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## Implementing respondent-driven sampling to recruit women who exchange sex in New York City: Factors associated with recruitment and lessons learned

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### Abstract

Respondent-driven sampling (RDS) relies on productive peer recruitment to capture hidden populations. Domestic studies have identified characteristics of productive recruitment among RDS samples of men who have sex with men and persons who use drugs, but not of women who exchange sex, a group vulnerable to HIV infection. We examined sociodemographic-, behavioral-, exchange-sex-, and protocol-related factors associated with recruitment among seeds (n=25) and peers (n=297) in the 2016 New York City National HIV Behavioral Surveillance Study cycle focused on women who exchange sex. Recruiter productivity was significantly associated with not having been recently incarcerated, lower rate of HIV testing, and larger exchange sex networks among seeds, and with HIV-prevention services usage among peers. We describe challenges and lessons learned from implementing RDS in this population. Our study identifies seed characteristics and protocol improvements researchers can utilize when implementing future RDS studies among women who exchange sex.

### Keywords

respondent-driven sampling; recruitment; exchange sex; HIV; USA

### Introduction

Women who exchange sex are a group at high risk for HIV that remains understudied in the United States. In the US, women comprised 19% of new HIV diagnoses in 2016, with heterosexual contact being the predominant risk of transmission [1]. Exchange sex is an encompassing term that describes the exchange of sexual services for money, drugs, or other goods, that may occur regularly or occasionally [2]. Although the frequency of transmission related to exchange sex is unknown, women who exchange sex are more likely to engage in

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#### Conflict of Interest

The authors declare that they have no conflict of interest.

#### Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

high-risk sexual behaviors, including condomless sex, having multiple concurrent sex partners, and having sex with partners of unknown HIV status, compared to other high-risk subgroups of women [3, 4, 5]. Substance abuse and experiencing violence may further exacerbate these high-risk sexual behaviors, by leading to an earlier sexual debut, needing to exchange sex because of drug dependency, hindering the ability to negotiate condom use, and experiencing sexual violence (e.g., rape) [4, 6, 7, 8, 9]. These experiences are compounded by socioeconomic factors, including poverty, homelessness, and lower education among this population, which are associated with a higher risk of acquiring HIV [5, 10, 11, 12].

The criminalization of prostitution (in almost all US states) and stigmatization surrounding exchange sex in the US poses a barrier to recruiting these women into research, making them a hard-to-reach population [6, 13]. A recent systematic review found that convenience sampling is most often used to recruit women who exchange sex [14]. However, convenience sampling of women who exchange sex can contribute to the oversampling of self-selecting participants from easy to access subgroups, often women who primarily find clients on the street [4], is unable to capture more isolated or less-networked women who comprise the full range of exchange sex modalities [15], and results are therefore not generalizable to the larger population of women who exchange sex. Respondent-driven sampling (RDS) can be used to recruit women who exchange sex in the US to estimate HIV prevalence and associated risk behaviors in this population.

RDS is a sampling method originally designed to conduct behavioral research among groups at high risk for HIV, particularly persons who inject drugs (PWID) [16]. Since its conception, RDS has been used to sample other at-risk groups such as men who have sex with men (MSM), those who use non-injection drugs, and those who exchange sex [17, 18, 19]. RDS was designed to recruit hidden populations that are hard to reach for which no other sampling frames exist, so that research findings can be used to make population-based inferences [16]. RDS methodology has been successfully implemented among populations at high risk for HIV in both high- and low-income settings. In RDS, a diverse group of initial recruits, or seeds, are purposefully selected from the target population by researchers. Seeds then recruit a set number of their peers (typically 3–5) to participate, who in turn recruit additional peers. This referral process continues until a desired sample size is met. In order to obtain a large enough sample and to ensure that the sample is independent of seeds, successive recruitment waves are necessary [20, 21].

RDS has been implemented among women who exchange sex in international HIV surveillance efforts, primarily in low-income countries. These studies have shown varying success in using RDS among women who exchange sex with regard to generative seeds (i.e., seeds who recruit their peers), geographical representativeness, and ability to capture the full range of exchange sex modalities (i.e., different ways that women find clients to exchange sex with) [22, 23, 24, 25]. RDS has been used to conduct behavioral HIV studies among subgroups of women at high risk of HIV in the US including recent immigrants [26] and PWID [27]. However, RDS has not been used to exclusively recruit women who exchange sex in the US.

A recent surge of literature has begun to examine individual- and structural-level components of productive RDS recruitment [28, 29, 30, 31, 32, 33, 34]. However, these analyses have predominantly assessed RDS recruitment in studies among MSM and PWID. The few studies that have examined productive RDS recruitment among women who exchange sex were conducted in resource-poor countries with limited generalizability to higher-income settings [23, 24, 35, 36, 37]. Understanding the sociodemographic and network variables associated with productive recruitment in this subpopulation is critical for improving the implementation and operations of RDS in future studies among women who exchange sex.

We describe the challenges faced and lessons learned from implementing RDS to recruit women who exchange sex in New York City (NYC) for a biobehavioral HIV surveillance study. We identify factors associated with productive peer recruitment among seeds and peers. The purpose of this analysis is to understand independent predictors associated with productive recruitment among women who exchange sex to improve the implementation of future RDS studies among this population.

## Methods

### Design and setting

Data for this analysis were drawn from the Centers for Disease Control and Prevention (CDC)-funded National HIV Behavioral Surveillance (NHBS) system in NYC and were collected from August-December 2016. NHBS is a national cross-sectional study that conducts repeated three-year surveillance cycles among three populations at high risk for HIV: MSM, PWID, and heterosexuals at increased risk for HIV [38]. In 2016, NYC was selected as one of five metropolitan statistical areas (MSAs) to conduct the fourth cycle of heterosexuals at increased risk among high risk women (also known as the High Risk Women cycle), specifically women who exchange sex for money or drugs. All activities were approved by the Institutional Review Board of the NYC Department of Health and Mental Hygiene.

Prior to data collection, a formative assessment was conducted among stakeholders, including service providers and members of the community, to improve our knowledge of the local population and obtain input on study implementation, including appropriate field site locations, hiring, study incentive amounts, and to help identify seeds to initiate recruitment.

A total of four data collection sites at nonprofit organizations were established throughout NYC. Field sites operated in Manhattan and Queens from August to September, in the Bronx and Brooklyn from October to November, and only in the Bronx in December. All field sites were safe, easily accessible by public transportation, and operated on weekdays during business hours (9am-5pm or 10am-6pm). During August and September, the Queens field site was open on Saturdays to accommodate women who worked during the week. To address privacy concerns, field sites were chosen in neutral locations to protect the nature of participation in the study.

### Seed recruitment

Seeds were recruited via stakeholder referrals and through street outreach conducted directly by study staff. Potential seeds were given a study appointment to be screened for study eligibility at a field site.

### Study eligibility criteria

Prior to consent, potential participants (seeds and peer recruits) were screened for eligibility. Those who were screened were eligible if they identified as female (not male or transgender), were between the ages of 18 and 60 years old, lived in the NYC MSA, had vaginal or anal sex with a man in the past 12 months, and were able to complete the interview in English or Spanish. Those who completed the study screener received a roundtrip MetroCard, regardless of eligibility.

### Data collection

Oral informed consent was obtained from all eligible participants. Study participation consisted of an interviewer-administered computer-assisted personalized interview (CAPI) and optional incentivized HIV testing. The interview questionnaire covered topics such as sociodemographic characteristics, exchange sex practices, sexual and drug use behaviors, HIV and STI testing history and diagnoses, and HIV prevention knowledge and usage. All participants, regardless of self-reported HIV status, were offered HIV testing. For those who self-reported a negative or unknown HIV status in the survey, rapid HIV blood-based testing was conducted with the INSTI HIV-1/HIV-2 antibody test (BioLytical Laboratories, Richmond, Canada) and reactive rapid test samples were confirmed with Western blot by providing dried blood spot (DBS) samples. Participants who self-reported as HIV-positive in the survey only had to provide a DBS sample for Western blot confirmatory testing. Participants who provided samples for confirmatory testing were given a two-week follow-up appointment for their results. Participants were compensated with a \$50 gift card for completion of the survey and a \$25 gift card for taking the HIV test.

### Eligibility to recruit others and RDS training

Since the study goal was to recruit women who exchange sex, only those participants who reported exchange sex were eligible to recruit others. At study onset, only participants who reported receiving money or drugs in exchange for sex from a casual male sex partner (defined as “A man you have sex with but do not feel committed to or don’t know very well”) in the past 12 months were eligible to recruit. In early October, in order to increase recruitment, participants who reported exchange sex with any male partner in the past 12 months were eligible to recruit.

After the interview, those who were eligible and agreed to recruit received a brief interviewer-conducted recruiter training in which they were instructed to give their coupons to other women they knew who exchange sex in NYC, were between 18–60 years old, and had not yet participated in the study. Due to the anticipated difficulty of recruiting women who exchange sex, all recruiters received five coupons (versus two or three) to improve the likelihood that a coupon would yield a productive recruit and to prevent recruitment chains from dying out. Recruiters received an incentive for each participant they recruited who was

eligible for the study and completed the interview. If a recruit was found to be ineligible for the study, the recruiter was not given a replacement coupon. The recruitment incentive was increased from a \$10 gift card to a \$20 gift card at the start of the third month of data collection. Peer recruitment was halted two weeks before the end of data collection.

At the start of the third month of data collection (which coincided with field sites moving to the Bronx and Brooklyn), in addition to changing the criterion for recruiting others and increasing the recruitment incentive, recruiters were given the option of recruiting other participants by sending a photo of the coupon via text message or email. Providing an option to recruit peers electronically, versus paper coupons alone, has shown to improve RDS recruitment efficiency in other studies monitoring low recruitment [39]. Recruiters continued to receive paper coupons, however, during recruiter training they were informed that they could alternatively take a photo of each individual coupon to text or email to women they wanted to recruit but did not often see in person.

## Measures

Recruiters were operationalized as “productive” if they recruited at least one other woman who reported exchange sex in the past 12 months in the questionnaire.

To identify factors associated with productive recruitment, we examined sociodemographic-, behavioral-, exchange-sex-, and protocol-related variables.

**Sociodemographic.**—We measured sociodemographic characteristics including age (<30 years vs. 30 years), race/ethnicity (Hispanic/Latina, Black, White/Other), country of birth (US vs. foreign-born), education level (<high school vs. high school diploma/GED), NYC borough of residence (Bronx, Brooklyn, Manhattan, Queens, Staten Island), annual household income (<\$10,000 vs. \$10,000), current marital or cohabitating status (currently married/cohabitating vs. not), and HIV status (confirmed positive vs. negative). Homelessness was defined as currently “living on the street, in a shelter, in a Single Room Occupancy (SRO), or in a car.” Incarceration was defined as being arrested or held in a “detention center, jail, or prison for more than 24 hours” in the past 12 months.

**Behavioral.**—We assessed past-12-month behavioral characteristics including injection drug use (no vs. yes), same-sex behavior (no vs. yes), and any condomless vaginal or anal sex. Participants who did not self-report an HIV-positive status in the questionnaire were asked for the date of their last HIV test; we dichotomized responses to past 12 months vs. not. To ascertain use of HIV prevention services, participants were asked if they had had a “one-on-one conversation or participated in a group session to discuss ways to prevent HIV infection” in the past 12 months.

**Exchange sex.**—Only women who reported exchanging sex with a male partner in the past 12 months were asked the following supplemental questions, including: at what age they first exchanged sex to calculate number of years exchanging sex, the number of women they knew in NYC who exchanged sex, and the total number of men with whom they had exchanged sex with for money or drugs in the past 12 months. To determine modality, women were asked, “In the past 12 months, what was the most common way you found men

to exchange sex with?” We dichotomized modality to street vs. any other modality. Participants were asked to identify what they had received in exchange for sex in the past 12 months; options included: money, drugs, and basic needs (like food or rent), and participants were able to choose more than one option. The measure was dichotomized to exchanged sex for money only vs. not. Participants were asked how strongly they agreed or disagreed with the statement, “It is difficult to tell family or friends that I exchange sex for money or drugs.” Those who indicated they strongly disagreed or disagreed were defined as not having difficulty with disclosure and those who indicated they strongly agreed or agreed were defined as having difficulty with disclosure.

**Protocol changes.**—We assessed whether survey participation occurred before or after the implementation of protocol-related changes (increased recruiter incentive, implementation of photo coupons, broadened recruiter eligibility criteria) which coincided with the change of field sites (Manhattan and Queens vs. Brooklyn and the Bronx).

### Data Analysis

Since seeds and peers differed by key demographics and recruitment method, two separate analyses were conducted to ascertain factors associated with productive recruitment among 1) seeds and 2) peers. Both analyses were restricted to those who received coupons to recruit others. Among seeds, Fisher’s exact tests (due to small expected cell counts) for categorical variables and Wilcoxon exact tests for continuous variables were used to obtain differences in productive recruitment by characteristics of interest. Among peers, we conducted bivariate analyses to determine differences in productive recruitment using log-linked Poisson regression, with an indicator for the changes in the study protocol changes (taking the survey prior to the protocol changes vs. taking the survey after the protocol changes) as a fixed effect. Independent variables associated with productive recruitment with a significance level of  $p < 0.10$  were tested for inclusion in a multivariable model. The final multivariable model was created using backward selection, accounting for protocol changes. Variables with a significance level of  $p > 0.05$  were removed from the model one at a time; only variables with a significance level of  $p < 0.05$  were retained in the final model. As a sub-analysis, we also examined differences among those who presented with a photo coupon vs. paper coupon by 1) study eligibility and 2) exchange sex in the past 12 months using Chi-square tests. Analyses were conducted using SAS 9.3 (SAS Institute, Cary, North Carolina).

To assess whether equilibrium was reached, we compared the equilibrium sample distribution with the sample proportion for the following sociodemographic variables: race/ethnicity, HIV status, age, country of birth, education level, income, homelessness, and incarceration history. Equilibrium was considered to be met if the sample proportion differed from the equilibrium proportion within a range of  $\pm 0.04$  [16]. In order to explore biases that may be present due to differential recruitment, we measured homophily, or the tendency for participants to recruit others in their social network who are similar to themselves [20], among the sample for the following variables: HIV status, age, and race/ethnicity. Equilibrium and homophily were assessed using RDSAT version 7.1 (Cornell University, Ithaca, NY).

## Results

Seeds who reported exchange sex (n=25) recruited a total of 505 peers who were screened for the study, of which 436 (86.3%) were eligible and completed the survey. Of those peers with a completed survey, 330 (75.7%) reported exchange sex. Since recruiter training was halted two weeks prior to the end of data collection, of those who reported exchange sex, only 279 participants underwent recruiter training and were given coupons to recruit (Figure 1). The sample reached equilibrium for the variables race/ethnicity, age, nativity, education level, income, homelessness, and incarceration status. Equilibrium was not met for HIV status where the sample proportion differed from the equilibrium distribution by 5.3%.

### Seeds

Seed characteristics are shown in Table I. The majority of seeds were 30 years or older (88.0%), Hispanic/Latina or non-Hispanic Black (76.0%), had at least a high school level education (56.0%), and an annual household income under \$10,000 (56.0%).

Less than half (n=12; 48.0%) of all seeds recruited another woman who reported exchange sex (Figure 2). Productive recruitment was significantly associated with the seed not having been incarcerated in the past 12 months ( $\chi^2=9.08$ ;  $p=0.0048$ ), not receiving an HIV test in the past 12 months ( $\chi^2=7.21$ ;  $p=0.0166$ ), having a greater number of women who exchange sex in one's network ( $Z=2.64$ ;  $p=0.0084$ ), and being interviewed after protocol changes were implemented ( $\chi^2=5.00$ ;  $p=0.0414$ ).

### Peers

Characteristics of peers who received coupons to recruit are shown in Table II. Most peer recruiters were aged 30 years or older (94.6%), Hispanic/Latina or non-Hispanic Black (88.9%), and had at least a high school level education (54.5%). Half (50.2%) had an annual household income under \$10,000.

Productive peer recruitment (i.e., 1 recruit who was eligible for the survey and reported exchange sex) was conducted by about half (50.9%) of peers. After accounting for changes in study protocol, productive recruitment was significantly associated with use of HIV prevention services in the past 12 months ( $\chi^2=5.23$ ;  $p=0.0222$ ). Additional associations with productive recruitment were observed (at  $p<0.10$ ), including not currently being homeless ( $\chi^2=2.93$ ;  $p=0.0869$ ), having a confirmed positive HIV status ( $\chi^2=2.88$ ;  $p=0.0896$ ), and a higher number of years exchanging sex ( $Z=3.54$ ;  $p=0.0600$ ). In the final multivariable model (Table III), those who productively recruited were more likely to have used HIV prevention services (aPR: 1.32; 95% CI: 1.03–1.68;  $p=0.0258$ ) in the past 12 months, compared to those who did not productively recruit.

### Photo coupon recruitment

After the implementation of photo coupons, 18 of 487 (3.7%) recruits who were screened presented a photo coupon (Table IV). There were no differences in study eligibility by type of coupon presented ( $\chi^2=0.00$ ;  $p=1.0000$ ). Half (n=9; 50.0%) of the women who presented a photo coupon reported exchange sex in the questionnaire. Women who presented photo

coupons were slightly less likely to be eligible to recruit others compared to women did not, yet this difference did not reach statistical significance (56.3% vs. 76.7%;  $\chi^2=3.51$ ;  $p=0.0744$ ).

### Homophily

There was a tendency toward within-group recruitment by HIV status (among both HIV-positive and HIV-negative participants) and by older age (> 30 years) (data not shown). Participants who were HIV-positive comprised 33.7% of the total sample of women who reported exchange sex, and had a positive homophily score ( $H=0.50$ ), indicating that HIV-positive participants recruited within-group 50% of the time and recruited randomly 50% of the time. 66.3% of participants were HIV-negative, and HIV-negative women also tended to recruit other HIV-negative women ( $H=0.54$ ). In addition, women who were aged 30 or older constituted the majority of women who reported exchange sex (93.5%) and these women preferentially recruited older women ( $H=0.41$ ); women who were <30 years (6.5% of participants) did not exhibit the same affinity to recruit within-group ( $H=0.03$ ). Regarding race/ethnicity, homophily scores were relatively low (Hispanic/Latina ( $H=0.04$ ), non-Hispanic Black ( $H=0.20$ ), and non-Hispanic White/Other ( $H=0.14$ )), suggesting non-preferential recruitment patterns among all races/ethnicities.

### Discussion

To our knowledge, this is the first assessment of RDS implementation in a biobehavioral HIV surveillance study exclusively among women who exchange sex in the US, and the first analysis to identify independent predictors of productive recruitment among seeds and peer recruiters in this population. This study found that larger network size, not having been incarcerated in the past 12 months, not receiving an HIV test in the past 12 months, and being interviewed post-protocol changes, were independently associated with recruitment productivity among seeds. Among peers, history of use of HIV prevention services was independently associated with recruiting another woman who exchanges sex. It is important to note that the majority of seeds (64.0%) were interviewed prior to implementing several important protocol changes (expanded recruiter eligibility, increased secondary recruitment incentive, implementation of photo coupons for recruitment, and the pre-planned transition of field site locations) in response to slow recruitment, whereas peer recruiters were primarily interviewed (96.8%) after these changes. Therefore, differences observed in predictors of recruitment success among seeds and peers are largely affected by the period of data collection in which they were interviewed (i.e., pre- vs. post-protocol changes, respectively).

#### Productive recruitment among seeds

Among seeds, a larger network size was correlated with productive recruitment, a finding consistent with some other recent RDS recruiter analyses [30, 34] but contrary to others [29, 32]. This finding confirms the importance of selecting well-networked seeds to initiate recruitment chains. By designing a screening tool that additionally incorporates a question on network size, researchers could quickly and reliably determine whether a potential seed will be eligible to participate and is likely to be productive in recruiting.



Among HIV-negative seeds, productive recruiters were those who had not received an HIV test in the past 12 months. It may be that for these women, having an HIV test was an added bonus to survey participation, and that they wanted their peers to have the same opportunity to be tested. Current HIV prevention efforts insufficiently reach all women who exchange sex in the US, with many HIV interventions focused specifically on women who exchange sex and use drugs [6]; little data exist on HIV prevention usage among women who exchange sex and do not use drugs, or more broadly, among women who exchange sex regardless of drug using status. In our analysis, seeds who had not recently been tested for HIV may represent those missed by HIV prevention efforts, in particular those that only focus on high-risk behaviors related to drug use. By recruiting seeds who have not recently been tested for HIV, it may be possible to recruit from networks of similar high-risk women who are also not otherwise receiving HIV prevention services.

In addition, we found that seeds with no arrest or incarceration history in the past 12 months were more likely to productively recruit. The criminalization of exchange sex and challenges associated with recruiting these women into studies in the US have been well documented [6, 13]; and data that exist on women who exchange sex and incarceration are often limited to prostitution-related criminal charges [40]. In the context of NYC, a study conducted among recently incarcerated women found that incarcerated women who exchange sex tended to be younger and have several prior incarcerations, compared to other incarcerated women [40]. It is possible that incarceration, including parole conditions that prohibit fraternizing with others known to have criminal records [41] and high recidivism [40], disrupts social networks among women who exchange sex. Thus, networks among women who were incarcerated in the past 12 months may not have been as strong for recruiting as women who had not been recently incarcerated. It is important to note that despite that productive recruitment was more frequent among seeds who were not recently incarcerated, recently incarcerated women were nonetheless recruited in subsequent waves; nearly a fifth (19.1%) of peers had recent incarceration histories.

Lastly, as expected, seeds who were interviewed post-protocol changes had more productive recruitment. Recruitment enrollment by week is shown in Supplemental Figure 1. Apart from the pre-planned move of study sites, the primary purpose of implementing the suite of other changes (recruiter eligibility, secondary recruitment incentive, and photo coupons) was to speed up recruitment. Unfortunately, because all of the changes were implemented simultaneously, we are unable to determine the relative impact of individual changes on productive recruitment. In other RDS studies monitoring slow recruitment, researchers have implemented various strategies after the start of data collection, including but not limited to: implementing alternative recruitment strategies (e.g., allowing electronic peer recruitment, accepting individuals who self-present at a study site to serve as seeds) [39, 42], widening participant eligibility criteria [43], changing incentive type and amount [39], and changing study site locations [18]. RDS studies with short data collection periods may significantly benefit by implementing mid-study changes to facilitate recruitment necessary to reach a sufficient sample size.

### **Productive recruitment among peers**

Among peers, women who used HIV prevention services in the past 12 months were more likely to have productive recruitment. It is possible that participants received these HIV prevention services from a social service organization; since social service organizations may foster close network ties among clients, women who attend social service organizations likely have strong networks from which they can recruit others (i.e., women's groups). Furthermore, this may explain the high homophily by HIV status observed in this study, as many social service organizations offer programming and groups for clients with a specific HIV-status. RDS studies among other high-risk populations (e.g., MSM, PWID) have similarly observed high homophily by HIV status, specifically among HIV-positive participants [28, 34]. In order to ensure a representative sample is recruited, researchers should continually monitor recruitment chains and adapt strategies to prevent a skewed sample. Among groups that are highly networked (e.g., women who attend social service organizations, or who are HIV-positive), researchers may need to reduce the number of coupons or discontinue recruitment entirely for a given chain to ensure population representativeness in the study sample and meet the objectives of RDS.

### **Implementation of photo coupons**

The use of photo coupons proved feasible among women who exchange sex; women recruited by photo coupons were just as likely to be eligible for the study and to report exchange sex as those recruited by paper coupons. RDS studies in this population considering using photo coupons should do so in addition to paper coupons given that some women may not have cell phones or the technological literacy to send a text or email through their phones. Due to the small number of women recruited by photo coupons in this study, we were unable to assess whether the population recruited by photo coupons differs (e.g., by socioeconomic status or network size) from the population recruited by paper coupons. The efficacy of photo coupons in RDS studies among hard-to-reach subpopulations, specifically those experiencing slow recruitment, should be further explored.

### **Lessons learned from implementing RDS among women who exchange sex**

There were several challenges experienced and lessons learned from implementing RDS to recruit women who exchange sex in NYC for this study. Recruitment of women who exchange sex was a consistent challenge across all network chains.

Among all recruits, 13.6% were ineligible for study participation, and of those eligible for the study, 24.3% did not report exchange sex in the past 12 months despite explicit instructions during recruiter training that women should recruit other women who exchange sex. This could be due to the underground and informal nature of exchange sex (i.e., women may not outright discuss their exchange sex practices with one another), the criminalization of sex work (i.e., women may not have wanted to participate in a formal study about exchange sex) or the incentives may not have been high enough to encourage participation among women who exchange sex. Alternatively, it is possible that some women who were recruited did not exchange sex in the past 12 months, but did in their lifetime; recruiter training did not specify a timeframe in which a woman had to exchange sex to be eligible. Since lifetime exchange sex was not measured in the survey, we are unable to examine this.

It is also possible that some women denied their exchange sex status, as we were not able to objectively verify exchange sex status. However, since exchange sex was not a criterion for survey participation, this should have minimized the chances that a participant would falsely report exchange sex, for example to receive the study incentive. The recruitment of some women who completed the survey but did not exchange sex could have also been a result of the study paying recruiters for any recruit who completed the survey, regardless of exchange sex status. It is possible that recruiters were not particularly motivated to recruit women who exchange sex knowing they would be compensated regardless.

With regard to selecting and recruiting seeds, we were unable to explicitly market the study as one for women who exchange sex because of the need to avoid revealing eligibility criteria. As such, seeds who may have otherwise participated in the study for altruistic reasons may have been less likely to participate. We originally relied on community stakeholders to passively refer women they knew to be eligible and believed would be effective in recruiting. Due to the anonymous nature of the study, we were unable to contact these seeds ourselves to schedule interviews or reschedule missed appointments. The feasibility and acceptability of obtaining phone numbers to contact seeds for improved seed study visit attendance in this population should be assessed. To supplement stakeholder-initiated seed recruitment, study staff began to recruit additional seeds through street outreach mid-way through the study. This method required a large number of seeds to be interviewed before successive waves of peer recruitment were initiated; this incurred unanticipated staff time and effort.

There may have been additional study-related factors that influenced peer recruitment. As mentioned, we implemented several protocol changes in the third month of data collection to improve recruitment. Although the total number of recruits did increase, the eligibility of recruits and likelihood of reporting exchange sex did not significantly differ post-protocol changes (data not shown). In our formative assessment, stakeholders described the stigmatization around exchanging sex in NYC, and how exchanging sex is not explicitly discussed among women due to the stigma (e.g., if women who work in strip clubs are exchanging sex they do not talk about it with one another). During recruiter training, some participants expressed that they “thought” they knew other women who exchanged sex, but were not entirely sure. This could have contributed to participants overestimating the proportion of their peers who exchange sex and recruiting other women they only suspected of exchanging sex, leading to ineligible recruits. Additionally, since a woman is told in recruiter training to recruit other women who exchange sex, a recruiter may have not wanted to potentially “out” herself to peers by recruiting someone who would then find out in recruiter training that the study is for women who exchange sex. However, we found that peer recruitment was not associated with discomfort of revealing exchange sex status. It is also possible that recruits who were deemed ineligible to participate in the study may have spread word to other potential recruits that participation was not guaranteed, thus deterring potentially eligible participants from traveling to a field site. Despite our efforts to establish field sites accessible to women throughout NYC, we only had at most two sites operating concurrently. Lastly, the implementation of photo coupons, which was intended to improve recruitment among women who did not see peers often in-person (i.e., women whose primary exchange sex modality was online), was made after the majority of seeds were

interviewed. Due to the anonymity of the study, we were unable to notify these seeds of the changes made to protocol.

### Limitations

There are a few limitations to the findings of this study. First, researchers should be wary of the applicability of these findings to contexts outside of urban, US-based settings. The success of RDS implementation relies on underlying social structures, laws, policing, and attitudes specific to a city and larger country. Second, the sample's demographics and high HIV prevalence should not be considered representative of all women who exchange sex in NYC. We were limited to interviewing women who could complete the interview in English or Spanish only, thus excluding many sub-populations of women who exchange sex in NYC that contribute to the larger population of women who exchange sex. Third, history or experience of exchange sex is not able to be objectively verified, and so individuals' self-report of membership in this group could not be confirmed. Fourth, we cannot assess whether individual protocol changes were differentially associated with productive peer recruitment since all protocol changes occurred at the same time. Furthermore, with regard to unproductive recruiters, we were not able to determine whether the recruiter did not distribute all of her coupons, or if she gave out all of her coupons but recruits did not come in on their own volition. Lastly, due to the small sample size among seeds, true associations may not have been identified since we were not able to obtain adjusted associations. However, seed sample size in RDS studies is small by definition, so this limitation is not specific to our study. Despite these limitations, our findings do have temporality as we know that predictors of productive recruitment were dependent on the period of data collection in which participants were interviewed (i.e., seeds and peers were mostly interviewed before and after protocol changes were implemented, respectively).

### Conclusions

Overall, our findings suggest that RDS can be successfully implemented to recruit a sample of women who exchange sex in NYC. A strength of assessing seeds and peers separately was to identify criteria researchers could use when selecting initial seeds and for monitoring ongoing recruitment chain productivity. Considerations of lessons learned could improve the successful implementation of future RDS studies among women who exchange sex.

### Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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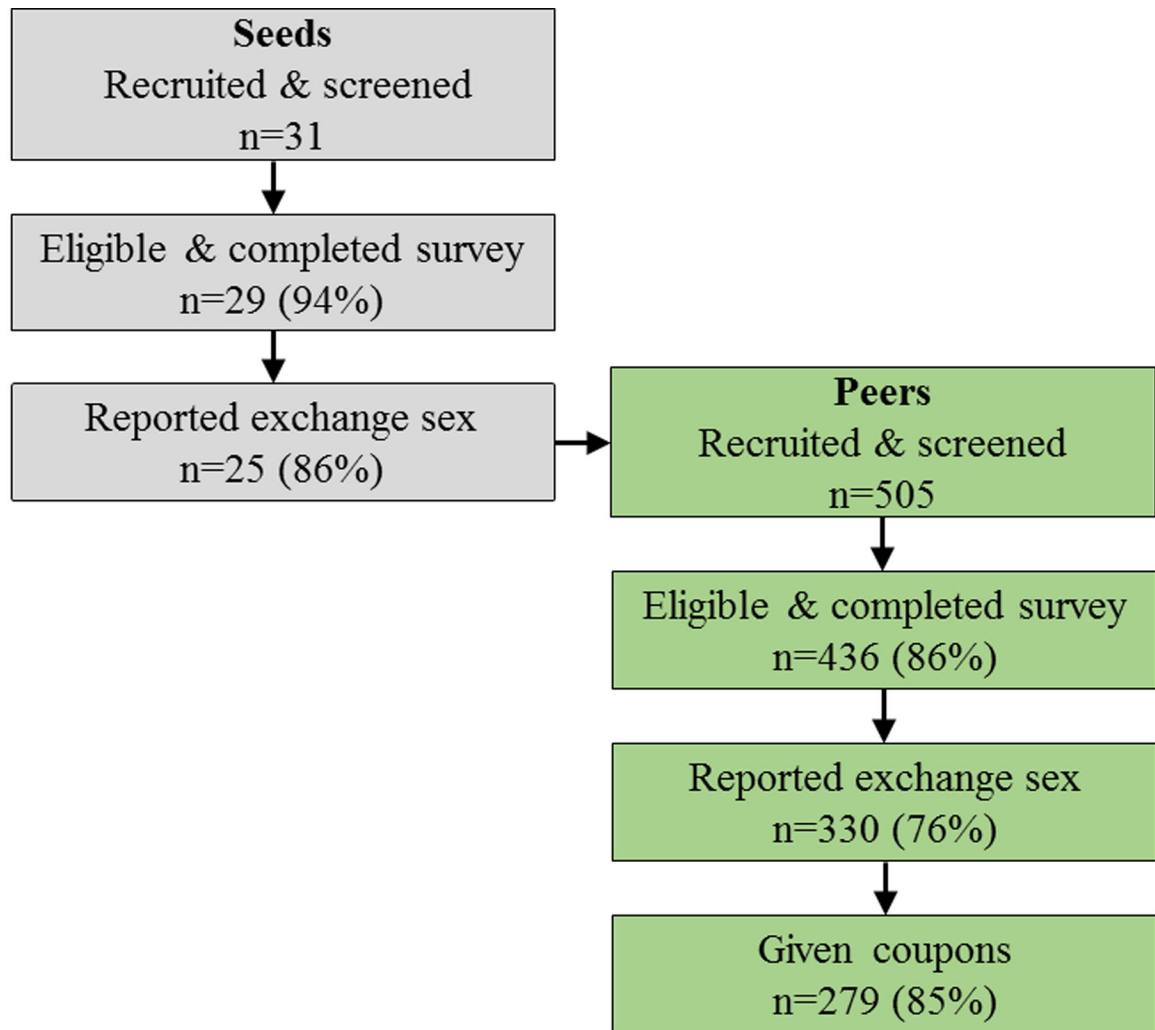
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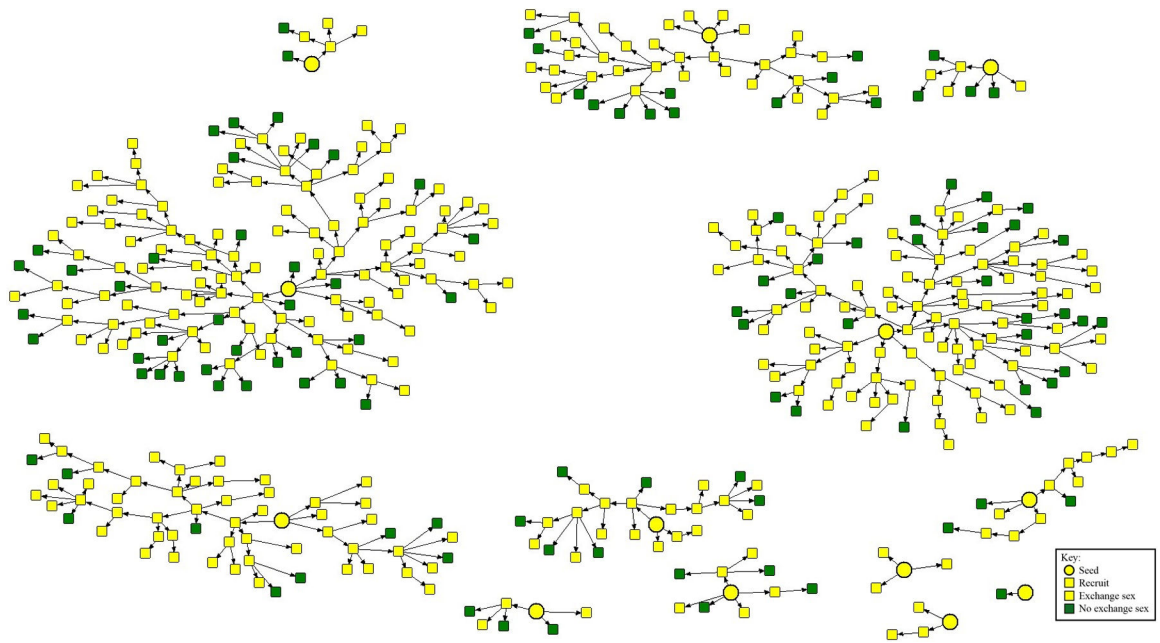
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**Figure 1.** Study recruitment and eligibility; New York City National HIV Behavioral Surveillance Study, High Risk Women Cycle, 2016.





**Figure 2.**  
Respondent-driven sampling recruitment chain diagram; New York City National HIV Behavioral Surveillance Study, High Risk Women Cycle, 2016.

**Table I.**

Selected characteristics by productive peer recruitment among seeds (n=25), New York City National HIV Behavioral Surveillance Study, High Risk Women Cycle, 2016.

	Total (n=25)	Productive (n=12)	Unproductive (n=13)	Test statistic <sup>a</sup>	p value <sup>a</sup>
	n (%)	n (%)	n (%)		
<b>Sociodemographic Variables</b>					
Age (years)				0.29	1.0000
<30	3 (12.0)	1 (8.3)	2 (15.4)		
30	22 (88.0)	11 (91.7)	11 (84.6)		
Race/ethnicity				1.22	0.6828
Hispanic/Latina	11 (44.0)	5 (41.7)	6 (46.2)		
Black	8 (32.0)	5 (41.7)	3 (23.1)		
White/Other	6 (24.0)	2 (16.7)	4 (30.8)		
Foreign-born <sup>b</sup>	2 (8.0)	1 (8.3)	1 (7.7)	0.00	1.0000
Education level				0.05	1.0000
<High school	11 (44.0)	5 (41.7)	6 (46.2)		
High school/GED	14 (56.0)	7 (58.3)	7 (53.9)		
Borough of residence				2.46	0.7662
Manhattan	4 (16.0)	1 (8.3)	3 (23.1)		
Bronx	10 (40.0)	5 (41.7)	5 (38.5)		
Brooklyn	8 (32.0)	5 (41.7)	3 (23.1)		
Queens	2 (8.0)	1 (8.3)	1 (7.7)		
Staten Island	1 (4.0)	0 (0)	1 (4.0)		
Annual household income <sup>c</sup>				1.92	0.2377
< \$10,000	14 (56.0)	5 (41.7)	9 (69.2)		
\$10,000	11 (44.0)	7 (58.3)	4 (30.8)		
Currently homeless <sup>b</sup>	6 (24.0)	4 (33.3)	2 (15.4)	1.10	0.3783
Currently married or cohabiting <sup>b</sup>	3 (12.0)	1 (8.3)	2 (15.4)	0.29	1.0000
Incarcerated <sup>b,c</sup>	12 (48.0)	2 (16.7)	10 (76.9)	9.08	0.0048
HIV status				1.10	0.3783
Negative	19 (76.0)	8 (66.7)	11 (84.6)		
Positive	6 (24.0)	4 (33.3)	2 (15.4)		
<b>Behavioral Variables</b>					
Injection drug use <sup>b,c</sup>	8 (32.0)	4 (33.3)	4 (30.8)	0.02	1.0000
Same-sex partnership <sup>b,c</sup>	16 (64.0)	7 (58.3)	9 (69.2)	0.32	0.6882
Condomless vaginal or anal sex <sup>b,c</sup>	25 (100)	12 (100)	13 (100)	n/a	n/a
Received HIV test <sup>b,c,d</sup>	13 (65.0)	3 (33.3)	10 (90.9)	7.21	0.0166
Use of HIV prevention services <sup>b,c</sup>	14 (70.0)	8 (72.7)	6 (66.7)	0.09	1.0000
<b>Exchange Sex Variables</b>					

	Total (n=25)	Productive (n=12)	Unproductive (n=13)	Test statistic <sup>a</sup>	p value <sup>a</sup>
	n (%)	n (%)	n (%)		
Years exchanging sex (median, IQR)	30 (15–33)	32 (27–40)	19 (12–33)	1.83	0.0677
Number of women who exchange sex in network (median, IQR)	10 (5–50)	35 (9–60)	5 (5–15)	2.64	0.0084
Number of exchange sex partners (median, IQR) <sup>c</sup>	8 (2–19)	4.5 (3–25)	15 (2–19)	–0.16	0.8698
Modality (most common) <sup>c</sup>				0.32	0.6882
Street	16 (64.0)	7 (58.3)	9 (69.2)		
Other	9 (36.0)	5 (41.7)	4 (30.8)		
Exchanged sex for money only <sup>b,c</sup>	2 (8.0)	1 (8.3)	1 (7.7)	0.00	1.0000
Difficulty with disclosure of exchange sex status to family/friends <sup>b</sup>	16 (64.0)	7 (58.3)	9 (69.2)	0.32	0.6882
<b>Protocol changes</b>					
Period of data collection				5.00	0.0414
Pre-protocol changes	16 (64.0)	5 (41.7)	11 (84.6)		
Post-protocol changes	9 (36.0)	7 (58.3)	2 (15.4)		

<sup>a</sup>Fisher exact tests were used for categorical variables; exact Wilcoxon tests were used for continuous variables

<sup>b</sup>Reference category is “No”

<sup>c</sup>Past 12 months

<sup>d</sup>Among those who did not self-report positive HIV status

**Table II.**

Selected characteristics of productive recruitment among peers (n=279), New York City National HIV Behavioral Surveillance Study, High Risk Women Cycle, 2016.

	Total (n=279)	Productive (n=142)	Unproductive (n=137)	Test statistic <sup>a</sup>	Adjusted p value <sup>a</sup>
	n (%)	n (%)	n (%)		
<b>Sociodemographic Variables</b>					
Age (years)				0.88	0.3485
<30	15 (5.4)	6 (4.2)	9 (6.6)		
30	264 (94.6)	136 (95.8)	128 (93.4)		
Race/ethnicity				2.53	0.2817
Hispanic/Latina	87 (31.2)	41 (28.9)	46 (33.6)		
Black	161 (57.7)	89 (62.7)	72 (52.6)		
White/Other	31 (11.1)	12 (8.5)	19 (13.9)		
Foreign-born <sup>b</sup>	22 (7.9)	11 (7.8)	11 (8.0)	0.13	0.7158
Education level				1.48	0.2236
<High school	127 (45.5)	70 (49.3)	57 (41.6)		
High school/GED	152 (54.5)	72 (50.7)	80 (58.4)		
Borough of residence				5.27	0.2603
Manhattan	31 (11.1)	12 (8.5)	19 (13.9)		
Bronx	140 (50.2)	81 (57.0)	59 (43.1)		
Brooklyn	78 (28.0)	38 (26.8)	40 (29.2)		
Queens	28 (10.0)	10 (7.0)	18 (13.1)		
Staten Island	0 (0.0)	0 (0.0)	0 (0.0)		
Annual household income <sup>c</sup>				0.24	0.6274
< \$10,000	140 (50.2)	74 (52.1)	66 (48.2)		
\$10,000	139 (49.8)	68 (47.9)	71 (51.8)		
Currently homeless <sup>b</sup>	75 (26.9)	32 (22.5)	43 (31.4)	2.93	0.0869
Currently married or cohabiting <sup>b</sup>	43 (15.4)	21 (14.8)	22 (16.1)	0.00	0.9701
Incarcerated <sup>b,c</sup>	53 (19.1)	24 (16.9)	29 (21.3)	1.02	0.3130
HIV status				2.88	0.0896
Negative	183 (66.3)	86 (61.0)	97 (71.9)		
Positive	93 (33.7)	55 (39.0)	38 (28.2)		
<b>Behavioral Variables</b>					
Injection drug use <sup>b,c</sup>	39 (14.0)	18 (12.7)	21 (15.3)	0.22	0.6423
Same-sex partnership <sup>b,c</sup>	152 (54.5)	80 (56.3)	72 (52.6)	0.33	0.5664
Condomless vaginal or anal sex <sup>b,c</sup>	253 (90.7)	128 (90.1)	125 (91.2)	0.12	0.7327
Received HIV test <sup>b,c,d</sup>	116 (53.2)	60 (56.6)	56 (50.0)	0.71	0.3995
Use of HIV prevention services <sup>b,c</sup>	151 (54.5)	87 (61.7)	64 (47.1)	5.23	0.0222

	Total (n=279)	Productive (n=142)	Unproductive (n=137)	Test statistic <sup>a</sup>	Adjusted p value <sup>a</sup>
	n (%)	n (%)	n (%)		
<b>Exchange Sex Variables</b>					
Years exchanging sex (median, IQR)	28 (19–35)	28 (23–36)	26 (15–35)	3.54	0.0600
Exchange sex network size (median, IQR)	12 (5–30)	13.5 (5.5–30)	10 (5–30)	0.57	0.4497
Number of exchange sex partners (median, IQR) <sup>c</sup>	4 (2–15)	5 (2–23)	4 (2–12)	1.00	0.3176
Modality (most common) <sup>c</sup>				0.03	0.8623
Street	88 (31.5)	46 (32.4)	42 (30.7)		
Other	191 (68.5)	96 (67.6)	95 (69.3)		
Exchanged sex for money only <sup>b,c</sup>	36 (12.9)	19 (13.4)	17 (12.4)	0.11	0.7410
Difficulty with disclosure of exchange sex status to family/friends <sup>b</sup>	235 (84.2)	118 (83.1)	117 (85.4)	0.35	0.5519
<b>Protocol changes</b>					
Period of data collection				3.00	0.0833
Pre-protocol changes	9 (3.2)	2 (1.4)	7 (5.1)		
Post-protocol changes	270 (96.8)	140 (98.6)	130 (94.9)		

<sup>a</sup>Adjusted for period in which data collection occurred: pre- vs. post-protocol changes (increased recruiter incentive, implementation of photo coupons, change of field sites, and broadened recruiter eligibility criteria).

<sup>b</sup>Reference category is “No”

<sup>c</sup>Past 12 months

<sup>d</sup>Among those who did not self-report positive HIV status

**Table III.**

Adjusted associations of successful recruitment among peers (n=279), New York City National HIV Behavioral Surveillance Study, High Risk Women Cycle, 2016

	aPR (95% CI) <sup>a</sup>	p value <sup>a</sup>
Use of HIV prevention services <sup>b,c</sup>	1.32 (1.03–1.68)	0.0258

<sup>a</sup> Adjusted for period in which data collection occurred: pre- vs. post-protocol changes (increased recruiter incentive, implementation of photo coupons, change of field sites, and broadened recruiter eligibility criteria)

<sup>b</sup> Reference category is “No”

<sup>c</sup> Past 12 months

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**Table IV.**

Study eligibility and exchange sex status by type of recruitment coupon presented among peers (n=487), New York City National HIV Behavioral Surveillance Study, High Risk Women Cycle, 2016<sup>a</sup>

	<b>Total (n=487)</b>	<b>Photo (n=18)</b>	<b>Paper (n=469)</b>	<b><math>\chi^2</math></b>	<b>Exact <i>p</i> value</b>
	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>		
Eligible for survey <sup>b</sup>	435 (89.3)	16 (88.9)	419 (89.3)	0.00	1.0000
Exchanged sex <sup>b,c</sup>	318 (75.9)	9 (56.3)	309 (76.7)	3.51	0.0744

<sup>a</sup>Among peers who were screened for eligibility after photo coupons were implemented

<sup>b</sup>Reference category is "No"

<sup>c</sup>Among eligible participants who completed the survey (n=419)

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