The feasibility of using web-based respondent driven sampling (RDS) among men who have sex with men (MSM) in Thailand

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Abstract

Background: Respondent-driven sampling (RDS) is the current standard for sampling key populations at risk for HIV infections but is usually limited to local implementation in single towns or cities. Web-based sampling eliminates this spatial constraint but often relies on self-selected convenience samples. We piloted an online RDS survey with biomarker collection among men who have sex with men (MSM) in Thailand.

Objective: To study the feasibility of using a largely automated web-based respondent driven sampling (RDS) among men who have sex with men (MSM) in Thailand that aimed to replace and fulfill all attributes of a physical and staffed RDS office

Methods: We developed a website to fully function like a conventional RDS survey office, including coupon verification, eligibility screening, consenting, interviewing (self-administered), peer recruitment training, coupon issuance, compensation, and recruitment tracking. All functions were automated; data managers monitored recruitment, data collection and payment, and could be contacted by recruits as needed. Eligible participants were male, aged 15+ years, resided in Thailand, and had anal sex with a man in the past 6 months. Recruits who resided in Bangkok were additionally invited to attend a participating health clinic of their choice for an HIV-related blood draw. Data were weighted to account for the complex sampling design.

Results: The survey was implemented from February to June 2022; seeds (21 at start, 14 added later) were identified mostly through targeted online banner ads; coupon uptake was 45.1%. Of 2,578 candidate recruits screened for eligibility, 2,151 (83.2%) were eligible and 2,142 (99.6%) enrolled. Almost all (2,067 or 96.5%) completed the questionnaire; however, 318 survey records were removed from analysis as fraudulent enrolments. The final sample size was 1,749, the maximum number of waves achieved was 191, sampling covered all 6 geographic regions and 75 of 77 (97.4%) provinces; convergence was reached for several salient variables. Mean age was 20.5 years, most (69.8) had never tested for HIV before, with fear of stigma as the biggest reason (97.1%) for not having tested. Most (76.9%) had visited gay-focused physical venues several times a week. A condom was used in 97.6% of last sex acts, 11.0% had purchased sex from other men (past 12 months), 4.5% had sold sex to men (past 12 months), and 95.3% had 3+ male sex partners (last 3 months). No participant in Bangkok presented for a blood draw.

Conclusions: We successfully conducted an online RDS survey among MSM in Thailand, covering virtually the entire country although, as in physical RDS surveys, sampling was dominated by younger MSM. The survey also failed to collect biomarkers in Bangkok. Public health interventions should aim at increasing testing and addressing (the perception of) stigma.

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Introduction

The global share of new HIV infections due to key populations and their partners is steadily rising and was estimated at 70% in 2021 [1] Key populations, including men who have sex with men (MSM), transgender persons, sex workers, people who inject drugs and people in prisons and other enclosed settings face extraordinarily high HIV acquisition risks [1], warranting intense HIV control efforts tailored to these populations. To inform programming and policy making, accurate HIV estimates at the population level are needed, in addition to monitoring and evaluation of programs. However, the lack of sampling frames for key populations poses a substantial challenge for surveillance and estimation and necessitates workarounds to generate population-level estimates, such as HIV prevalence, uptake of services, and progress towards the UNAIDS 95-95-95 targets. Currently, the most frequently used sampling and analytic design to facilitate such population level estimates is respondent-driven sampling (RDS) [2,3] RDS represents an advanced version of snowball sampling, with refinements both in the way data are collected and analyzed. Relying on the recruitment among socially connected peers, RDS surveys are typically conducted in a single location and rely on staffed survey offices for data collection.

The rise of the internet and the increasing access to and time spent on the internet also opens new possibilities for HIV surveillance, such as population size estimation [4,5] and surveys [6] Similar to most health-related online surveys, web-based data collection among key populations primarily relies on samples based on self-selection and or unknown sampling probabilities [7,8] Successfully implemented online RDS surveys among various populations [9,10] including MSM [11] remain sparse perhaps because building the required IT infrastructure can appear daunting. Still, online surveys facilitating population estimates are attractive for two principal reasons: The promise of large-scale surveys covering geographies not normally included in BBS due to budgetary or sampling (rural areas) reasons and lower costs compared to a “brick-and-mortar” survey office. However, new challenges arise with online data collection such as fraudsters or duplicate enrolments due to the compensation paid out to recruits, as well as the impracticality of biomarker collection. For HIV-focused population surveys, biomarkers are often considered essential metrics facilitating estimates such as HIV prevalence, HIV status awareness, or viral load suppression.

Thailand faces a key population dominated HIV epidemic with an estimated adult HIV prevalence of 1.0% [12] Most new infections (52%) appear to arise from male-male sex [13] Thailand has a long history of HIV surveillance, including time location sampling surveys for MSM and benefits from a robust case surveillance system [14]. A consensus meeting reviewing data from 2014-18 concluded that HIV prevalence and incidence among MSM in Bangkok declined [15] but nevertheless remained high, with UNAIDS estimating HIV prevalence among MSM in Thailand at 11.9% [16].

We piloted an online RDS survey with biomarker collection among MSM in Thailand. In this paper we report on the survey’s design, implementation, and findings.

Methods

Survey setting and design

We conducted a webRDS survey among MSM in all of Thailand, dubbed *Kai Noi Survey*. The survey was implemented by staff from the Division of Epidemiology (Ministry of Public Health, Thailand) with funding support and technical assistance from the US Centers for Disease Control and Prevention (CDC). The RDS survey system's virtual architecture is explained in detail. In short, a website was constructed to fully function like a conventional RDS survey office, including coupon verification, eligibility screening, consenting, interviewing (self-administered), peer recruitment training, coupon issuance, compensation, and recruitment tracking. All these functions were automated; even so, a data manager monitored recruitment, data collection, answered anecdotal questions from recruits (online or by phone), and supervised the execution of payments. Additional survey monitoring included coupon uptake, sampling speed, as well as convergence and bottleneck graphs.

Eligible participants and seeds (i.e., participants who started the peer referral-based sampling process) were born male, identified as male, 15 years of age or older, had anal sex with another man in the last six months, had not previously participated in this survey, resided in Thailand, could read Thai, and presented a valid eCoupon (except seeds). Seeds were solicited through banner ads or micro-messaging in gay-friendly social media (pages) and were sought from each of Thailand's six geographic regions to ensure geographic diversity and social distance. Eligible and consenting seeds started the recruitment process using electronic coupons (eCoupons) that could be distributed through various social media, such as *Line*, or SMS. eCoupons were labeled with a non-serial coupon ID and displayed a web address linking to the survey website [17].

Interview data collection

The self-administered questionnaire was short and covered basic demographics, personal network size (used to inform sampling weights), recruiter-recruit relationship, cyberspace usage, HIV service uptake, and HIV-related risk behaviors. Pre-programmed data checks and skip patterns were embedded. An attention filter question was inserted in about the middle of the questionnaire (i.e., a question informing the recruit that this question probes whether he pays attention and asking him to select a specific response value). Time points at which sentinel events occurred were recorded for documentation and monitoring.

Data analysis

RDS Analyst [18] software was used to derive weighted estimates adjusting for the complex sampling design using the Gile's SS estimator and a national MSM size estimate of 588,000 (source: AIDS Epidemic Model, Thailand data sheet). We conducted a univariate analysis, stratified by age or other characteristics as needed.

Biomarkers

Following interview completion, participants in Bangkok only were also offered to attend 1 of 10 routine health clinics of their choice for a blood draw. A venous blood sample would be tested for HIV serology (using the prevailing HIV rapid test algorithm), HIV recency, hepatitis B and C, and syphilis. At the clinic, recruits were to present their phone number and undergo in-person consenting at the clinic.

Ethics statement

The survey protocol was approved by the Ethical Review Committee of the MOPH, and was approved by the

CDC in Atlanta, USA. Informed consent was obtained electronically separately for the interview and biomarker testing. A copy of the consent could be downloaded by the participant. Personal identifiers, including cell phone numbers and IP addresses, were collected and converted to unique anonymous codes. All records were labeled using the eCoupon ID number. Participants could call survey staff with questions. At the clinic, recruits were to be pre- and post-test counseled and as warranted initiated on HIV PrEP or treatment, as well as provided treatment or care for syphilis and viral hepatitis as per MOPH guidelines. Recruits were compensated for survey enrolment and interview (USD 8.8), peer recruitment (USD 4.4) for each successfully recruited peer, up to a maximum of USD 8.8, and biomarker collection at a clinic (USD 14.7).

Survey costs

The costs for preparing and implementing the webRDS survey included meetings and consultations to design the survey and develop the protocol, create the Kai Noi website, graphic design, hardware equipment, training, testing, server rental fees, volunteer compensation, online advertising, and compensation paid to survey participants, resulting in total costs of USD 36,046 or USD 22 per participant (N=1,643).

Results

Sampling

The *Kai Noi* survey was implemented from February to June 2022. 673 self-selected online candidate seeds volunteered to initiate the eligibility screening; of these, 390 (57.9%) were deemed ineligible and a further 248 (36.8%) did not complete the eligibility interview. The remaining 35 (5.2%) candidates were eligible and all consented to enroll. We initiated peer-recruitment with 21 of the 35 candidate seeds and added the remaining 14 seeds during the sampling period. Of the 35 seeds, 13 (31.1%) successfully recruited at least one peer, the remaining 22 did not successfully recruit any eligible peers.

Each seed and recruit were issued three eCoupons for peer recruitment. Of 6,207 eCoupons issued, 3,000 (45.1%) were redeemed. The mean time between eCoupon issuance and redemption was 9.7 hours (standard deviation = 32.7). A further 1,008 eCoupons were presented that had already been redeemed and were therefore deemed invalid; in addition, 243 eCoupon IDs logged in by candidate participants were deemed invalid as they never had been issued. Almost half (48%) of candidate recruits logged into the survey website between 5:00 p.m. and 11:59 p.m (GMT+7).

A total of 2,578 candidate recruits (including seeds) with valid eCoupons and unique phone numbers were admitted to screening for eligibility, of which 136 (5.3%) were deemed ineligible due to reasons related to sex or gender (36.1%), age (5.9%) or lack of recent same sex behavior (58.0%); a further 291 (11.3%) did not complete the eligibility screening questionnaire. The remaining 2,151 (83.2%) were deemed eligible. Of these, 2,142 (99.6%) agreed to participate, and of these, 2,067 (96.5%) completed the questionnaire. During the sampling period, survey staff noticed potentially fraudulent behavior, confirmed it, and subsequently identified 318 survey records as repeat enrolments and hence fraudulent. These records, along with their redeemed and unredeemed eCoupons were removed from the analysis, leaving 1,749 valid survey records. The mean social network size (based on having been in contact with known and likely eligible peers within the last seven days) among enrolled survey participants was 2.3, with an interquartile range of 1 to 3. We excluded 103 records stemming from participants who did not pass the main interview's attention filter question, leaving a final sample size of 1,643 for the main interview data analysis. This sample restriction did not apply to the eligibility screening data (sex, age, residence, same-sex sexual behavior) which was

administered separately and prior to the main interview.

Table 1 displays seed-related sampling characteristics. For the sample of 1,749 recruits, the maximum number of waves achieved was 191; with one seed accounting for 1,549 (88.6%) recruits sampled. Recruits were sampled from all 6 regions (Table 3) and from 75 of 77 (97.4%) provinces (data not shown). The frequency distribution of recruits' provincial residences ranged from 0.02% (Pattani) to 8.0% (Bangkok), with an interquartile range of 0.3%-1.9%

Table 1. Seeds, waves, and seed-specific sample sizes, Kai Noi Survey, Thailand, 2022

Seed No.	Age	Degree	Province (Seed)	Max No. waves	No. recruits (Including seeds)	Percentage of sample
1	31	10	Bangkok	18	73	4.2%
4	20	8	Payao	4	18	1.0%
5	36	20	Bangkok	1	3	0.2%
7	22	2	Ratchaburi	3	5	0.3%
12	25	5	Bangkok	1	4	0.2%
13	30	5	Nongbualamphu	15	48	2.7%
14	39	10	Chiang Mai	2	5	0.3%
15	31	5	Chiang Rai	3	12	0.7%
17	19	5	Khon Khaen	191	1549	88.6%
18	31	6	Ang thong	1	2	0.1%
19	47	2	Phetchaburi	1	2	0.1%
28	28	3	Ratchaburi	1	3	0.2%
31	30	14	Nonthaburi	1	3	0.2%
Total (excluding non-productive seeds)					1,727	98.7%
Number of non-productive seeds					22	1.3%
Grand total					**1,749**	**100%**

Figure displays the recruitment tree (N=1,749); figure 2 shows the distribution or survey enrolments across Thailand.

Figure 1. Recruitment tree

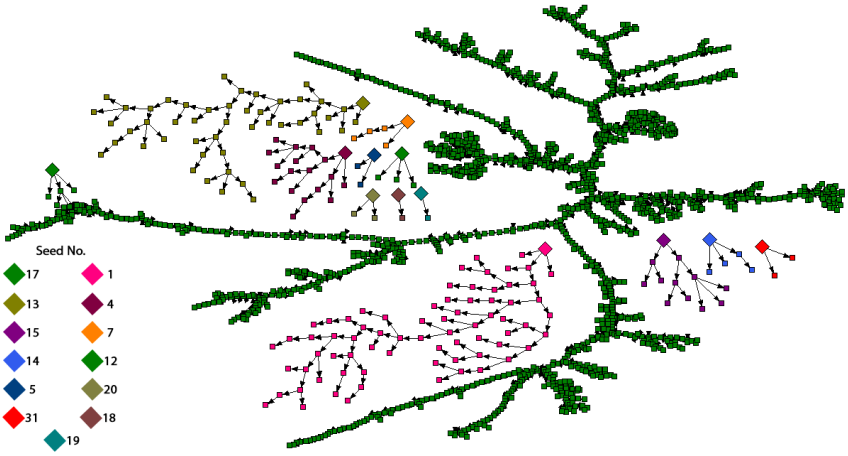
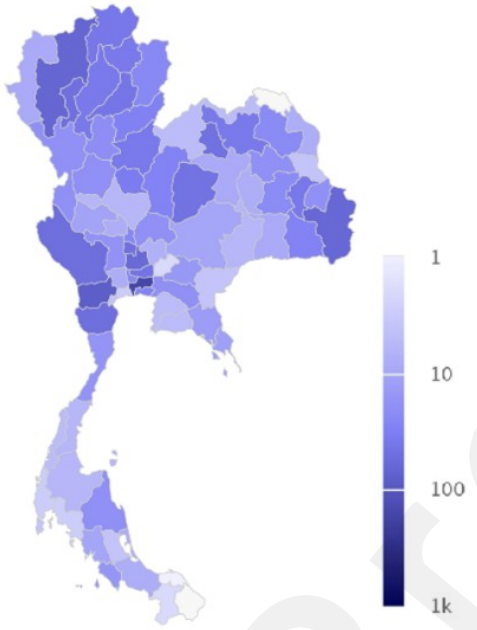


Figure 2. Distribution of enrolments by province (N = 1,749)



Homophily and convergence

Homophily. Table 2 displays homophily by select characteristics. We observed homophily for all four traits examined, with substantial homophily for age, region of residence, and timing of last HIV test. Recruiters were almost twice as likely to recruit peers sharing their age (group), region of residence, or HIV status as expected for random recruitment. There was little homophily for condom use.

Table 2. Homophily by characteristics.

Trait	Categories	Homophily	*P* value
Age	15-19, 20-24, 25-34, 35+ years	1.97	<.001
Residence	Region 1 through 6	1.86	<.001
Timing of last HIV test	Last 12 months, >12 months ago, never	1.98	<.001
Condom use at last sex	Yes, No	1.08	<.001

Convergence. Figures 3-6 displays convergence graphs for select characteristics. Convergence for age and region was reached after approximately 1,000 participants, that for (regional) residence and condom use was seemingly reached earlier. The interpretability of bottleneck graphs was greatly diminished as one seed's recruitment tree accounted for 89% of the total sample, hence no bottleneck graphs are displayed here.

Figure 3. Convergence graphs for age

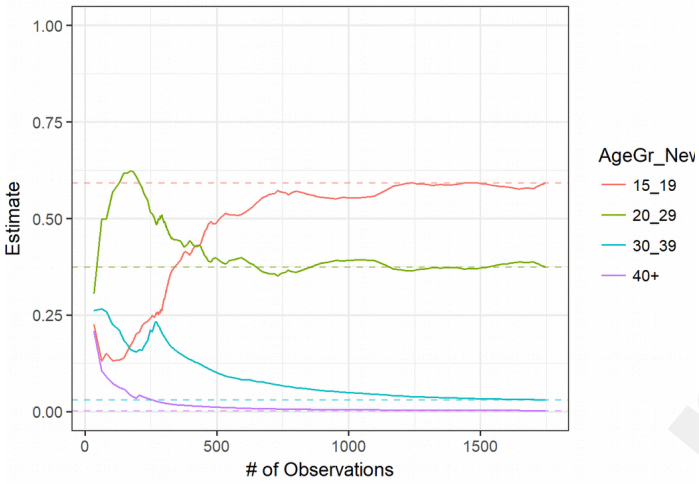


Figure 4. Convergence graphs for HIV Testing

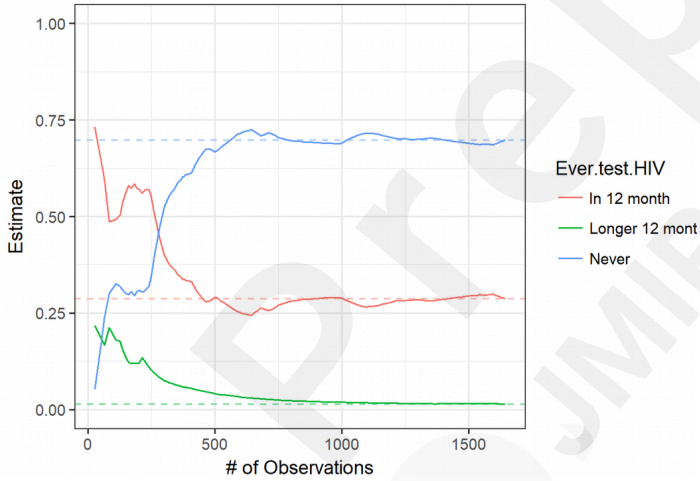


Figure 5. Convergence graphs for condom use at last sex

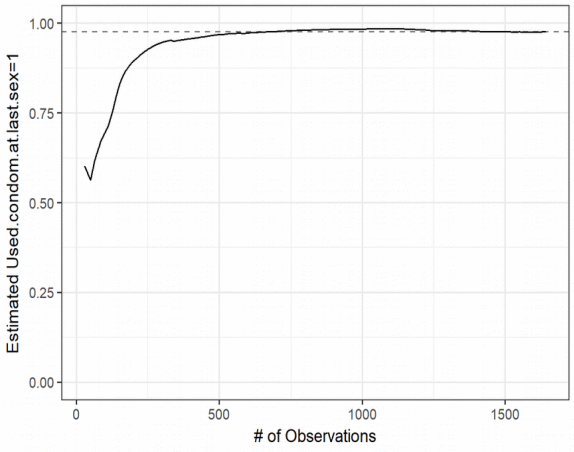
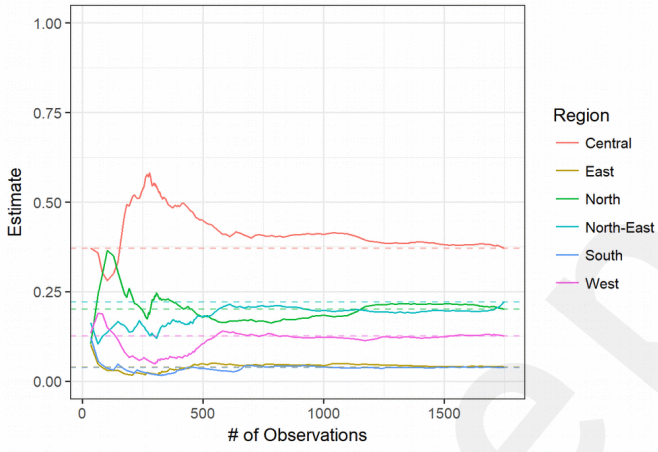


Figure 6. Convergence graphs for region



MSM characteristics

Demographics. Table 3 displays demographic characteristics of MSM Sampling covered all six regions, the mean age was 22.5 years (median: 20, interquartile range: 19-24, range: 15-56). Most had high school education or higher and/or were currently in school. The majority (70.6%) used the internet to find sex or play games; BlueD was the most used social media app (77.6%).

Table 3. MSM characteristics, Kai Noi Survey, Thailand, 2022

Characteristics	Unweighted		Weighted		
	n	%	Point	L95%CI	U95%CI
Sampling by Region. (N=1,749)					
North	336	19.2	20.1	17.4	22.9
Central	653	37.3	37.1	33.5	40.8

North-East	378	21.6	22.2	19.3	25.0
West	220	12.6	12.7	10.4	15.0
East	74	4.2	4.1	3.0	5.1
South	88	5.0	3.8	2.4	5.2
Age distribution. (N=1,749)					
15-19	807	46.1%	59.3%	51.2%	67.4%
20-24	552	31.6%	25.9%	21.4%	30.4%
25-29	315	18.0%	11.5%	8.0%	15.0%
30+	75	14.3%	3.3%	1.45%	5.3%
Highest education (N=1,643)					
No schooling	14	0.9%	0.5%	0.**0**%	1.7%
Secondary school	39	2.4%	2.7%	0.8%	4.5%
High school	1138	69.3%	83.0%	76.4%	89.6%
Diploma	98	6.0%	3.8%	2.3%	5.2%
Bachelor	233	14.2%	6.1%	2.9%	9.3%
Master's and higher	121	7.4%	3.9%	1.3%	6.6%
Work (N=1,643)					
Student	927	56.4%	70.6%	58.3%	82.8%
Employee	320	19.5%	16.9%	9.1%	24.6%
Own business	99	6.0%	2.7%	1.3%	4.1%
Laborer	97	5.9%	3.7%	1.4%	6.0%
Office worker	67	4.1%	2.0%	0.9%	3.2%
Unemployed	60	3.7%	1.3%	0.0%	3.4%
Merchant	35	2.1%	1.0%	0.4%	1.7%
Government employee	18	1.1%	0.7%	0.2%	1.1%
Other	20	1.2%	0.9%	0.4%	1.4%
Reasons to use the internet (multiple choice format)					
To find sex	1,451	88.3%	89.3%	85.9%	92.6%
To sell or buy sex	87	5.6%	1.9%	1.4%	2.4%
To learn about HIV or use HIV services	35	2.1%	0.6%	0.3%	0.9%
To pay or receive money	259	15.8%	16.1%	12.0%	20.1%
To play games	1,006	61.2%	68.1%	61.3%	74.9%
Social app usage (multiple choice format)					
BlueD	1103	53.2%	77.6%	64.6%	90.5%
Grindr	75	3.6%	3.0%	1.2%	4.8%
Hornet	92	4.4%	2.6%	1.4%	3.9%
Jack'd	71	3.4%	2.1%	0.6%	3.5%
Gay Romeo	286	13.8%	9.0%	3.6%	14.4%
Tinder	445	21.5%	16.7%	11.6%	21.8%
Facebook	779	47.4%	39.5%	32.3%	46.6%
Line	555	33.8%	20.8%	14.6%	27.0%

Instagram	417	25.4%	17.0%	13.0%	21.1%
Twitter	494	30.1%	18.5%	14.7%	22.2%

L95%CI: Lower 95% confidence interval; U95%CI: Upper 95% confidence interval. Sample size for age data is 1,749 as age data were collected in the eligibility interview, separate from the main interview with the embedded attention filter question that led to the exclusion of 103 records from the main interview, leading to a final sample size for data analysis of 1,643.

HIV-related behaviors and service uptake (Table 4). Most (76.9%) MSM visited gay-focused venues several times a week, 11.0% had purchased sex from men in the past 12 months, and 4.5% had sold sex to men in the past 12 months. Almost all (95.3%) had more than 2 sex partners in the last 3 months and almost all (97.6%) used a condom at their last sex act. Few (4.0%) had sex with a woman in the last 12 months or had injected drugs in the last 12 months (0.3%). Two thirds (68.9%) had never tested for HIV, almost always out of fear for being stigmatized (97.1%). Current PrEP use was high (89.4%).

Table 4. Risk behaviors and service uptake, Kai Noi Survey, Thailand, 2022

Risk behavior (N=1,643)	**Unweighted**		**Weighted**		
	n	%	Point	L95%CI	U95%CI
Visits to gay friendly venues (e.g., saunas, clubs, bath houses) several times a week	1,095	66.6%	76.9%	70.5%	83.3%
Bought sex from other men (last 12 months)	376	22.9%	11.0%	7.2%	14.8%
Sold sex to other men (last 12 months)	211	12.8%	4.5%	2.7%	6.2%
Two or more male sex partners (last 3 months)	1,555	95.6%	95.3%	93.1	97.5
Condom use at last same sex act	1,554	94.6%	97.6%	95.8%	99.4%
Sex with women (last 12 months)	108	6.6%	4.0%	1.8%	6.2%
Injecting drug use (last 12 months)	8	0.5%	0.3%	0.0%	0.6%
Service uptake					
Timing of last HIV test					
In the last 12 months	675	41.1%	28.7%	11.7%	45.7%
Longer than 12 months ago	54	3.3%	1.5%	0.4%	2.6%
Never tested for HIV	914	55.6%	69.8%	52.1%	87.5%
Reason for never having tested for HIV (n=914)					
Don't feel at risk	40	4.4%	1.6%	0.0	5.7%
Fear of positive result	14	1.5%	0.7%	0.1%	1.3%
No money to get tested	12	1.3%	0.1%	0.0%	0.3%
No time to get tested	16	1.8%	0.4%	0.0%	1.4%
Fear of stigma	832	91.0%	97.1%	91.9%	100.0%
Pre-exposure prophylaxis (PrEP, restricted to those who reported previous HIV negative test result, n=728)					
Have heard about PrEP	676	92.9%	95.6%	88.2%	100.0%
Currently using PrEP	612	90.5%	89.4%	80.1%	98.8%
Among those who not currently using PrEP (n=64)					
Used it in last 6 months	4	6.3%	2.6%	1.2%	3.9%
Used it > 6 months ago	7	10.9%	7.5%	2.6%	12.5%
Never used it	53	82.8%	89.9%	84.7%	95.1%

Among those never used PrEP, main reason: (n=53)					
Don't know about it	1	1.9%	0.3%	0.0%	0.7%
Don't know where to get prep	4	7.5%	5.4%	1.7%	9.1%
Embarrassed to ask for it	3	5.7%	1.6%	0.0%	4.3%
Don't feel at risk	36	67.9%	81.2%	64.9%	97.6%
Afraid of side effects	4	7.5%	4.9%	0.0.%	11.5%
Don't want others to know	5	9.4%	6.5%	0.0%	16.9%

L95%CI: Lower 95% confidence interval; U95%CI: Upper 95% confidence interval.
Only one participant stated that his last test result was HIV-positive (data not shown).

Biomarkers

There were 144 participants who resided in Bangkok. All of these were invited to attend 1 of 10 clinics to provide a blood sample; 82% agreed online to do so. However, no recruit presented at any of the 10 clinics during the survey and no biomarker data were collected.

Discussion

We successfully conducted an online RDS survey among MSM in Thailand, adding to the still small body of literature on web-based probability sampling among key populations. The survey covered virtually the entire country with no region or province dominating recruitment, and reached convergence for salient variables. However, our goal of collecting biomarkers was not achieved and the fraudulent enrolments are a reminder that financial compensation for online data collection may quickly attract fake (duplicate) enrolments.

As seen with other conventional RDS surveys, sampling was dominated by younger, relatively well educated MSM. A large proportion of MSM use the internet to "find" (mostly non-commercial) sex, which suggests that the web may be a useful tool to engage MSM for safe sex and HIV prevention messages. Of potential importance are the estimates for social media apps as these estimates can inform the reach of public health messaging in cyberspace across various apps. The most frequently used app appears to be BlueD, followed by Facebook. The estimated HIV testing uptake was low with less than a third ever having tested for HIV, even considering the age distribution skewed towards younger ages. Still, restricting our analysis to just the four provinces overlapping with the 2020 MSM biobehavioral surveys (Bangkok, Chiang Mai, Chonburi and Phuket) [19], the lifetime HIV testing uptake estimates appear similar (webRDS: 63.8%, BBS: 52.9%). "Fear of stigma" was by far the most frequent reason given for not having tested, an important finding for Thailand's HIV testing services. The low rate of HIV testing is contrasted by high proportions of MSM reporting condom use (at last sex) and PrEP use.

This survey also confirms that many (young) MSM continue to use offline venues such a saunas, bars, and clubs several times a week. HIV risk behaviors were confirmed in several dimensions, including buying and selling sex, as well as having multiple sex partners (for most MSM, three to five partners in the preceding three months). A positive finding was the very high proportion of condomized sex acts (98%).

Several substantial challenges and limitations must be noted, including a very low proportion (n=1) of participants reporting an HIV-positive status which is unlikely for a sample size of 1,643 and suggests that some participants were reluctant to report an HIV-positive status. Convergence for the traits examined was only reached after hundreds of recruits had been sampled, perhaps due to the very large sampling area. Because a single seed accounted for a very large proportion of our sample, we could not assess bottlenecks; at the same time this observation supports the assumption that Thai MSM form a single network. The self-reported degrees were somewhat lower than expected, raising the possibility of inaccuracies. Further, our survey was exposed to fraud, an unsurprising risk given that compensation in RDS surveys is common. Survey staff suspected and eventually confirmed large scale fraud when a participant contacted the survey staff with questions related to compensation that appeared odd to our staff. Over 300 fraudulent enrolments were detected despite multiple security measures to prevent such fraud. From an analysis point-of-view the fraud

cases in our survey represented mostly a loss of funds (paid-out compensation) and, assuming we identified all fraudulent "participants", did not do lasting damage to the data set as we simply removed fraudulent enrolments from the data set for analysis. Further, because (unsurprisingly) none of the fraudulent "recruits" peer-referred valid recruits our data set did not suffer from breaks in the recruitment chains. Online RDS surveys are well advised to maximize anti-fraud measures and to monitor pro-actively to detect fraudulent enrolments. Our national-level survey may mask important differences across localities and hence may not make local surveys redundant. Our biggest limitation is perhaps the failure to collect blood samples from recruits residing in greater Bangkok. The reasons for this are unclear as most participants residing in Bangkok indicated online that they would be willing to present at a clinic, in exchange for additional financial compensation. Alternative designs involving compensation (all-in-one compensation paid only after the blood draw), blood collection (mailing kits for self-collection) or testing (mailing self-tests) should be evaluated. Of note, our survey was launched during the peak period of COVID-19 transmission in Thailand. The number of persons testing for HIV at the same 10 Bangkok sites as in our survey decreased from 82,054 in 2020 to 60,124 in 2022 during the 5th wave of Omicron COVID-19 [20].

The strengths of our survey included a fully automated RDS system that fulfilled all essential functions of a "brick-and-mortar" RDS survey office, including checking coupon validity, eligibility screening, consent, interview, coupon issuance, peer recruitment training, and compensation, promising and delivering efficiency and resource savings. The online design also facilitated a sampling process that covered the entire country. The code for our webRDS system is available from the investigators and can be re-deployed with minimal preparatory effort within Thailand, i.e., can easily be adapted for other target populations. The code could also be used outside Thailand assuming IT expertise is available to adapt the survey to a different geographic setting.

While the upfront coding work to construct a virtual RDS office can be substantial, other tasks in survey preparation become obsolete such as securing physical survey office space or may pose substantially smaller burden such as the number of staff or computer and other hardware equipment needed.

The need for key population-specific population-level estimates will keep increasing as countries monitor their progress towards equitable HIV epidemic control. With internet usage becoming more ubiquitous, there is potential for webRDS surveys to help fill these data needs. More operational research is needed though in refining online RDS methods, including fraud prevention and detection, facilitating a more age diverse sample, and bridging the online-offline gap in collecting biomarker data.

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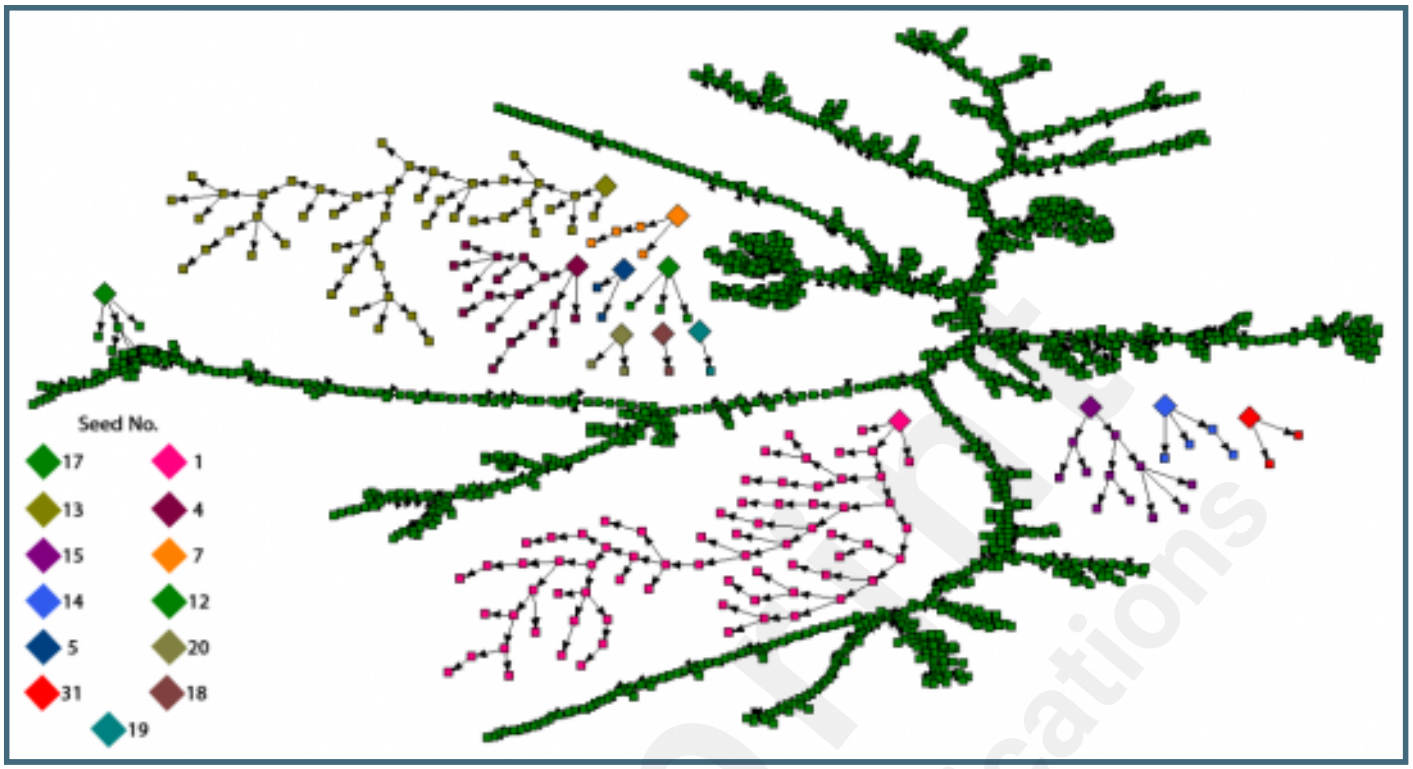
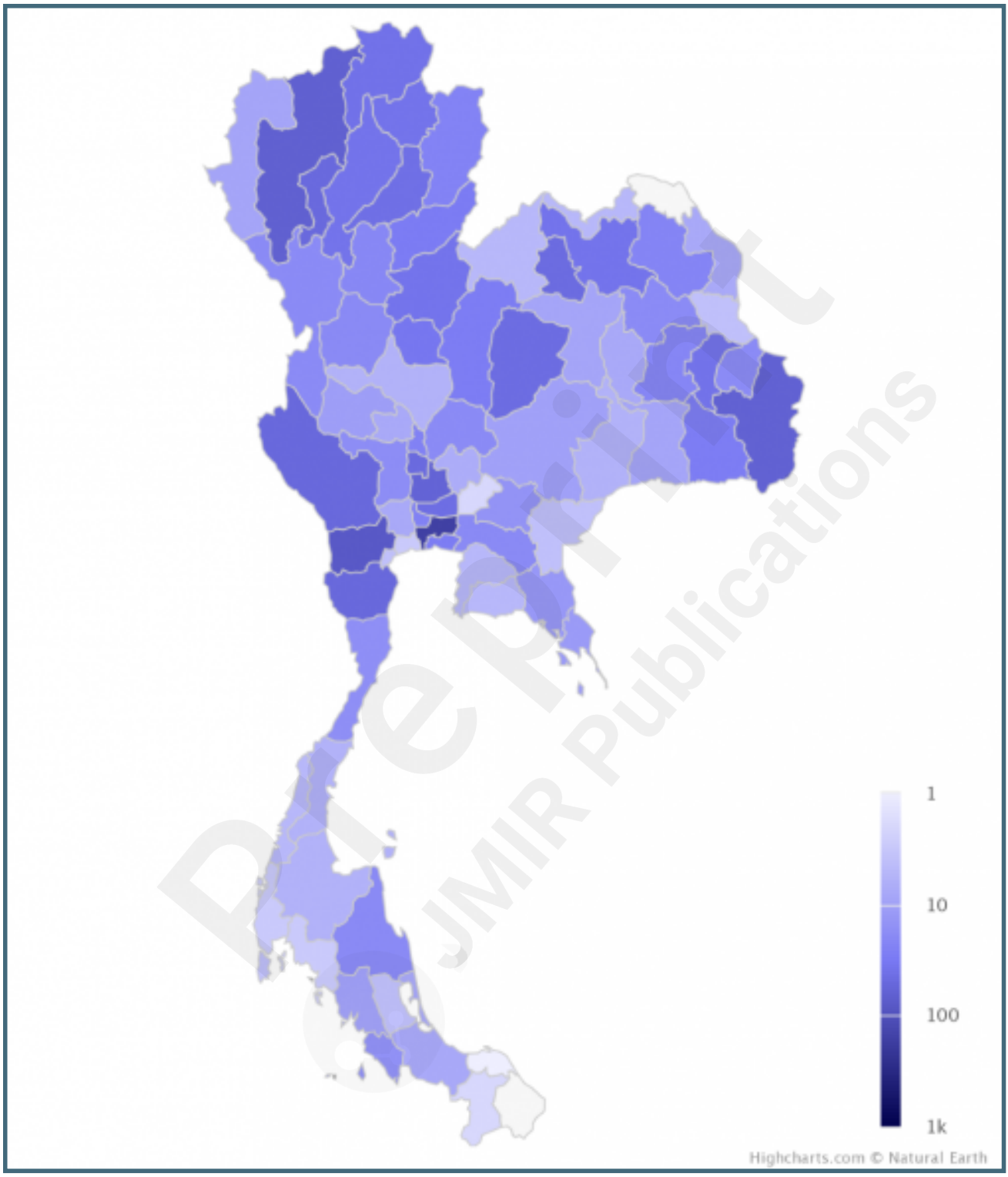
Supplementary Files

Figures

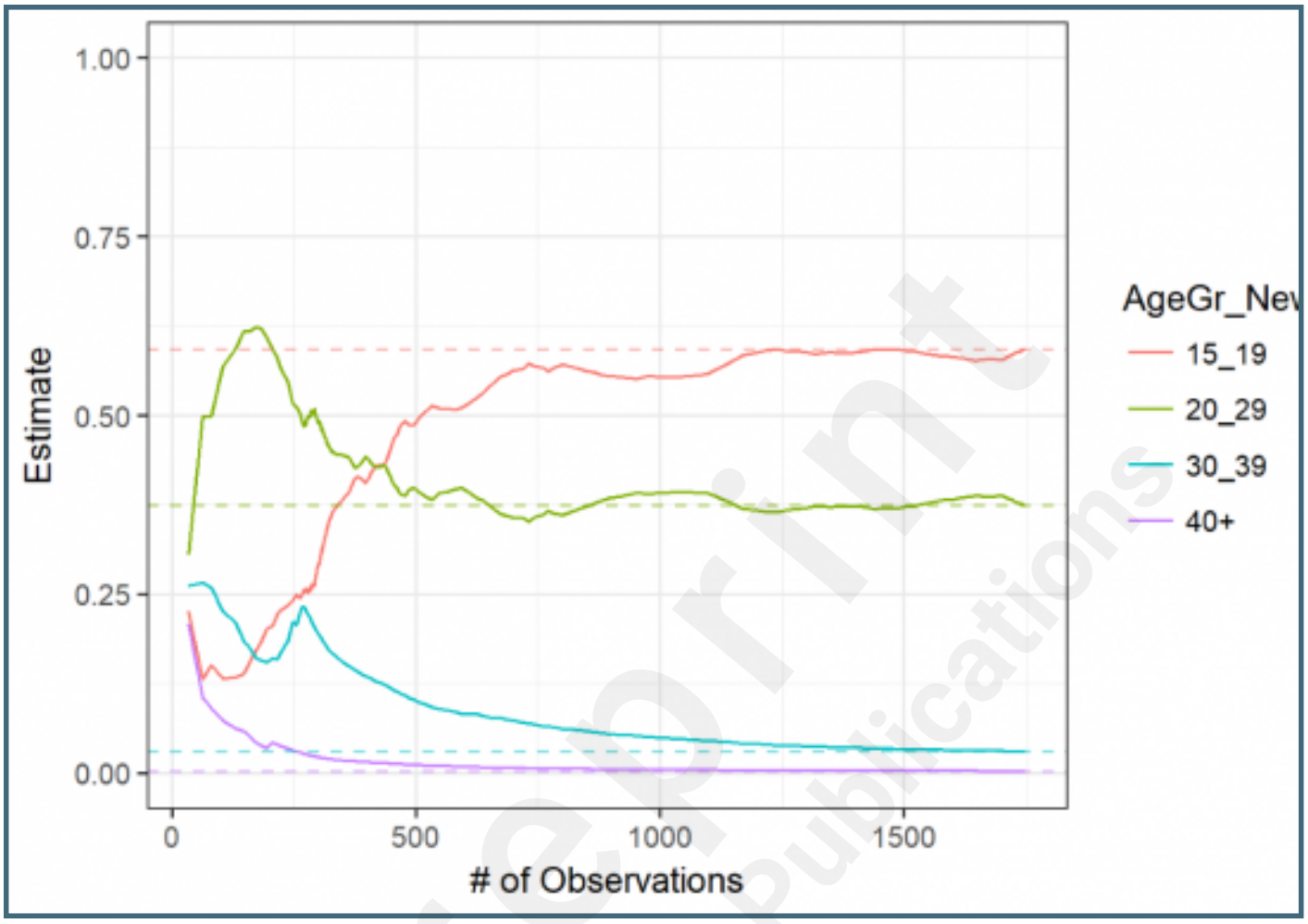
Recruitment tree.



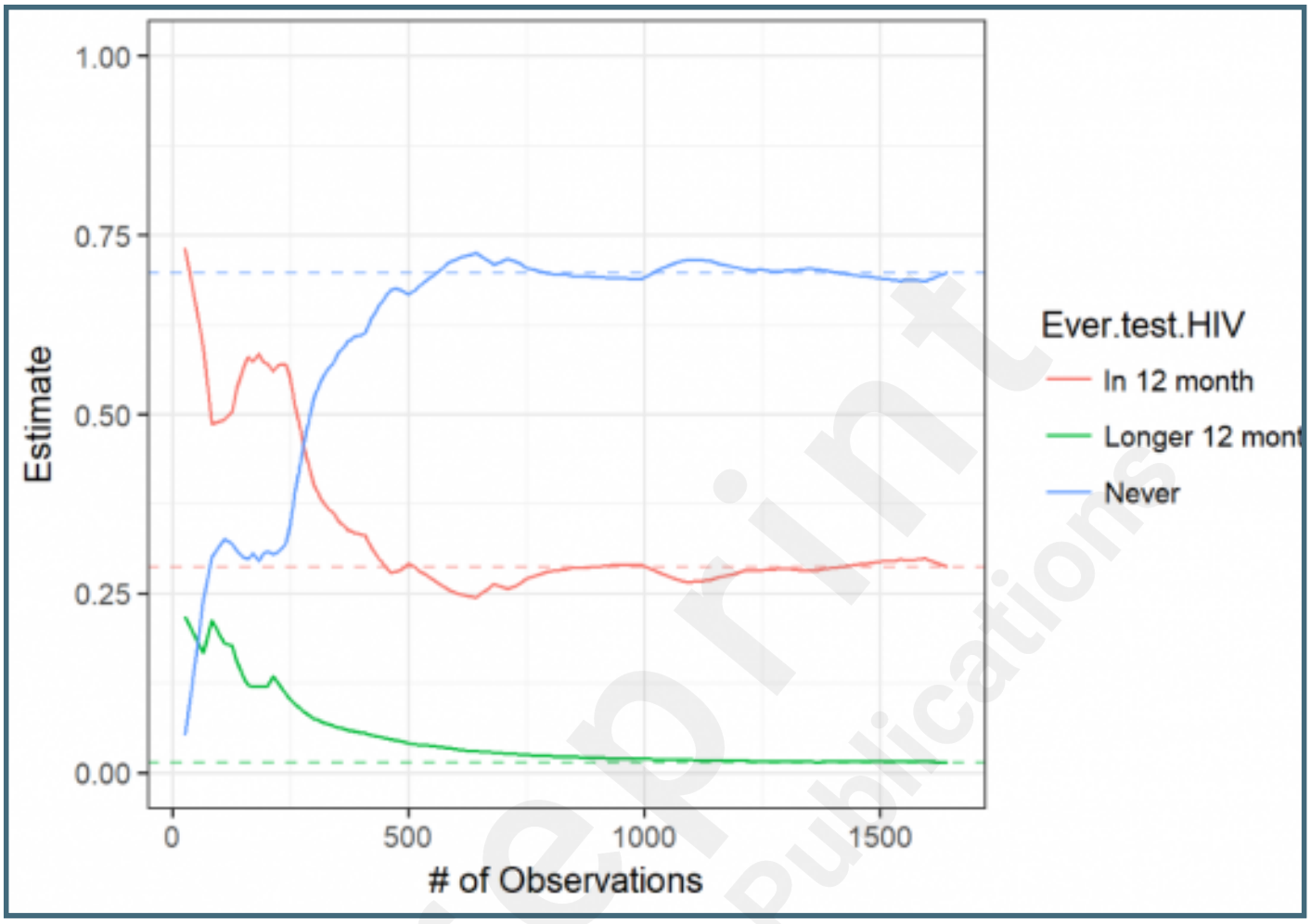
Distribution of enrolments by province.



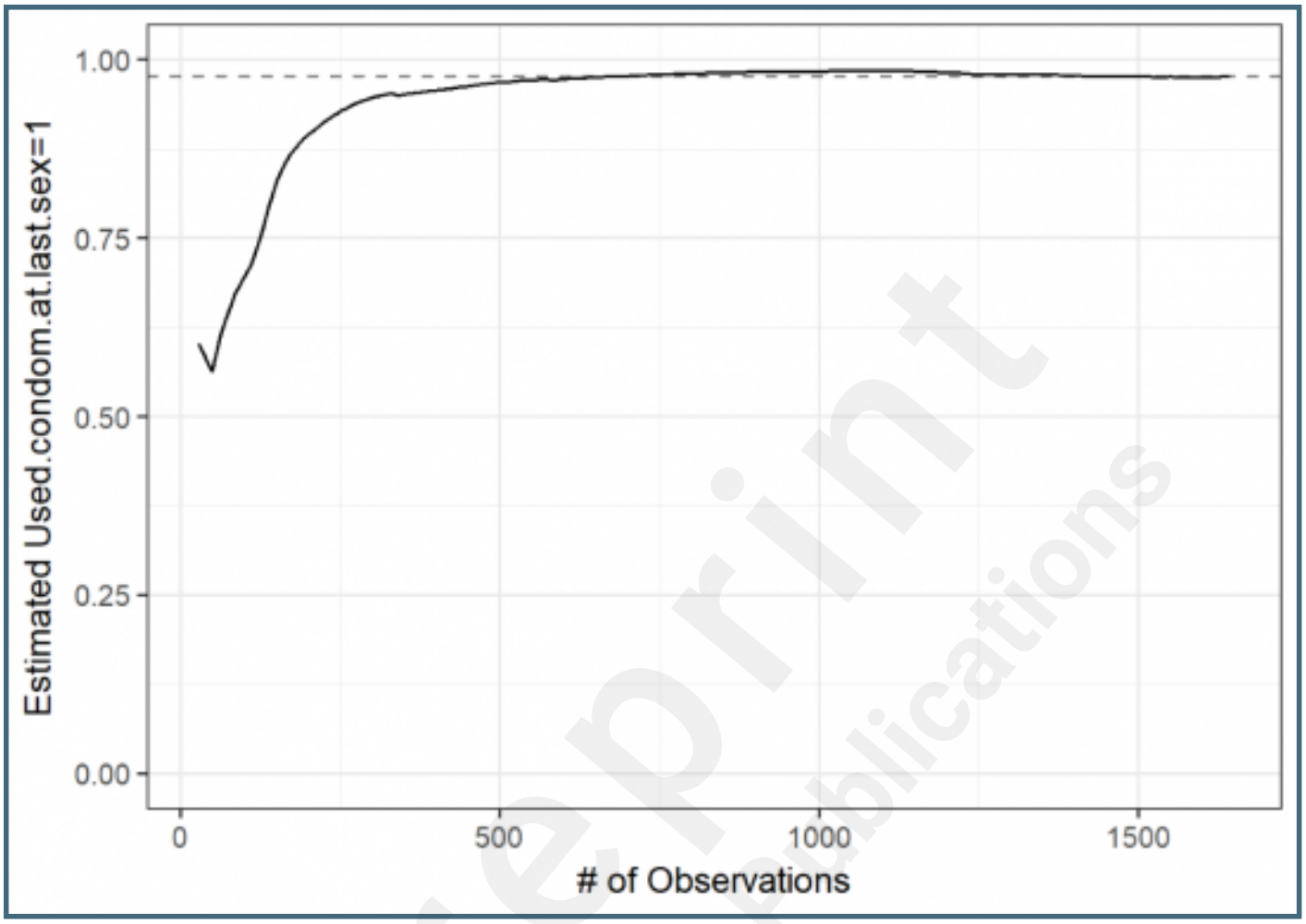
Convergence graphs for age.



Convergence graphs for HIV Testing.



Convergence graphs for condom use at last sex.



Convergence graphs for region.