services at an existing VCT site. Future RDS surveys in Bangladesh should carefully consider providing HIV test results as part of the survey protocol. MSM's positive response to this survey indicates that future RDS activities could provide an excellent venue for providing VCT as well as other services to this population.

Overall the application of RDS to sample MSM in Dhaka was successful. This survey required limited formative research, was easy to implement, resulted in the rapid recruitment of a diverse group of MSM in Dhaka and received positive feedback from MSM participants. Furthermore, this survey accessed previously hidden groups of MSM and those that had not been reached through previously used HIV surveillance sampling methods. RDS will likely be used to gather information on HIV and STI prevalence and risk factors among MSM in future surveillance activities in Bangladesh.

Acknowledgments The survey was conducted by ICDDR,B in collaboration with IEDCR, on behalf of the Govt. of Bangladesh, with support of grant from Govt. of Bangladesh/DFID/IDA, credit number 3441 BD. Family Health International, Dhaka provided technical assistance. The ICDDR,B acknowledges with gratitude the commitment of the different development partners to the Centre's research efforts. We also acknowledge with gratitude all participants and staff of the survey.

References

- Abdul-Quader, A., Heckathorn, D., McKnight, C., Bramson, H., Nemeth, C., Sabin, K., Gallesher, K., & Des Jarlais, D. (2006). Effectiveness of respondent driven sampling for recruiting drug users in New York City: Findings from a pilot study. *Journal of Urban Health, 83*(3), 459–476.
- Dowset, G., Grierson, J., & McNally, S. (2006). A review of knowledge of sexual networks of behaviors of men who have sex with men in Asia: Annotated bibliography. Australian Research Centre in Sex, Health and Society. La Trobe University, Melbourne, Australia. Monograph series number 59.
- Erickson, B. H. (1979). Some problems of inference from chain data. *Sociological Methodology, 10*, 276–302.
- Family Health International. (2000). Behavioral surveillance surveys: Guidelines for repeated behavioral surveys in populations at risk of HIV. FHI, Arlington, VA. <http://www.fhi.org/en/HIVAIDS/pub/guide/bssguidelines.htm>
- Goel, S., & Salganik, M. (2007). Respondent driven sampling as Markov Chain Monte Carlo. University of California, Los Angeles. <http://www.rcf.usc.edu/~sharadg/papers/RDSasMCMC.pdf>
- Government of Bangladesh. (2003). National HIV serological surveillance, 2002, Bangladesh: Fourth round technical report. National AIDS/STD programme, directorate general of health services, Ministry of Health and Family Welfare, Dhaka. <http://www.icddr.org/activity/index.jsp?activityObjectID=2430>
- Government of Bangladesh. (2005). National HIV serological surveillance, 2004–2005, Bangladesh: Sixth round technical report. National AIDS/STD programme, directorate general of health services, Ministry of Health and Family Welfare, Dhaka. <http://www.icddr.org/activity/index.jsp?activityObjectID=2080>
- Heckathorn, D. (1997). Respondent driven sampling: A new approach to the study of hidden populations. *Social Problems, 44*(2), 174–199.
- Heckathorn, D. (2002). Respondent driven sampling II: Deriving valid population estimates from chain-referral samples of hidden populations. *Social Problems, 49*(1), 11–34.
- Johnston, L. G., Huong, P. T., Hien, M. T., Chau, L. M., & Hau, D. H. (2005). HIV prevalence and risk factors among injecting drug users in Ho Chi Minh City, Vietnam. Presented at the international conference for the reduction of harm among injecting drug users. Belfast, Ireland.
- Johnston, L. G., Sabin, K., Hien, M. T., & Huong, P. T. (2006). Assessment of Respondent driven sampling for recruiting female sex workers in two Vietnamese cities: Reaching the unseen sex worker. *Journal of Urban Health, 83*(Suppl. 7), 16–28.
- Johnston, L. G. (2007). *Conducting respondent driven sampling studies in diverse settings: A manual for planning RDS studies*. Arlington, VA: Centers for Disease Control and Prevention, Atlanta, GA and Family Health International.
- Klov Dahl, A. (1989). Urban social networks: Some methodological problems and possibilities. In M. Kocken (Ed.), *The small world*. Norwood, NJ.
- Khan, S., Khan, S. I., & Hollerbach, P. E. (2005a). *In their own words: The formulation of sexual and health related behavior among young men in Bangladesh, summary report*. Washington, DC: Catalyst Consortium.
- Khan, S. I., Hudson-Rodd, N., Saggors, S., & Byutya, A. (2005b). Men who have sex with men's sexual relations with women in Bangladesh. *Culture, Health and Sexuality, 7*(2), 159–169.
- Magnani, R., Sabin, K., Saidel, T., & Heckathorn, D. (2005). Sampling hard to reach and hidden populations for HIV surveillance. *AIDS, 19*(Suppl. 2), S67–S72.
- McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology, 27*, 415–444.
- Ogunnaikie-Cooke, S., & Bombereau, G. (2007). Report of the pilot behavioural and HIV seroprevalence surveillance surveys of men who have sex with men and female sex workers in Antigua and Barbuda and St. Vincent and the Grenadines. Caribbean Epidemiology Centre-Special Programme on Sexually Transmitted Infections. Port of Prince, Trinidad.
- Platt, L., Wall, M., Rhodes, T., Judd, A., Hickman, M., Johnston, L. G., Sarang, A., & Bobrova, N. (2006). Methods to recruit hard-to-reach groups: Comparing two chain referral sampling methods of recruiting injecting drug users (IDU) across nine studies in Russia and Estonia. *Journal of Urban Health, 83*(Suppl. 7), 28–34.
- Ramirez-Valles, J., Heckathorn, D., Vasquez, R., Diaz, R. M., & Campbell, R. (2005). Respondent driven sampling among gay men: Lessons from a two-city field study with Latino gay men. *AIDS and Behavior*. doi:10.1007/s10461-005-9012-3.
- Salganik, M. (2006). Variance estimation, design effects, and sample size calculations for respondent-driven sampling. *Journal of Urban Health, 83*(Suppl. 7), 98–112.
- Salganik, M., & Heckathorn, D. (2004). Sampling and estimation in hidden populations using respondent-driven sampling. *Sociological Methodology, 34*, 193–239.
- Semaan, S., Lauby, J., & Liebman, J. (2002). Street and network sampling in evaluation studies of HIV risk-reduction interventions. *AIDS Review, 4*, 213–223.
- Simic, M., Johnston, L. G., Platt, L., Baros, S., Andjelkovic, V., Novotny, T., & Rhodes, T. (2006). Exploring barriers to 'Respondent Driven Sampling' in sex worker and drug-injecting sex worker populations in Eastern Europe. *Journal of Urban Health, 83*(Suppl. 7), 6–15.
- Stromer, A., Tun, W., Guili, L., Harxhi, A., Bodanovskaia, Z., Yakovleva, A., Rusakova, M., Levina, O., Bani, R., Rjepaj, K.,

- & Bino, S. (2006). An analysis of respondent driven sampling with injection drug users in Albania and the Russian Federation. *Journal of Urban Health*, 83(Suppl. 7), 73–82.
- UNAIDS/WHO (2000). Guidelines for second generation HIV surveillance for HIV: The next decade. UNAIDS/WHO: Working group on global HIV/AIDS and STI Surveillance. <http://www.who.int/hiv/pub/surveillance/pub3/en/index.html>
- Yeka, W., Maibani-Michie, G., Prybylski, D., & Colby, D. (2006). Application of respondent driven sampling to collect baseline data on FSWs and MSM for HIV risk reduction intervention in two urban centers in Papua New Guinea. *Journal of Urban Health*, 83(Suppl. 7), 1–5.