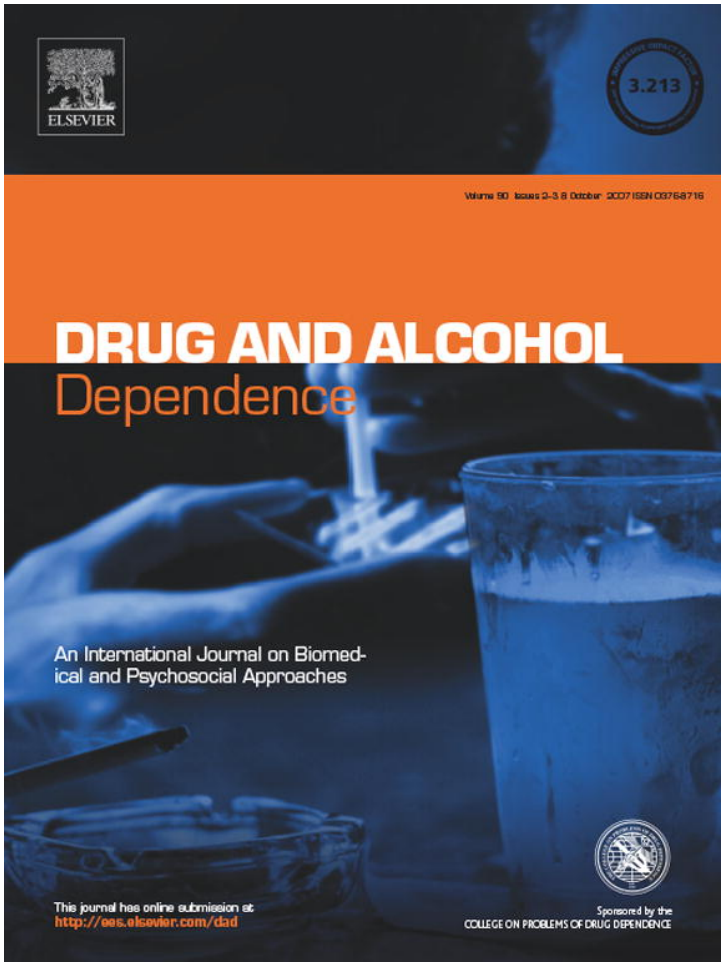

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Respondent-driven sampling to assess characteristics and estimate the number of injection drug users in Bangkok, Thailand☆

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Abstract

Background: Since early in Thailand's HIV epidemic, HIV seroprevalence among injection drug users (IDUs) in Bangkok has been around 40%. As Thailand moves to strengthen HIV prevention and care programs for Bangkok IDUs, information on current patterns of drug use and an estimate of the size and composition of the IDU population are essential.
Methods: We used respondent-driven sampling (RDS) to recruit Bangkok IDUs who reported injecting in the past 6 months. IDUs were interviewed with a standardized questionnaire. Logistic regression was used to compare IDUs currently or previously in treatment with those never treated. RDS software was used to estimate IDU population size based on the proportion in treatment.
Results: Of 963 IDUs recruited, 828 (86%) were men. One hundred and twelve IDUs (12%) reported never having attended a drug treatment clinic. Young age, unemployment, injection of single drug, and never having been HIV tested were significantly associated with never-in-treatment status. The estimated proportion of IDUs in treatment was 0.55 (95% confidence interval, 0.52–0.60). Dividing the known number of IDUs in treatment (1981 IDUs attending Bangkok drug treatment clinics during October 2003 through March 2004) by this proportion, we estimated the number of IDUs in Bangkok during the period of RDS to be 3595 (95% confidence interval, 3296–3810).
Conclusions: Data obtained through RDS, although subject to limitations from co-existing government drug control policies and possible under-recruitment of out-of-treatment IDUs, will be useful in informing policy, strengthening prevention approaches, and improving methods to monitor the HIV epidemic among Thai IDUs.
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Keywords: Epidemiology; Injection drug users; HIV; Sampling methodology; Thailand

1. Introduction

Following the rapid increase of HIV infection among injection drug users (IDUs) in Thailand in the late 1980s, HIV seroprevalence among IDUs stabilized at around 40% nationwide (Bureau of Epidemiology, 2004). In 2004, the HIV seroprevalence among Bangkok IDUs surveyed at drug treatment clinics was 38% (Bureau of Epidemiology, 2004). Since 1991, when the number of IDUs in Bangkok was estimated at 36,000 persons, most of whom (89%) were heroin injectors (Mastro et al., 1994), patterns of drug use have changed greatly with the introduction of methamphetamine (primarily smoked, but some injected) (Poshyachinda et al., 1999; van Griensven et al., 2005), widespread use of injected midazolam (a short-acting benzodiazepine) (van Griensven et al., 2005), and the launching of Thailand's anti-drug campaign, which began in 2003 (Vongchak et al., 2005). From 1991 through 2002, the reported numbers of IDUs attending Bangkok's drug treat-

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ment clinics declined from about 7500 persons to about 4000 persons, and declined further to about 2000 persons in 2003 and 1000 persons in 2004, overall an 87% decline (Bureau of Health Service System Development, 2005). However, the extent to which this reflects a decline in the total number of IDUs in Bangkok or changes in patterns of drug use is unknown.

As Thailand moves to strengthen HIV prevention and care programs for IDUs, information on current patterns of drug use and estimates of the size and composition of the IDU populations, both in and out of treatment, are essential. Some data have been available on IDUs attending drug treatment services, but no data have been available on the characteristics or numbers of out-of-treatment IDUs. To gain access to the IDU population in Bangkok, including out-of-treatment IDUs, and to estimate the size and composition of this population, we used respondent-driven sampling (RDS), a new form of chain-referral sampling that assumes that those best able to access members of hidden populations are their own peers (Heckathorn, 2002). The capture–recapture methodology used in 1991 (Mastro et al., 1994) was not repeated because it would have required consent and access to personal identifying information, potentially placing persons at risk for breaches of confidentiality and subsequent criminal prosecution.

2. Methods

Active IDUs (defined as having injected drugs in the past 6 months) residing in the Bangkok Metropolitan Administration (BMA) were recruited using RDS. Each enrolled IDU was given the opportunity to become a recruiter. Each recruiter was provided with three recruitment coupons to pass to their active IDU peers. Recruiters also completed a training module for HIV education of their peers, as described by Broadhead et al. (1998). The coupons were presented to project staff at each of four BMA drug treatment clinics to confirm that IDUs were referred to the study site by a specific peer recruiter. Each recruiter was reimbursed for successfully recruiting and educating other members of their network of IDUs to participate in the project. The RDS process started with 16 seeds and reached equilibrium by the fourth wave of recruitment, as determined by stable distribution by sex and proportion of IDUs who were in- and out-of-treatment.

Participants were reimbursed 150 baht (~US $3.50) for the interview, and for those who agreed to be recruiters, 50 baht (~US $1.20) for each person they successfully recruited. For each of the 10 education items answered correctly by the person recruited, the recruiter received an additional 10 baht (~US 20 cents). A 50 baht bonus was paid for the recruitment of women and persons less than 20 years old as these were thought to be more difficult to enlist. A risk behavior questionnaire was administered by trained interviewers to collect information on demographics, history of drug use, injection risk behaviors, history of drug treatment, sexual behavior, incarceration (jail or prison) history, network size, and perceptions of availability, accessibility, utilization and barriers to using drug treatment services. Data on physical characteristics (e.g. height, skin color, scars, or tattoos) were also collected to check for potential duplication. No names or other personal information such as national identification numbers were recorded. Before participating in the project, participants provided verbal informed consent. Prior to project initiation, a meeting was held with law-enforcement authorities to inform them and seek their cooperation for the study. This project was approved by the Ethical Review Committee of the Thailand Ministry of Public Health and by the U.S. Centers for Disease Control and Prevention, Atlanta, GA, USA.

Data were entered and likely duplicates excluded prior to analysis of IDU characteristics with SPSS (SPSS, Inc., Chicago, IL). Frequency data were analyzed by the chi-squared (or Fisher's exact) test. Odds ratios, with 95% confidence intervals, were computed as measures of effect. Group differences for continuous variables were compared using the 2-sample non-parametric Mann–Whitney test. Modeling of predictors associated with never-in-treatment status was carried out using multiple logistic regression; factors that were significant at $p < 0.1$ in the bivariate analysis were considered for the multivariate model using a stepwise selection method.

Respondent-Driven Sampling Analysis Tool (RDSAT) version 5.0.1 (Cornell University, NY) was used to analyze network characteristics and to estimate the proportion of IDUs in and out of treatment. Likely duplicates were retained in these analyses because each occurrence of the likely duplicate held a defined network location and contributed information to that network. The number of persons defined as being within a respondent's network was considered to be the number of IDUs that the participant reported knowing personally by first name or nickname and with whom they had contact in person, by phone, or some other way during the past 2 years. These could include sexual partners, friends, or others.

To estimate the number of active IDUs, we divided the number of IDUs attending drug treatment clinics in the BMA with an estimate of the proportion of IDUs in treatment from RDSAT. The proportion of IDUs in treatment was estimated using the following formula (Heckathorn, 2002):

$$\mathrm{Pa} = \frac{\mathrm{Sba} \times \mathrm{Nb}}{\mathrm{Sba} \times \mathrm{Nb} + \mathrm{Sab} \times \mathrm{Na}}$$

where Pa is the proportion of IDUs in treatment, Sba the proportion of in-treatment IDUs recruited by out-of-treatment IDUs, Nb the mean network size of out-of-treatment IDUs, Sab the proportion of out-of-treatment IDUs recruited by in-treatment IDUs and Na is the mean network size of in-treatment IDUs.

3. Results

3.1. Characteristics of seeds

Of the 16 seeds, 11 were men. The median age of the seeds was 30.5 years (range 24–49 years). Most (88%) had at least 6 years of education. Half (50%) lived with a spouse or partner. Less than half (44%) were employed. All had current or past treatment experience; only one was not in treatment at the time of the study. Three reported injecting heroin only, while 13 (81%) reported injecting multiple drugs (heroin, methamphetamine, and/or midazolam).

3.2. Characteristics of IDU recruits

From October 2003 through March 2004, 963 IDUs were recruited through 16 waves at the four clinics ($n = 128$, 192, 263, and $n = 380$). Fig. 1 displays an example of a recruit-

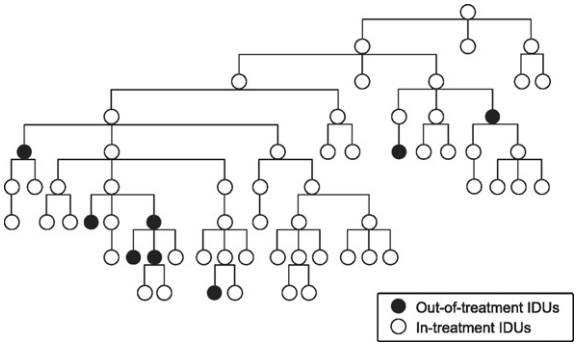

Fig. 1. A sample peer recruitment network from one IDU seed. All participants were given coupons to recruit peers.

Table 1
Characteristics of 947 IDUs in Bangkok, Thailand, October 2003–March 2004

	Number (%) among all IDUs ($n=947$)	Number (%) among IDUs with prior treatment ($n=835$)	Number (%) among IDUs never-in-treatment ($n=112$)	P[a]
Demographics				
Age group				
≤25 years	157 (17)	115 (14)	42 (38)	<0.001
26–35 years	430 (45)	383 (46)	47 (42)	
>35 years	360 (38)	337 (40)	23 (21)	
Male	815 (86)	731 (88)	84 (75)	0.001
≥6 years of education	861 (91)	761 (91)	100 (89)	0.50
Marital status				
Single	396 (42)	340 (41)	56 (50)	0.08
Living with a spouse or partner	296 (31)	261 (31)	35 (31)	
Divorced, separated, widowed	254 (27)	233 (28)	21 (19)	
Employed	535 (57)	484 (58)	51 (46)	0.04
Behavioral characteristics				
Type of drug injected				
Heroin only	183 (19)	149 (18)	34 (30)	<0.001
Methamphetamine or midazolam only	15 (2)	3 (0.4)	12 (11)	
Multiple drugs	749 (79)	683 (82)	66 (59)	
Ever injected methamphetamine	459 (49)	412 (50)	47 (42)	0.13
Shared needles in past 6 months	161 (17)	144 (17)	17 (15)	0.59
Of those, shared needles in past month	78 (49)	66 (46)	12 (71)	0.31
Shared injection equipment in past 6 months	274 (29)	248 (30)	26 (23)	0.16
Had sex with casual partner in past month	141 (15)	119 (14)	22 (20)	0.18
Condom use at last sex with casual partner[b]	362 (38)	331 (40)	31 (28)	0.05
Ever been tested for HIV	726 (77)	682 (82)	44 (39)	<0.001
Of those tested, HIV-positive	169 (23)	164 (24)	5 (11)	0.13
In jail during past year	294 (31)	253 (30)	41 (37)	0.18
Of those in jail in past year, injected drugs while there	37 (13)	33 (13)	4 (10)	0.56
Of those, shared needles or injection equipment there	27 (73)	24 (73)	3 (75)	0.92
In prison during past year	164 (17)	140 (17)	24 (21)	0.22
Of those in prison in past year, injected drugs while there	24 (15)	19 (14)	5 (21)	0.35
Of those, shared needles or injection equipment there	19 (79)	16 (84)	3 (60)	0.24
Of those in prison in past year, had sex while there	15 (9)	12 (9)	3 (13)	0.55
Of those, used condom for sex in prison	4 (27)	2 (17)	2 (67)	0.08

[a] P-value comparing IDUs with prior treatment to IDUs never in treatment.
[b] Of those who reported sex with a casual partner ever; $n=565$ for all IDUs, $n=511$ for IDUs with prior treatment, $n=54$ for IDUs never in treatment.

ment tree showing treatment status. Seeds recruited a median of 19 (range 0–168) in-treatment IDUs and a median of 1 (range 0–46) out-of-treatment IDUs. Using a computer program to compare physical characteristics of enrolled IDUs, 16 persons (1.7% of the study population) were identified as likely duplicates and excluded from analyses of IDU characteristics.

Characteristics of the IDUs are shown in Table 1. Seventeen percent of IDUs were aged 25 years or younger; median age at first injection was 18 years (range 7–42 years). Most (86%) of the IDUs recruited were men, 91% reported having at least 6 years of education, and 42% were single. The majority (79%) reported using multiple drugs such as heroin, methamphetamine, and/or midazolam, while a small proportion (2%) injected a single drug other than heroin. Sharing needles and sharing injection equipment in the past 6 months was reported by 17 and 29% of IDUs, respectively. Of those who shared needles in the past 6 months, almost half (49%) had shared in the past month. Sharing of needles and equipment was common among IDUs who reported injecting during incarceration. The majority of IDUs had had an HIV test and of those tested, 23% reported that they were HIV-positive.

3.3. Comparison of IDUs with and without drug treatment experience

One hundred and twelve (12%) IDUs reported never having attended a drug treatment clinic. Characteristics of IDUs differed depending on whether or not they had ever been in treatment (Table 1). Compared with IDUs who had been in treatment, those never-in-treatment were younger, more likely to be female, less likely to be currently employed, more likely to inject a single drug, and less likely to have been tested for HIV. Of those ever in treatment and reporting HIV testing, 166 (24%) said they were HIV-infected, compared with 5 (11%) of those never in treatment, but this difference was not statistically significant ($p=0.13$).

Logistic regression identified factors independently associated with never-treated status (Table 2). Young age, female sex, unemployment, injection of single drug, and never having had

Table 2
Multivariate analysis of factors associated with never-in-treatment status among 947 IDUs in Bangkok, Thailand, October 2003–March 2004

	Odds ratio (95% CI)	Adjusted[a] odds ratio (95% CI)
Age group		
≤25 years	5.35 (3.09–9.28)	3.40 (1.85–6.24)
26–35 years	1.80 (1.07–3.02)	1.80 (1.03–3.15)
>35 years	ref	ref
Sex		
Male	ref	ref
Female	2.34 (1.46–3.77)	1.84 (1.04–3.26)
Currently employed		
Yes	ref	ref
No	1.65 (1.11–2.46)	1.58 (1.01–2.47)
Type of drug injected		
Heroin only	2.36 (1.51–3.70)	2.06 (1.25–3.40)
Methamphetamine or midazolam only	41.39 (11.39–150.40)	17.14 (3.97–73.98)
Multiple drugs	ref	ref
Condom use at last sex		
Yes	ref	[b]
No	10.00 (0.58–171.20)	
Ever had HIV test		
Yes	ref	ref
No or do not know	6.89 (4.64–10.71)	6.30 (4.01–9.90)

Abbreviation: CI, confidence interval.
[a] Adjusted for factors listed in table, using logistic regression.
[b] Variable not significant in the final multivariate model.

an HIV test were significantly associated with never-treated status.

3.4. Network characteristics reported by IDUs

The median self-reported network size of never-treated IDUs (five persons) was not significantly different than that reported by IDUs with treatment experience (six persons) (Mann–Whitney test, $p = 0.09$; Table 3). Never-treated IDUs reported having never-treated IDUs and IDUs under 20 years of age in their networks more often than did IDUs with treatment experience. A small of proportion of IDUs overall reported having HIV-infected IDUs in their networks, although more IDUs with treatment experience reported having HIV-infected network members than did never-treated IDUs (32.7% versus 13.0%, $p = 0.003$; Table 3).

Table 4
RDS estimation of the IDU population proportions in treatment and out of treatment, based on recruitment of 947 IDUs, Bangkok, Thailand, October 2003–March 2004

	In-treatment IDUs	Out-of-treatment IDUs
Total IDUs recruited	599	348
Recruitments by out-of-treatment IDUs	87	138
Recruitment proportion	0.39	0.61
Recruitments by in-treatment IDUs	512	210
Recruitment proportion	0.71	0.29
Sample population proportion	0.64	0.36
Adjusted average network size	5.24	4.85
Equilibrium	0.57	0.43
Index of clustering (homophily)	0.35	0.30
Estimated population proportion	0.55	0.45

3.5. Estimated number of IDUs in the BMA area

A total of 348 (37%) of recruited IDUs were out of treatment (including those never-treated and those with past treatment) at the time of the RDS interview. Table 4 shows the RDS recruitment patterns and estimates of IDU population proportions that were in treatment and out of treatment. In-treatment IDUs were 2.5 times more likely to recruit another in-treatment IDU ($n = 512$) than to recruit an out-of-treatment IDU ($n = 210$). Adjusting for comparative network size using the formula above, we estimated that the proportion of IDUs in treatment was 0.55 ($[0.39 \times 4.85]/[0.39 \times 4.85 + 0.29 \times 5.24]$), with a 95% confidence interval of 0.52–0.60.

Data on the number of IDUs attending Bangkok drug treatment clinics indicated that 1981 IDUs were in treatment during the period of RDS recruitment (October 2003 through March 2004). Dividing this number by the estimated proportion of IDUs in treatment, the number of IDUs in Bangkok during the 6-month period of RDS was projected to be 3595 (95% confidence interval, 3296–3810).

Table 3
Network member characteristics reported by 947 IDUs recruited through respondent-driven sampling, Bangkok, Thailand, October 2003–March 2004

Characteristic	Percentage of IDUs reporting network members with given characteristic			P[a]
	All IDUs ($n = 947$)	IDUs with prior treatment ($n = 835$)	IDUs never-in-treatment ($n = 112$)	
Never in treatment	35.9	32.2	66.0	<0.001
Currently in treatment	82.7	86.1	55.2	<0.001
Prior treatment, currently not in treatment	58.0	59.9	42.2	<0.001
Women	47.8	48.5	42.9	0.26
Under 20 years old	11.2	9.1	27.0	<0.001
HIV-positive	30.4	32.7	13.0	0.003
Number of IDUs in network, median (range)	6 (1–112)	6 (1–112)	5 (1–30)	0.09

[a] P-value for χ^2-test comparing IDUs with prior treatment to IDUs never-in-treatment; Mann–Whitney test used to compare medians.

4. Discussion

This study documents a continued high level of HIV risk behavior among Bangkok IDUs. About one-sixth reported having shared needles in the past 6 months and of those who injected while incarcerated, most shared needles or injection equipment. This finding is consistent with previous studies among Bangkok IDUs which have shown high levels of injection-related risk behaviors both in and outside the incarceration setting (Vanichseni et al., 2000; Buavirat et al., 2003). Our study found that never-treated IDUs, compared to their counterparts currently or previously in treatment, were younger, more likely to inject a single drug, and less likely to have been tested for HIV. These findings underscore the need to access never-treated IDUs so that they can receive prevention messages and other HIV prevention services.

Many IDUs reported that they had been tested for HIV, and a substantial proportion of these reported their serostatus. The high reported HIV prevalence (23%) is consistent with clinic-based serosurveillance data documenting HIV infection among nearly 40% of IDUs over the past decade (Bureau of Epidemiology, 2004; Vanichseni et al., 2000, 2004). However, we found a lack of awareness of the likely HIV prevalence among their within-network peers; IDUs in treatment believed that only 10% of persons in their networks were HIV-infected, and IDUs out of treatment believed that only 3% were HIV-infected. IDUs' perception of low HIV prevalence among their network peers is consistent with their continued high rates of injection-related and sexual risk behaviors.

It should be noted that comparisons of treated and never-treated IDUs were conducted with standard statistical software, because the current version of RDSAT does not provide options for multivariate analysis. These comparisons therefore do not incorporate RDSAT weighting based on network size and participant relatedness, and although the results showed small differences in average network size and homophily between these two groups we cannot discount the possibility of biased effect estimates and thus findings that are not generalizable to the larger populations of treated and never-treated IDUs.

Our estimate of 3595 IDUs in Bangkok is far lower than the 36,000 IDUs estimated for the same area in 1991 (Mastro et al., 1994), suggesting a large decline in IDU numbers. However, the methodologies of these studies are not directly comparable and the actual difference may be larger or smaller. The low estimated number of IDUs is consistent with a steady decrease in the number of heroin treatment admissions to Thanyarak National Institute of Drug Abuse (NIDA) in Bangkok, Thailand's largest drug use treatment center, and in the number of people receiving methadone treatment at the BMA clinics. The number of heroin users admitted for treatment to NIDA was 8373 in 1996, 1296 in 2002, and 805 in 2003 (Division for Coordination of Drug Abuse Treatment, 2005). Similarly, as previously noted, the number of persons receiving methadone treatment at the BMA clinics declined by 87% from 1991 to 2004 (Bureau of Health Service System Development, 2005).

The RDS estimate of the IDU population size rests largely on the determination of the proportion of IDUs that were in and out of drug treatment while RDS was being conducted (October 2003 to March 2004). About 37% of recruited IDUs were out of treatment, and one-third of those had never received treatment. However, the social context of Thailand's recent anti-drug campaign and changes in drug use patterns may have resulted in under-recruitment of out-of-treatment IDUs. The so-called "war on drugs" policy, initiated in 2003, was criticized for its violent approach which reportedly resulted in killing, beating, incarceration, and forced treatment of thousands of drug dealers and users (Human Rights Watch, 2004). This policy may have led to disruption of out-of-treatment IDU networks and thus fewer out-of-treatment IDUs recruited through the RDS process. Fear of criminal prosecution or other harm also may have kept out-of-treatment IDUs from participating in the RDS survey and thereby identifying themselves as IDUs. In contrast, IDUs in treatment were officially exempt from the legal sanctions applied to other IDUs and could conveniently participate in survey interviews which took place at the BMA drug treatment clinics. In addition, as expected, in-treatment IDUs were more likely to recruit other in-treatment IDUs than to recruit out-of-treatment IDUs. Whether this was due to differential recruitment, differential acceptance, distinct networks, or exhaustion of the population of potential recruits is unclear.

Shifts in drug use patterns away from heroin and toward the use of other drugs could also contribute to under-recruiting of out-of-treatment IDUs. In our data, fewer than 20% reported using only heroin, while the majority reported using multiple drugs. The decreasing number of heroin users in treatment at NIDA and BMA facilities may reflect such a shift, accentuated by the anti-drug campaign beginning in 2003. A study in northern Thailand reported that 70% of IDUs had ceased injecting since the anti-drug campaign began, and that 71% of those who ceased injecting continued to use other drugs (Vongchak et al., 2005). Drug users who injected methamphetamine, benzodiazepines, or other psychotropic drugs may have been part of different IDU networks, showing little overlap with heroin IDU networks, and therefore less likely to be recruited through the RDS process. Unlike methadone treatment for heroin users, only limited treatment was available at BMA clinics for abuse of other psychotropic drugs, and thus drug treatment opportunities were not an incentive for this group to come to the clinics. All of these factors may have resulted in under-recruitment of out-of-treatment IDUs and potentially an underestimation of IDU population size.

RDS methodology assumes that recruits for the most part will have characteristics similar to those of their recruiters, which, following Markov theory, will result in a demographic equilibrium of the sample population similar to that of the population at large, that is, if the number of waves is large enough (Heckathorn, 2002). Even though this assumption was met in our assessment after the completion of four waves, if out-of-treatment IDUs or IDUs using drugs other than heroin had a constant lower probability of being recruited, the sample population may have reached equilibrium with these groups still being under-represented. Considering these possible biases, our

estimate of the size of the Bangkok IDUs population is likely to be conservative, and thus, this estimate should not undermine the importance of implementing public health intervention programs for this vulnerable population.

Our data have several implications not only for future assessment of the size of the IDU population in Bangkok, but also for the design of HIV prevention programs for this population. Previous studies have suggested that HIV prevention programs consider adapting the RDS procedure as a strategy for IDU outreach (Broadhead et al., 1998) and to monitor HIV prevalence and related risk behaviors among out-of-treatment IDUs (Magnani et al., 2005). Repeating RDS outside of the anti-drug campaign setting and using interviewing sites located in the community may provide important information on the reliability of our estimate and could facilitate further use of RDS for prevention and surveillance programs. As Thailand begins to expand programs for community-based outreach and conducts trials to evaluate biomedical interventions for HIV prevention among IDUs, the data obtained during the RDS process will be useful in addressing policy issues, strengthening prevention approaches, and improving methods to monitor the HIV epidemic among IDUs.

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