

Population Size Estimation of People Who Inject Drugs: An Overview of Methodologies

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Overview

This guidance provides an overview of methodologies for estimating the size of the population of people who inject drugs (PWID) and is primarily intended for local health departments, academia, and other community-based organizations. Local harm reduction or syringe service programs (SSPs) should be considered as partners due to their direct connection to the population. Recent estimates suggest that at least 0.24% to 0.59% of the 2012-2016 US adult population injected drugs in the past year, or between 600,000 and 1.2 million people, although this number is likely an underestimate.¹ In addition, the number of PWID varies geographically based on urbanicity, region of the US, and other factors.² Obtaining an accurate count of population sizes is important for the distribution of public health resources. However, a census of the general population is difficult and expensive, and it is generally not feasible for so-called “hard-to-reach” or “hidden” populations who may experience stigma, criminalization, and discrimination based on behaviors or identities, such as for PWID. This document provides an overview of the different methods and considerations for estimating the size of the population who injects drugs. Programs intending to estimate the size of a population who injects drugs should consider partnering with health departments or academic institutions, or reaching out to the [National Harm Reduction Technical Assistance Center](#)³ for additional expertise and support.

What are the benefits of population size estimation?

Population size estimates are essential to inform public health response planning and resource allocation, as well as for monitoring and evaluating program outcomes and impact. For example, knowing the size of a population within different geographic areas can help local, state, and national public health agencies understand the scale of the response required to ensure adequate availability of services needed to prevent or treat HIV infection. Population size estimates can enable local jurisdictions to monitor progress toward service coverage goals, for instance, by estimating the proportion of people who use drugs accessing syringe services programs (SSPs) and the annual number of syringes provided per person who injects drugs. It also helps programs to monitor the prevalence of health outcomes that disproportionately impact people who inject drugs (e.g. new HIV or hepatitis C virus [HCV] diagnoses). For example, a recent analysis used population size estimation methods to determine that 7,400 (or 51%) HCV cases were not captured in San Francisco’s HCV surveillance case registry.⁴ Lastly, population size estimates can benefit the people who comprise the target population itself; these estimates can be used as an advocacy tool to demonstrate the existence and magnitude of any public health problem to policy makers and funders.

¹ Bradley et al., “Use of Population-Based Surveys for Estimating the Population Size of Persons Who Inject Drugs in the United States.”

² Rosenberg et al., “A Standardization Model for Estimating Populations of Persons Who Inject Drugs in US States, 2017.”

³ <https://harmreductionhelp.cdc.gov/>

⁴ Facente et al., “Estimated Hepatitis C Prevalence and Key Population Sizes in San Francisco: A Foundation for Elimination.”

How do I estimate the size of a population?

1. Define the **Target Population**:

- **Who:** What specific characteristics, identities, or behaviors define the target population? For example, does your target population include people who have injected drugs in the past 3 months, in the past 6 months, in the past 12 months, or people who had *ever* injected drugs? If the goal of population size estimation is to identify people who currently inject drugs for SSP monitoring and evaluation, it is recommended to ask about recent injection drug use (i.e. within the last 3 or 6 months). It is also important to determine the age range of your target populations, for example, by considering if you are interested in adult PWID age 18 and older or if you also want to include adolescents age 12 and up.
- **Where:** What geographic area are you estimating the population size for? The geographic region should approximately reflect the geographic region within which program services are provided (e.g. city/town, county, or metropolitan-statistical area [i.e. a city and the surrounding communities that are linked by social and economic factors])
- **When:** During what calendar time period are you estimating the population size (e.g. months or years during which data were or will be collected)?
- **Why:** Knowing why you are estimating population size, whether for advocacy purposes, funding, or to measure program outcomes, can serve as a check on whether you've chosen the most useful parameters in defining your target population.

2. Gather and review any previous local population size estimates for PWID, as well as local methods used to estimate the size of other key populations (e.g., men who have sex with men, sex workers).
3. Choose one or more method for population size estimation (see Table).
4. Conduct data collection and/or request data from an existing source (e.g. from service providers if using the Multiplier Method). Keep documentation of the methods, data, and assumptions used during the population size estimation process.
5. Analyze data to estimate the number of people in the target population.
6. Disseminate methods and results and solicit feedback on your estimates from the stakeholders and member of the population.

Overview of PWID Population Size Estimation Method

A gold standard method for population size estimation does not exist.⁵ The table below provides an overview of existing methods, which generally fall into two categories: (A) methods that survey the *general population* (e.g. the overall population of adults living in a jurisdiction), and (B) methods that survey the *target population*.

⁵ UNAIDS/WHO Working Group on Global HIV/AIDS and STI Surveillance, "Guidelines on Estimating the Size of Populations Most at Risk to HIV"; Abdul-Quader, Baughman, and Hladik, "Estimating the Size of Key Populations."

Table 1. Overview of PWID Population Size Estimation Methods

Name of Method	Description	What data are required?	Pros & Cons	Resources
A. Methods that Survey the General Population				
<i>Population-based Survey Methods</i>	<p>This method uses existing data from surveys of the general population that asks whether they are members of the target population.</p> <p>This method estimates the percentage of the general population that injects drugs. This estimate can then be multiplied by the total population size of the jurisdiction (for example 0.59% × 209 million adults in the US) to obtain an estimated <i>count</i> of PWID.</p>	A population-based survey that is representative of the general population.	<p>Pros</p> <ul style="list-style-type: none"> • Uses existing data sources • Calculation for the population size estimate is simple • Has been previously used with PWID populations <p>Cons</p> <ul style="list-style-type: none"> • Few population-based surveys ask questions about injection drug use • Vulnerable to response-bias/underreporting of injection drug behaviors due to stigma and criminalization • Vulnerable to sampling bias since many of these surveys exclude populations who are experiencing homelessness or incarceration, living in shelters or group homes, or who do not have telephones • May not have sufficiently large samples sizes for smaller geographic areas to obtain reliable estimates 	6

⁶ Bradley et al., “Use of Population-Based Surveys for Estimating the Population Size of Persons Who Inject Drugs in the United States”; Oster et al., “Population Size Estimates for Men Who Have Sex with Men and Persons Who Inject Drugs.”

<p><i>Network Scale-up Methods</i></p>	<p>This method uses a survey of the general population that asks whether <i>their acquaintances</i> are members of the target population. This method is based on the assumption that people’s social networks reflect the general population sampled in a survey.</p>	<p>Requires a sample of the general population that asks two questions:</p> <ol style="list-style-type: none"> 1. Ask questions that estimate each participant’s individual social network size 2. Ask how many people they “know” in the target population 	<p>Pros</p> <ul style="list-style-type: none"> • Has been previously used with PWID populations • Reduces social desirability bias because this method doesn’t directly ask participants if they inject drugs, rather, it asks how many other people they know who inject drugs <p>Cons</p> <ul style="list-style-type: none"> • Often requires new data collection • Can be resource intensive • PWID may not be a “visible” population because injection drug use is stigmatized and people may not disclose their injection use to acquaintances • Requires advanced statistical methods 	<p>7</p>
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B. Methods that Survey the Target Population

<p><i>Sample-Resample</i></p>	<p>This method is typically referred to as “capture-recapture” in the scientific literature due to its origins in ecology for estimating wildlife population sizes. We use “sample-resample” in this guidance as a more accurate</p>	<ul style="list-style-type: none"> • Two independent data sources of the target population. Data sources are considered <i>independent</i> of each other if they are separate, unrelated, and data collection from one 	<p>Pros</p> <ul style="list-style-type: none"> • Calculation for the population size estimate is straightforward • Can use simple survey methods, such as a point-in-time survey • Has been previously used with PWID populations 	<p>8</p>
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⁷ Nikfarjam et al., “National Population Size Estimation of Illicit Drug Users through the Network Scale-up Method in 2013 in Iran”; Maghsoudi et al., “Network Scale-up Correction Factors for Population Size Estimation of People Who Inject Drugs and Female Sex Workers in Iran.”

⁸ Allen et al., “Estimating the Number of People Who Inject Drugs in a Rural County in Appalachia”; Ruiz, O’Rourke, and Allen, “Using Capture-Recapture Methods to Estimate the Population of People Who Inject Drugs in Washington, DC”; Leclerc et al., “Estimating the Size of the Population of Persons Who Inject Drugs in the Island of Montréal, Canada, Using a Six-Source Capture-Recapture Model”; Jarlais et al., “Using Dual Capture/Recapture Studies to Estimate the Population size of Persons Who Inject Drugs (PWID) in the City of Hai Phong, Vietnam.”

<p>description of how this method is used in human populations.</p> <p>This method compares the number of people in the target population from two different sources. The population size is inversely related to the degree of overlap between the two samples (e.g., more overlap indicates smaller population size).</p>	<p>source does not influence data collection in the second source.</p> <ul style="list-style-type: none"> • A way to assess overlap between the two data sources. This often includes a survey question that asks if the survey respondent participated in the other data source. For example, some studies distribute an identifiable “token” (e.g., a backpack or lighter with the study logo) during the first sample and ask participants in the second sample if they received the original token. 	<p>Cons</p> <ul style="list-style-type: none"> • Always requires new data collection • Can be resource intensive • Very sensitive to sampling bias 	
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<p><i>Multiplier Method</i></p>	<p>This is a more general form of the sample-resample method.</p> <p>The population size estimate is the target population count from the sample phase (often a service provider or other existing data source) divided by the proportion of the target population found in the resample phase.</p>	<p>Two independent data sources:</p> <ul style="list-style-type: none"> • A count or list of people within a target population who use a service during a specific time period. For example, people who use a clinic or a SSP. The list of people does <i>not</i> need to be identifiable. • Representative survey of the target population that can determine the proportion of people who accessed that above service during the same time period. <p>For example, to determine the overlap between a sample of SSP clients and an independent sample of PWID from a community survey, this survey would ask participants if they were a client of the SSP.</p>	<p>Pros</p> <ul style="list-style-type: none"> • Calculation for the population size estimate is straightforward • Can use simple survey methods, such as a point-in-time survey • Can increase accuracy through the use of multiple data sources • The first data source (e.g., a service provider) does not need to be a representative sample • Has been previously used with PWID populations <p>Cons</p> <ul style="list-style-type: none"> • Often requires new data collection • Can be resource intensive • Very sensitive to sampling bias 	<p>9</p>
<p><i>Respondent-driven Sampling Methods</i></p>	<p>These are also called <i>successive sampling</i> population size</p>	<p>This requires a single respondent-driven sampling</p>	<p>Pros</p>	<p>10</p>

⁹ Chen, McFarland, and Raymond, “Estimated Number of People Who Inject Drugs in San Francisco, 2005, 2009, and 2012,” December 1, 2016; Wesson, Mirzazadeh, and McFarland, “A Bayesian Approach to Synthesize Estimates of the Size of Hidden Populations: The Anchored Multiplier”; Wesson et al., “Estimating the Population Size of Transgender Women in San Francisco Using Multiple Methods, 2013”; Larney et al., “Estimating the Number of People Who Inject Drugs in Australia.”

¹⁰ Chen, McFarland, and Raymond, “Estimated Number of People Who Inject Drugs in San Francisco, 2005, 2009, and 2012,” December 1, 2016; Wesson et al., “Estimating the Population Size of Transgender Women in San Francisco Using Multiple Methods, 2013”; Handcock, Gile, and Mar, “Estimating Hidden Population Size Using Respondent-Driven

	<p>estimation (SS-PSE) methods. This method uses complex statistical analyses based on network theory and uses data collected via chain-recruitment through a social network of PWID.</p>	<p>survey. This is a form of snowball sampling in which survey participants are incentivized to recruit other participants from within a population.</p>	<ul style="list-style-type: none"> • Can provide unbiased estimates • Has been previously used with PWID populations <p>Cons</p> <ul style="list-style-type: none"> • Often requires new data collection • Can be resource intensive • Subject to bias based on initial “seed” participants (first participants selected to complete the survey) • Requires advanced statistical methods • Only valid if respondent-driven sampling assumptions are satisfied 	
<p><i>Wisdom of the Crowds</i></p>	<p>This method asks members of the target population to guess the total population size.</p>	<p>Requires a representative sample of the target population.</p>	<p>Pros</p> <ul style="list-style-type: none"> • Calculation for the population size estimate is straightforward • Has been previously used with PWID populations <p>Cons</p> <ul style="list-style-type: none"> • Requires new data collection • Is not empirical and does not obtain reliable or accurate population size estimates 	<p>11</p>

Sampling Data.”; Handcock, Gile, and Mar, “Estimating the Size of Populations at High Risk for HIV Using Respondent-Driven Sampling Data.”; Wu et al., “Using Data from Respondent-Driven Sampling Studies to Estimate the Number of People Who Inject Drugs: Application to the Kohtla-Järve Region of Estonia.”

¹¹ Chen, McFarland, and Raymond, “Estimated Number of People Who Inject Drugs in San Francisco, 2005, 2009, and 2012,” December 1, 2016.

What are some considerations for choosing a method and getting started?

The population size estimation methods discussed in the previous section vary significantly in their feasibility for smaller geographies, resource requirements (e.g. for collecting new data), sources of bias, and statistical expertise required.¹² However, the quality of (and thus the usefulness of) estimates improves by using empirical methods and multiple high-quality data sources. Above, we described the steps for conducting population size estimation. Below are a few key considerations for programs to consider in choosing a feasible approach and improving the accuracy and reliability of population size estimates.

1. Partner with health departments or academic institutions as well as members of your local community of people who inject drugs. Programs should consider partnering with health departments, academic institutions, and local and/or state HIV planning groups. These partners may be able to provide expertise and support with accessing data sources, designing and implementing studies, and data analysis and statistical methods. Some data can be difficult to access without partnerships, and some may require a lengthy approval process. In addition, it is critical to collaborate and partner with the population whose size you are trying to estimate. Partnering with members of the local community of people who use drugs is important at all stages of planning and implementation and is crucial for obtaining valid estimates.

2. Determine if your program has the resources to conduct a survey and collect new data. If yes, consider points 3-5 below when choosing your method and designing the study. Otherwise, consider using previously published population size estimates to approximate the population size within your geographic area (see example from King County, Washington below). The most robust estimates of PWID population size that have been published as of September 2021 include:

- **Metropolitan-Statistical Area-level estimates:** Tempalski et al. (2013) *Trends in the population prevalence of people who inject drugs in US metropolitan areas 1992-2007*. Available at: <https://doi.org/10.1371/JOURNAL.PONE.0064789>
- **State-level estimates:** Rosenberg et al. (2019) *A Standardization Model for Estimating Populations of Persons Who Inject Drugs in US States, 2017*. Available at: <https://www.inhsu.org/resource/a-standardization-model-for-estimating-populations-of-persons-who-inject-drugs-in-us-states-2017>
- **National-level estimates, with subgroup estimates by age, race, and male/female categories:**
 - Bradley et. al (2020) *Use of Population-Based Surveys for Estimating the Population Size of Persons Who Inject Drugs in the United States*. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8176905/>
 - Lansky et al. (2014) *Estimating the number of persons who inject drugs in the united states by meta-analysis to calculate national rates of HIV and hepatitis C virus infections*. Available at: <https://doi.org/10.1371/JOURNAL.PONE.0097596>

¹² Wesson, Reingold, and McFarland, “Theoretical and Empirical Comparisons of Methods to Estimate the Size of Hard-to-Reach Populations: A Systematic Review.”

3. Use consistent language across surveys to ask about the target population. For example, if you ask about injection drug use behaviors *in the past 6 months* on one survey, make sure you specify the same time frame in all surveys. If possible, use exactly the same question across all data sources. For example: “In the past 6 months, have you injected any drugs other than those prescribed for you?” See Box 1 for another example of a standardized question that is asked on the National HIV Behavioral Surveillance (NHBS) System and other federal surveys. The NHBS question first asks about ever injection drug use, and the second question asks about the most recent time a participant injected drugs in order to identify people who recently injected or currently inject drugs.

Box 1. Example Survey Question About Injection Drug Use from the National HIV Behavioral Surveillance System

Have you ever in your life shot up or injected any drugs other than those prescribed for you? By shooting up, I mean any time you might have used drugs with a needle, either by mainlining, skin popping, or muscling.

- Yes
- No
- I don't know
- Refuse

When was the last time you injected any drug? That is, how many days or months or years ago did you last inject?

4. Understand the uncertainty and potential sources of bias in population size estimates.

Underestimates of population sizes are common. This is especially true for populations that experience stigma and criminalization, both of which create challenges in reaching populations through surveys (e.g. if people don't have access to phones or the internet), barriers to accessing services, or because people may be less likely to report certain behaviors. Notably, most population-based surveys exclude people who are homeless or unstably housed, as well as people living in institutions (such as shelters, hospitals, or the carceral system); therefore, estimates from these types of surveys underestimate the number of people who inject drugs. In addition, the fundamental assumption for the multiplier and sample-resample¹³ methods is that participation in one sample is not associated with the likelihood of participating in the other sample. Violations of this assumption will result in over/under estimates of populations size. For example, if participating in one sample is positively associated with participating in the second sample, then the methods will underestimate the population size; conversely, if participating in one sample is negatively associated with participating in the second sample, then the methods will overestimate the population size. Wesson et al. provides a detailed review of common sources of bias and statistical adjustment methods that can be applied to each population size estimation method.¹⁴

5. Use multiple methods and data sources. Using multiple methods and data sources is one way to understand and quantify the uncertainty in the different population size estimates. For example:

- Sample-resample and multiplier methods are vulnerable to sampling bias. However, it is often relatively low-cost to include multiple data sources (e.g. a 3-source sample-resample) and

¹³ This method is typically referred to as “capture-recapture” in the scientific literature due to its origins in ecology for estimating wildlife population sizes. We use “sample-resample” in this guidance as a more accurate description of how this method is used in human populations.

¹⁴ Wesson, Reingold, and McFarland, “Theoretical and Empirical Comparisons of Methods to Estimate the Size of Hard-to-Reach Populations: A Systematic Review.”

multiple service providers (e.g. more than one clinic, syringe services program, or outreach program) to improve estimates.

- Planning both a point-in-time survey and a respondent-driven sampling survey would allow for up to three different methods to be used: sample-resample, multiplier, and respondent-driven sampling methods.

What existing data sources are available?

Potential local data sources that could be used for the multiplier method and population-based survey methods include:

- Local surveys of people who inject drugs, including point-in-time surveys conducted at syringe service programs.
- Local hospital or clinical records [Note: Injection drug use does not have an administrative code, but there are examples of using other codes in combination. Some clinical settings ask about drug use separately on intake questionnaires].¹⁵
- Local substance use treatment program data, such as methadone clinics.
- Treatment Episode Data Sets (TEDS) on admission and discharges for people undergoing substance use disorder treatment. These data are available through the Substance Abuse and Mental Health Services Administration (SAMHSA) and reported at the state and national level. For more information, visit: <https://www.samhsa.gov/data/data-we-collect/teds-treatment-episode-data-set>
- In addition, consider adding local questions to existing surveys that are conducted within your jurisdiction, such as the **Behavioral Risk Factor Surveillance System (BRFSS)**. For more information, contact the BRFSS office at your state health department: https://www.cdc.gov/brfss/state_info/coordinators.htm

Several national population-based surveys ask questions related to injection drug use.¹⁶ These include:

- **National HIV Behavioral Surveillance (NHBS)**, which conducts a cycle among people who inject drugs every 3 years in 22 urban areas. ZIP code is the smallest geographic unit of analysis NHBS collects. If your program resides within one of the 22 participating urban areas, contact the primary investigator for your local site: <https://www.cdc.gov/hiv/statistics/systems/nhbs/projectareas.html>
- **National Survey on Drug Use and Health (NSDUH)** is an annual survey of people age 12 and older. The survey is unable to provide estimates for smaller geographic areas (e.g. city or county) but does collect information at the state-level and for 406 sub-state regions. For more information, visit: <https://nsduhweb.rti.org/respweb/homepage.cfm>

¹⁵ Janjua et al., “Identifying Injection Drug Use and Estimating Population Size of People Who Inject Drugs Using Healthcare Administrative Datasets.”

¹⁶ Bradley et al., “Use of Population-Based Surveys for Estimating the Population Size of Persons Who Inject Drugs in the United States.”

- **National Health and Nutrition Examination Survey (NHANES)** is an annual survey of adults and children. Data are only available at a national level, and use of smaller geographic units of analysis is restricted. For more information, visit: <https://www.cdc.gov/nchs/nhanes/index.htm>
- **National Survey of Family Growth (NSFG)** is a national survey of “men and women” age 15-49, and is conducted in two-year interview cycles. For data collected after 2011, county is the smallest available geographic unit of analysis. For more information, visit: <https://www.cdc.gov/nchs/nsfg/index.htm>
- **National Epidemiologic Survey on Alcohol and Related Conditions (NESARC)** is a national survey. To date, three waves have been conducted: NESARC-I (2002-2002), NESARC-II (2004-2005), and NESARC-III (2012-2013). Census block is the smallest geographic unit of analysis NESEARC collects. For more information, visit: <https://www.niaaa.nih.gov/research/nesarc-iii>

Examples of Population Size Estimation for PWID

Below are four examples of PWID population size estimations done using a variety of different methods. More information about examples 2, 3, and 4 can be found in the published articles associated with each and cited below.

Example 1: King County, Washington: Population Size Estimation Using Existing Data Sources

In 2014, Public Health—Seattle & King County (PHSKC) estimated the population size of PWID in King County, Washington by applying estimates obtained from two published analyses on the proportion of adults who inject drugs to the 2012 King County population estimate for people age 15-64 years old from the Census Bureau.¹⁷ Below is a brief description of these two published analyses:

- (1) Tempalski et al.¹⁸ estimated the population prevalence of people aged 15 - 64 years who inject drugs in the U.S. overall and in 96 metropolitan statistical areas (MSA) using data from 1992-2007. This analysis used a complex form of the *multiplier method*, in which the authors multiplied by the proportion of drug treatment entrants who injected by the annual number of drug users in treatment, and adjusted this estimate for temporal trends, the annual number of PWID tested for HIV, and incident AIDS cases.
- (2) Lansky et al.¹⁹ conducted a meta-analysis of several population-based surveys (NHANES, NSFG, NSDUH, and the General Social Survey [GSS]) to estimate the proportion of all US adults who had ever injected drugs.

First, PHSKC multiplied Tempalski et al.’s estimate of the prevalence of injection drug use in the past year for the Seattle-Bellevue-Everett MSA (lower estimate 1.02%, upper estimate 2.62%) by the overall population of King County (1,381,551). The midpoint of these two estimates was 25,155 PWID. Second,

¹⁷ Buskin et al., “HIV/AIDS Epidemiology Report, Washington State, Seattle & King County.”

¹⁸ Tempalski et al., “Trends in the Population Prevalence of People Who Inject Drugs in US Metropolitan Areas 1992-2007.”

¹⁹ Lansky et al., “Estimating the Number of Persons Who Inject Drugs in the United States by Meta-Analysis to Calculate National Rates of HIV and Hepatitis C Virus Infections.”

PHSKC multiplied Lansky et al.'s estimate of the lifetime prevalence of injection drug use nationally (2.6%) by the overall population of King County to get a second estimate of 41,830. Third, because Lansky et al. measured *lifetime* injection drug use, rather than *recent* or *current* injection drug use, PHSKC adjusted this estimate to obtain an estimate of *last year* injection drug use. Based on local NHBS data and data from the PHSKC Sexual Health Clinic, they found that the ratio between lifetime injection to injection in the last 12 months to be 2:1. Applying this ratio to the lifetime estimate from Lansky et al, PHSKC estimates that 20,914 people who inject drugs reside in King County, WA. PHSKC used the midpoint of these two estimates as their final population size estimate of 23,000 people who inject drugs.

Example 2: Cabell County, West Virginia: Conducting Sample-Resample Surveys in Rural Settings

In 2015, Allen et al. ²⁰ partnered with the Cabell- Huntington Health Department (CHHD) to estimate the size of the PWID population in Cabell County, a rural community in West Virginia. They defined their target population as people who resided in Cabell County and who injected drugs in the past 6 months.

Two 2-week periods of data collection were defined as the sample and resample periods. The first survey (the “sample” phase) recruited participants who attended Cabell-Huntington Harm Reduction Program (CHHRP). The second survey (the “resample” phase) recruited participants from community locations where people who inject drugs congregated. The authors identified community locations through stakeholder interviews, community engagement, and a geospatial analysis of overdose fatalities that occurred in 2016 in Cabell County. These locations included “public parks, transit locations, green spaces, neighborhoods known for drug-related activities, parking lots (apartments and businesses), gas stations, homeless encampments, on the stoops of abandoned properties, and on sidewalks.” All participants in the “sample” phase received a bright green bag filled with snacks, and the “resample” survey ascertained recounts by asking “Have you ever completed this survey before and received a bright green bag with food in it from the Cabell-Huntington Health Department?”

A total of 797 surveys were completed by participants, among which 395 met the target population definition (residence in Cabell County and injection drug use in the past 6 months). There were 194 unique people who inject drugs surveyed during the “sample” phase, 201 surveyed during the “resample” phase, and 21 participants who completed both surveys. Using these data, Allen et al. estimated the total population size using the following equation:

Box 2

$$\text{Estimated population size} = \frac{\text{Number "sampled"} \times \text{Number "resampled"}}{\text{Number who participated in both surveys}} = \frac{194 \times 201}{21} = 1,857 \text{ PWID}$$

This estimate represents approximately 2.4% of Cabell County's adult population. For additional guidance on sample-resample studies conducted in rural setting, please refer to the *Applying Population Estimation Methods in Rural America* toolkit ²¹ developed by the Johns Hopkins Bloomberg School of Public Health.

²⁰ Allen et al., “Estimating the Number of People Who Inject Drugs in a Rural County in Appalachia.”

²¹ Allen et al., “Applying Population Estimation Methods in Rural America.”

Example 3: Vietnam: Using Dual Sample-Resample Methods for Population Size Estimation

In 2016, Des Jarlais et al.²² partnered with local community-based organizations (CBOs) and peer support groups to estimate the size of the PWID population in Hai Phong, Vietnam. They defined their target population as people who reside in Hai Phong, Vietnam and who currently inject drugs. People were considered to be part of the target population if they had a positive urinalysis for heroin/morphine and skin marks suggestive of recent injection.

The authors used a dual sample-resample method that utilized two “sample” phases, and a single survey for the “resample” phase. The “sample” phase collected data through (i) a respondent-driven sampling (RDS) survey conducted in 2014, and (ii) the distribution of tokens at “hot spots” identified by CBOs where drug users frequently acquired drugs. The “resample” phase collected data through a second RDS survey, conducted one week after the token distribution in 2016. A fingerprint reader was used to identify people who participated in both the 2014 RDS survey (the “sample” phase) and the 2016 RDS survey (the “resample” phase). The tokens (a uniquely marked cigarette lighter) were used to identify individuals who participated in token distribution (the “sample” phase) and the 2016 RDS survey (the “resample” phase).

There were 603 people who participated in the 2014 “sample” RDS survey, 600 tokens were distributed in 2016, and 1,385 people who participated in the 2016 “resample” RDS survey. There were 144 unique people who use drugs who completed both RDS surveys and 152 tokens that were recaptured. Using these data, the authors obtained two estimates the total population size using the following equation:

Box 3

$$\text{Estimated population size (RDS)} = \frac{\text{Number "sampled"} \times \text{Number "resampled"}}{\text{Number who participated in both surveys}} = \frac{603 \times 1385}{144} = 5,800 \text{ PWID}$$

$$\text{Estimated population size (Tokens)} = \frac{\text{Number "sampled"} \times \text{Number "resampled"}}{\text{Number who participated in both surveys}} = \frac{600 \times 1385}{152} = 5,467 \text{ PWID}$$

The authors concluded that approximately 5000 current people who inject drugs (with a plausible range from 4000 to 6000) was a good population size estimate for resource allocation decisions in Hai Phong, Vietnam.

Example 4: San Francisco, California: Population Size Estimation Using Multiplier Methods

Chen et al.²³ used a large number of data sources to estimate the size of the PWID population in San Francisco. The authors primarily used the multiplier method, which is a generalized version of the sample-

²² Des Jarlais et al., “Using Dual Capture/Recapture Studies to Estimate the Population size of Persons Who Inject Drugs (PWID) in the City of Hai Phong, Vietnam.”

²³ Chen, McFarland, and Raymond, “Estimated Number of People Who Inject Drugs in San Francisco, 2005, 2009, and 2012,” December 31, 2016.

resample method. The first phase (the “sample” phase) involved obtaining a count of the number of people who inject drugs who used a specific service (e.g., an SSP) during a specific time period. The second phase (the “resample” phase) involved conducting an independent survey among a population of people who inject drugs to ask if they used that specific service during the defined time period. This method is sometimes referred to as the “service multiplier method.”

For the first “sample” phase, the authors used a variety of sources to obtain counts of PWID who interacted with institutions (e.g. public health, police) or utilized services. These included:

- The number of PWID living with HIV in San Francisco (obtained from HIV surveillance data)
- The number of PWID arrested in San Francisco within the last year
- The number of participants in a San Francisco based study of young PWID
- The number of PWID clients at the Walden House group home located in San Francisco
- The number of PWID who received an HIV/STI test at the municipal STD clinic (i.e. City Clinic)
- The number of emergency room visits that mention injection drug use at San Francisco General Hospital within the last year
- The number of anonymous HIV tests performed for PWID at San Francisco General Hospital within the last year
- The number of applications to and people treated at the Stonewall project (a state-certified drug and alcohol treatment program for gay, bi, trans men and other men who have sex with men who use crystal meth, crack cocaine, powder cocaine, alcohol and/or other drugs) within the last year
- The number of methadone clients at the Bayview-Hunter’s Point clinic within the last year
- The number of overdose visits at Davies Medical Center within the past year

For the second “resample” phase, the authors used data from the National HIV Behavioral Surveillance (NHBS) respondent-driven sampling (RDS) surveys conducted in San Francisco in 2005, 2007 and 2012 to obtain the proportion of survey respondents who used each specific service or had a specific outcome (e.g. the proportion who had been arrested, etc.). This involved adding local questions to the NHBS survey to ask participants about service utilization and specific outcomes. They estimated the total population size using the following equation. For this example, suppose that 350 PWID attended a municipal STD clinic in the past year, and 11% of NHBS participants reported attending the same municipal STD clinic within the same time period:

Box 4

$$\text{Estimated population size} = \frac{\text{Number of PWID who utilized a service}}{\text{Proportion of PWID who reported using the service}} = \frac{350}{0.11} = 3182 \text{ PWID}$$

This study also compared estimates they obtained using the multiplier method with population size estimates from two other methods: wisdom of the crowds and successive sampling. Overall they obtained 5 population size estimates for 2004, 6 estimates for 2009, and 7 estimates for 2012. They took the median of these separate estimates and reported that there were 10,158 people who inject drugs in San Francisco in 2004, 15,554 people who inject drugs in 2009, and 22,500 people who inject drugs in 2012.

I am interested in Population Size Estimation but don't know how to start

Our team at the University of Washington can help support you! We can work with your team to develop your key objectives, a work plan or timeline, assist with trainings, support you during data collection, and provide support for analyzing your data. We can help with a few small things or walk you through the entire process. Our goal is to support your team so you will be able to conduct future surveys on your own. There is absolutely no obligation to share any data you collect with us. However, our team is able to help you analyze and summarize your data, if needed.

Where can I learn more? The [Supporting Harm Reduction Programs \(SHaRP\)](#) team at the University of Washington offers expert technical assistance about harm reduction data and monitoring and evaluation. To reach out to the SHaRP team you can email sharpta@uw.edu

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