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Population Size Estimation of Men Who Have Sex with Men in Georgia, 2018

Study Report
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Table of Contents

<i>Executive summary</i>	5
<i>Introduction</i>	6
<i>Study Objectives</i>	7
<i>Methods</i>	7
Method 1: Network Scale-up	8
Method 2: Multiple Multiplier	13
Method 3: Capture-Recapture based on network sampling.....	15
Method 4: The Wisdom of the Crowd Method.....	17
Method 5: Handcock’s RDS based method	17
Ethical Issues	17
<i>Results</i>	18
Network Scale-Up estimates	18
Socio-demographic characteristics of General population and MSM recruited in IBBS surveys	19
Multiplier population size estimates.....	20
Capture-recapture estimates	21
Wisdom of the Crowd	21
Handcock’s method estimates	22
Data Synthesis and Triangulation.....	22
<i>Discussion</i>	24
<i>Recommendations</i>	27
<i>Annex 1- Survey questionnaires</i>	28
1. NSU questionnaire for Household survey	28
2. NSU bias adjustment questionnaire integrated in IBBS MSM survey	32
3. Unique object Multiplier questionnaire integrated in IBBS MSM survey	35
4. Service multiplier questionnaire integrated in IBBS MSM survey.....	36
5. Web/mobile application use multiplier questionnaire integrated in IBBS MSM survey.....	36
6. Network size questionnaire integrated in IBBS MSM survey.....	37
7. Capture-recapture questionnaire integrated in IBBS MSM survey	38
8. Wisdom of crowd questionnaire integrated in IBBS MSM survey	39
<i>References</i>	40

Acronyms

AIDS	Acquired Immune Deficiency Syndrome
IBBS	Integrated Biomarker Behavior Surveillance
CI	Confidence Interval
CIF	Curatio International Foundation
CRC	Capture-recapture
GEL	Georgian Lari
GFATM	Global Fund to fight AIDS, Tuberculosis and Malaria
HH	Household
HIV	Human Immunodeficiency Virus
MSM	Man who have Sex with Man
NSU	Network Scale-Up
PSE	Population Size Estimation
PSU	Primary Sampling Unit
PWID	People Who Inject Drugs
RDS	Respondent Driven Sampling
STI	Sexually Transmitted Infections
UNAIDS	Joint United Nations Programme on HIV/AIDS
USD	United States Dollar
UO	Unique object
VCT	Voluntary Counseling and Testing
WHO	World Health Organization
WOC	Wisdom of crowd

Executive summary

Background and objectives

Estimates of the number of people at risk for HIV infection, including men who have sex with men (MSM), are crucial for prevention, treatment and care planning. The Georgia Population Size Estimation of MSM is the third study of its kind (the first one conducted in 2010, second in 2014) to estimate the size of this population in Georgia, 2018. The primary objectives of the study was to estimate MSM population size in Tbilisi, Batumi and Kutaisi by using different estimation methods and triangulating the findings to provide the most plausible estimates for the population size of MSM in Georgia.

Methods

In this study we defined MSM using international definition, that includes following criteria: being male, having (anal) sex with another men in the past 12 months, being of at least 18 years old, residing or working in Georgia.

The present study proposed seven methodologies (Network Scale-Up, Service Multiplier, Unique Object Multiplier, two Mobile Apps and two Web Multiplier, Network based Capture-Recapture, Handcock's RDS based method and Wisdom of Crowd methods) to provide a range of estimates for population size of MSM in Georgia.

For MSM population size estimation, seven methods (Network Scale-Up, Service Multiplier, Unique Object Multiplier, two Mobile Apps and two Web Multiplier, Network based Capture-Recapture, Handcock's RDS based method and Wisdom of Crowd methods) were used to produce a range of estimates for three cities, Tbilisi, Batumi and Kutaisi.

Based on diverse nature of the survey methods household (HH) survey as well as MSM population survey were conducted to obtain data needed. To adjust the PSE estimates of above-mentioned methods, we applied anchored multiplier calculator, that was recently developed by Institute for Global Health Sciences of University of San-Francisco

Key findings

Adjusted MSM population prevalence was 1.85% in Tbilisi, while lower prevalence rate was estimated in Kutaisi and Batumi at 1.69% and 1.31% respectively. Overall Georgia estimates was defined as 18,500 MSM population or 1.55% of adult (15-64y) male population.

Summary table Table 1 represents point estimates with upper and lower bounds of MSM prevalence for each survey locations and overall Georgia.

Table 1 summary table of MSM population size estimation in Georgia

City	All male 15-64	Prevalence	95% CI		MSM size		
		Point - estimate	Lower bound	Upper bound	Point - estimate	Lower bound	Upper bound
Tbilisi (capital)	371,701	1.85%	1.34%	2.44%	6900	5,000	9,100
Batumi	52,431	1.31%	0.77%	1.99%	700	400	1,000
Kutaisi	45,220	1.69%	1.00%	2.54%	800	500	1,100
Georgia	1,196,459	1.55%	1.01%	2.19%	18,500	12,100	26,200

Discussion and recommendations

Our study revealed that the current estimates are in line with the previous 2015 study that was based on the two city PSE findings (Tbilisi and Batumi). The 2015 study estimated 17,200 MSM with the range of 11,700 – 27,600. It is worth to mention, that based on the latest IBBS survey the prevalence of HIV among MSM population is high requiring well planned preventive and treatment interventions. It is highly recommended to continue conduct of population size estimation studies since without proper population size estimates it is challenging to plan and implement prevention, care and treatment programs in today's resource-constrained settings.

Introduction

The overall prevalence of HIV infection in Georgia is 0.4% among adult population (15-49 years of age). As of December 31, 2018, a total of 7385 HIV cases have been registered by the national HIV surveillance system. Increasing number of HIV infections are diagnosed annually. The National Center for Disease Control and Public Health (NCDCPH) reported 673 new cases of HIV in 2018 (18 new cases per 100,000 population), while in early 2000 this number did not exceed to 100. Since the first reports of HIV in the late 1980s in Georgia, injecting drug use was the major route of transmission. However, for the last three years heterosexual contacts became a dominant route of HIV spread. According to the national HIV surveillance system, HIV infections acquired through homosexual contact account to a small proportion of all HIV cases. The homosexual route of transmission contributed to 19.97% and 19.64% of all newly registered cases in 2017 and 2018, respectively¹.

The latest Integrated Bio-Behavior Surveillance (IBBS) study among MSM in Tbilisi, Batumi and Kutaisi (2018) indicates that MSM have the highest HIV prevalence rates in Tbilisi 21.5(16.2-26.7); Batumi 15.6(9.2-22.1) and

¹ National AIDS Center database, unpublished.

Kutaisi 9.6(5.1-14.2) respectively, compared to other risk groups. This risk group, characterized by multiple sexual partners and unsafe sex behavior, generates the ideal environment for HIV transmission among the MSM population and their female partners.

Preventive intervention services targeting this high-risk group are in place in Georgia. To have estimate of the size of MSM population is crucial for better planning and scaling-up of comprehensive and effective preventive interventions.

There are several methods, but not gold standard to estimation size of MSM or other hidden populations, and it is difficult to assess which methods is most accurate. Selection of a method depends on factors such as networking patterns, the visibility of the population, data accuracy of service providers, cultural factors, budgetary issues, etc.(WHO et al. 2013).

In order to avoid weakness of each population size estimation methods described in the literature and to arrive the most acceptable size estimation use of multiple methods and triangulation of estimations is recommended.

Study Objectives

The current study aim was to estimate the MSM2 population size in Georgia in 2018 by applying diverse estimation methods and triangulate the findings to provide the most plausible estimates.

Methods

In the absence of a gold standard to estimate hard to reach population size, use of multiple methods strengthens confidence in estimates, providing upper and lower acceptability bounds, and reducing the likelihood that biases of any single method that would have substantially alter results. The present study proposed seven methodologies (Network Scale-Up, Service Multiplier, Unique Object Multiplier, two Mobile Apps and two Web Multiplier, Network based Capture-Recapture, Handcock's RDS based method and Wisdom of Crowd (WOC) methods) to provide a range of estimates for population size of MSM in Georgia. We applied anchored multiplier calculator, that uses a Bayesian modeling framework to combine estimates with prior knowledge. Tool was developed by Institute for Global Health Sciences of University of San-Francisco, that synthesizes multiple estimates into one estimate³. The calculator uses beta probability distribution that reflects the certainty (i.e. the strength) of the data point. Stronger data points (those with narrower confidence intervals) will have greater influence on the final estimate than weaker data points (those with wider confidence intervals).

² MSM refers to a diverse population that includes any men who have had sex with other men. It is an inclusive term that is based solely on behavior and does not take into account sexual identity. The term includes MSM who consider themselves to be gay, bisexual, heterosexual, are questioning their sexual orientation, or do not identify their sexual orientation in any way.

³ <https://globalhealthsciences.ucsf.edu/resources/tools>

The estimates were later discussed within a group of experts and stakeholders to triangulate and synthesize the most accurate estimate of the MSM population size in Georgia. The following describes the methods used in this study.

Method 1: Network Scale-up

The general concept behind network scale-up method is that an individual's social network is representative of the whole population. That is, one person's group of friends somehow reflects the characteristics of the whole community. Therefore, we can ask members of the general population whether their acquaintances, or alters, have high risk behaviors (such as having anal sex between men, or injecting drugs, or buying and/or selling sex). By asking questions about an acquaintance – a person other than the respondent – the interview takes on some anonymity allowing the responses to be honest without fear of stigma or other negative consequences for the respondent or his/her friends.

For example, if a respondent knows 100 men, and he knows that 2 of those acquaintances have sex with other men, then we can estimate that 2 out of 100 people in the general population are MSM. If we multiply that proportion by the total population of the country, say 5 million, we could estimate that there are 100,000 MSM in the country. The more respondents we have, the better the estimate becomes.

Estimating the hidden population size requires:

1. Estimating the number of people in the respondent's personal network (how many people does s/he know?)
2. Asking how many people they know in the hidden population
3. Dividing the number in the hidden population by the total network size
4. Multiplying that proportion by the total population
5. Adjusting the results for known and measurable biases.

Averaging these calculations over many respondents would create the following maximum-likelihood estimator:

$$\hat{N}_t = \frac{\sum_i y_i}{\sum_i \hat{d}_i} N$$

Where,

\hat{N}_t is the estimated size of the hidden population

d is the estimated personal network size of respondent i

y is the number of people in the hidden population known by respondent i

N is the total population of the country

We applied “known size populations” approach to estimate the number of acquaintances a respondent has, the active network size. Known population means that size of this sub-population is known e.g. number of people with first name” Mamuka”.

The concept is simple; reconfiguring the above formula suggests we can estimate personal network size (d), by asking how many people the respondent knows among populations with known sizes and comparing that to the proportion of that population in the total population. For example, we have statistics on the number of people with first name “Mamuka” or the number of teachers. Using these “known populations” we will back-estimate a respondent’s network size.

In this study, to improve the estimate of social active network size, we asked study participants on how many they knew from the 16 known size groups. The sixteen groups were:

Ten groups with specific “first names”:

1.	How many people do you know with the “first name of Mamuka ”?
2.	How many people do you know with the “first name of Luka ”?
3.	How many people do you know with the “first name of Zurab ”?
4.	How many people do you know with the “first name of Vazha ”?
5.	How many people do you know with the “first name of Sofio ”?
6.	How many people do you know with the “first name of Manana ”?
7.	How many people do you know with the “first name of Shorena ”?
8.	How many people do you know with the “first name of Nino ”?
9.	How many people do you know with the “first name of Maya ”?
10.	How many people do you know with the “first name of David ”?

Six additional groups of subpopulations:

1.	How many people do you know, who were married in 2017 year ?
2.	How many teachers do you know?
3.	How many people do you know, who died in 2017 year ?
4.	How many people do you know, who died due to cancer in 2017 year ?
5.	How many people do you know, who were injured or died in road accidents in 2017 ?
6.	How many students in higher education institutions do you know?

“Known size” subgroups were selected based on feasibility (the size is measured by some organization and seems to be accurate enough) and the general recommendation that the prevalence of every known size group should be between 0.1% to 4% (WHO, Regional Knowledge Hub for HIV/AIDS Surveillance, & Kerman University of Medical Sciences 2013). This is to prevent from over-recalling prevalent subgroups and under-recalling rare subgroups. We collect the size of above listed subgroups from the National Statistics Office of Georgia (National statistics office of georgia 2018).

To estimate personal active network size, a random sample of the general population from households in Tbilisi and Batumi were surveyed. The sample size was comprised of 1000 and 500 participants in Tbilisi and Batumi, respectively. A two-stage stratified sampling was used. The National Statistics Department election list for 2018 year was used as a sampling frame. According to the list Tbilisi and Batumi is divided by municipalities (strata) and election areas. Election areas were selected as primary sampling units (PSU) and households as the second. Number of households in each PSU was defined as five. Within each municipality number of PSUs were selected based on probability proportion to size method. PSUs were selected from the list by system random method. Within each PSU the random walk method was used to select households. Within each selected household one person (aged 18-49 years) was selected to be interviewed (based on last birthday). If there were no response at the household after 3 visits (on different day and different time) the next household was selected.

The study participants were from the adult population ranging 18-49 years of age, who provided verbal informed consent to participate in the study. Final sample comprise of 1,000 Tbilisi and 500 Batumi residents.

A structured questionnaire was developed to collect information on demographic characteristics, on personal network size and on the number of acquaintances representing high risk groups. The interviewer-based administered questionnaire was used, and data collectors were trained prior to the field work. The data was collected through anonymous face-to-face interviews.

In the study, we used two different versions of internationally accepted definition of “know” to provide a comparable personal network size to other studies/settings:

- *[People that you know them by sight and name, and who also know you by sight and name]*
AND
- **Version 1** *[People that you had some contact with either in-person, over the phone or internet (e.g.: e-mail, Skype, chat through social networks) in the last 2 years]*
- **Version 2** *[People that you had shared a meal or drink with in the last 2 years, including family members, friends, coworkers, or neighbors, as well as meals or drinks taken at any location, such as at home, at work, or in a restaurant]*
AND
- *[People of all ages who lives in Georgia].*

In addition to questions about the number of people they know among a certain group of people (known size populations), we also asked if they know any (and then how many) people in their network who are MSM, female sex workers, clients of female sex workers, or injecting drug users:

- How many people do you know who **inject drugs**?
- How many men do you know who are **clients of female sex workers**?
- How many men do you know **who have sex with other men**?
- How many female sex workers (**women who exchange sex for money**) do you know?

Questions about high risk-group populations were asked with caution. The sequence of questions was as follows: PWIDs, clients of FSW, MSM and FSW and each question included definitions of these groups. People who inject drugs were defined as “People who inject drugs is a person who injects narcotic drug without medical indication”, clients of sex workers was defined as “those men who pay for having sex with female sex workers”, MSM was defined as “men have sex with women, but there are some men who have sex with men.” Here in this report we only present MSM findings.

The household survey fieldwork took place during September- October 2018.

For calculation of MSM prevalence we used Tbilisi, Batumi , Kutaisi and Georgia population size in 2018 (National statistics office of georgia 2018) (Table 2)

Table 2-Population size Georgia, 2018

Area	Total	Male 15-64
Tbilisi	1,158,677	371,701
Batumi	163,440	52,431
Kutaisi	140,961	45,220
Rest	2,266,555	727,106
Georgia	3,729,633	1,196,459

Even with a high response rate in NSU this method has the following biases:(UNAIDS and The US Office of the Global AIDS Coordinator 2012)

- **“Transparency Bias “**– A respondent may know someone, but not be aware of all of their behaviors (e.g. homosexual behavior).
- **“Popularity Ratio “**–Members of the key populations may have a personal network size that is different from the general population.
- **“Barrier effect”** - The position of a respondent (e.g. physical barriers such as geographical or social barriers) may cause him/her to know fewer members of the population than would be expected. In

addition, there could be barriers between the key populations and the respondents that affect the likelihood that a respondent knows someone in the key populations.

- **“Reporting bias”** - People may fail to accurately report the populations in question or may be reluctant to do so because of the stigma surrounding the behavior of the population.

Transparency Bias and Popularity ratio can be corrected by directly contacting members of the high-risk populations and asking them questions about their acquaintances and how many of them know about the respondents sexual behaviors. For this purpose, we used IBBS study among MSM population to adjust above mentioned biases, that was conducted in three (Tbilisi, Batumi, Kutaisi) cities of Georgia in 2018.

The barrier effect is minimized when known populations satisfy “scaled-down” condition. In our case, for known population groups those names were selected that have minimal variations, whenever available all variations of the name were provided.

Reporting bias (which might be a case in our study due social desirability bias during face-to face interviewing) was not possible to correct.

The IBBS study among MSM was conducted using respondent-driven sampling methodology (RDS) methodology in three cities of Georgia (Tbilisi, Batumi, Kutaisi).

The inclusion criteria for participation in the study was following:

- age 18 years or older
- homosexual anal contact during the previous 12 months
- being a resident of Tbilisi, Batumi or Kutaisi
- ability to understand and communicate in Georgian

Recruitment was accomplished by six seeds in Tbilisi, 5 – in Batumi and 5 – in Kutaisi. A sample size of overall 621 respondents: 300 (Tbilisi), 172 (Batumi) and 149 (Kutaisi) was reached. Face-to-face individual interviews were conducted in Georgian by the trained interviewers using interviewer-administered electronic questionnaires.

RDS uses coupons with unique numbers to link who recruited whom and applied incentives for participating in a survey and for recruiting others to participate in the survey. In our study, participants were provided with a cash incentive of 25 GEL (9.8 USD)⁴ upon completing of the interview. They were given an additional incentive of 5 GEL (1.97 USD) for every successful recruitment. They were able to recruit maximum three of their peers into the study.

Apart from the demographic profile (age, education, marital status, ethnicity, income) a short version of the Game of Contact method was also applied (Salganik et al. 2011). It involved asking recruited MSM about the

⁴ According to the average exchange rate of the National Bank of Georgia for the fieldwork period in 2018.

number of people they know from the 16 “known population” groups. Following these questions, the respondents were asked about how many persons from each known population know that they have sexual contacts with other men.

Method 2: Multiple Multiplier

In the IBBS survey, we integrated several methods to estimate the size of the MSM population, collectively known as “multiplier methods”.

In this method two sources of data are needed:

- The first source should be a count from programme data including only the population whose size is being estimated (such as the number of MSM who attended the STI clinic or the number of persons who used mob/web apps during a defined time period, or the number of MSM reached by outreach team or were given a unique objective).
- The second source should be a representative survey of the populations whose size is being estimated.

The accuracy of estimated size from this method is highly dependent on the quality of the sources of existing data.

Method 2.1: Mobile/Web Apps Multipliers

During the previous PSE survey among MSM two focus group discussion were conducted to identify the most popular websites and mobile phone applications used by Georgian MSM population and prior to the present survey representatives of this population were asked to update existing list of applications based on their knowledge. We found that the most popular websites are Mamba.ru, Gayromeo.com; the most popular mobile application are: Grindr and Hornet and the list remained unchanged afterwards we implemented the bellow two steps:

1. Obtaining the unduplicated counts of the MSM using the above mobile and web apps over the course of two weeks prior to the interview and one month during IBBS survey (1.5 month in total).
2. Estimating the proportion of MSM (in the IBBS survey) who have used of the mobile applications or websites (2 weeks for mob application and one months for websites) prior to the interview.

Using these two data sources, the multiplier method provides a population size estimate by the formula:

$$N = \frac{n}{p}$$

Where N is the MSM population size, given by n as the number of MSM using the mobile and web apps in the specified time period and p as the adjusted proportion of MSM reporting using the mobile/web apps in the time period collected in the IBBS survey.

Method 2.2: Unique Object Multiplier

This method is similar to the Mobile/Web apps Multiplier method (explained above) but uses a “tag” of the target population shortly prior to the survey as the unduplicated MSM count.

The kind of unique objects that would be applicable by the target population was discussed during the focus group, which revealed that leather bracelets would be the most suitable objects for marking. Venues (streets, bars) where MSM population could be reached and gathering hours were identified in the focus group. At the end, outreach workers distributed 234, 168 and 76 bracelets in Tbilisi, Batumi and Kutaisi respectively to eligible MSM during 5 working days.

The MSM study questionnaire included questions regarding the study participants having received the bracelet. These questions included:

1. In the previous 2 months, did you receive a bracelet?
2. Can you show it to me?
3. (if not available)
4. Can you describe it to me? (if the bracelet is described properly, show it to them)
5. Is this the bracelet you received?
6. How many bracelets did you receive?
7. When did you receive this bracelet?
8. Where did you receive this bracelet?
9. Who did you receive this bracelet from?

To strengthen accuracy and recall, the outreach workers provided instructions to the MSM not to give the object to anyone else and to hold on to the object for at least three months.

Method 2.3: Service multiplier

In this another additional multiplier method we used records of MSM service users by unique code from health centers of each survey locations. The number of beneficiaries who used these services during last 6 months was obtained from the health center. The study participants were asked whether they received “health center” services in their cities during the last 6 months or not. The question was formulated as follows:

“Did you receive service in “health cabinet located at ... (address for respective city)” during last 6 months?”

Analysis: The following analysis was performed for each multiplier method. The confidence intervals (CI) around the population size estimates was calculated using the Taylor-linearized variance estimation.(Johnston et al. 2013) The uncertainty around the number of individuals who logged into the mobile/web apps was estimated by a normal distribution as a good approximation of the Poisson distribution with equal mean and variance to M:

M: Number of MSM who received the unique object and its variance

α = Type I Error. Set at a maximum 0.05

$Z_{1-\alpha/2}$ = the normal standard transformation. When the Type I Error is 0.05, $Z_{1-\alpha/2}$ is equal to 1.96

The variances for M and P were combined by using the following formula (delta method):

$$Var(N) = \frac{Var(M)}{[E(P)]^2} + \frac{[E(M)]^2}{[E(P)]^4} Var(P)$$

$$95\%CI \text{ for } N = N \pm 1.96 \times \sqrt{Var(N)}$$

Method 3: Capture-Recapture based on network sampling

To estimate the population size of MSM we also applied modified capture-recapture method (Dombrowski et al. 2012) which addresses traditional problems associated with the capture-recapture technique:

- The need for two distinct samplings of the population.
- The need for subject anonymity throughout the matching process when dealing with highly stigmatized behaviors (like MSM).

The proposed method depends on data captured during a single survey and involves a reliable way to recognize matches while maintaining anonymity, as well as a method for estimating the number of false matches.

In our study, in addition to demographic characteristics, network size, and questions about their social network size and information transparency ratio, every participant was asked to provide their own personal information (height, approximate weight, hair color, eye color, and ethnicity) and “telefunken code”. The telefunken code derived from the last four digits of their own mobile phone number. To arrive at the code, each of the four digits is encoded as being either even or odd, and low or high (with 4.5 being the threshold). For example, the telefunken code for any phone numbers which ends with 1234 (or 3435, or 3235) is odd-even-odd-even-low-low-low-high, while for phone numbers ending in 7012 (or 5233) the code is odd-even-odd-even-high-low-low-low.

In addition to their own personal information and telefunken code, each respondent was asked to select up to five MSM contacts whose phone number they currently had in their mobile phone’s directory. This selection was carried out by choosing initial letters of last names from a randomized list of alphabet letters. If they had five or less MSM contacts in their phone, all of these contacts were selected. The respondent was then questioned about the randomly selected contacts, in order to obtain data on the contacts’ personal characteristics (approximate height, approximate weight, hair color, and ethnicity) and telefunken code.

The coded phone number (telefonken) together with height, approximate weight, hair color, and ethnicity produced (almost) an unique anonymized code for each respondent that serve in matching the respondent to contacts reported by other respondent interviews.

For purposes of the population estimate, study participants were treated as the “capture” population, while each of the contacts provided during the interviews (“reports”) were considered a “recapture assay”. Given the number of original respondents discovered via recapture assays (as a proportion of the total number of assays), we had a basis for estimating the overall size of the MSM population. As an illustrative example, let’s assume we ended up with 150 respondents ($n = 150$) who have provided 445 “reports” ($s=445$). By considering six categorical variables (telefonken code, height, weight, hair color, and eye color) as the unique code, we will find the repeated cases ($t=7$) between the capture (study participants) and recapture (reports).

Using the Lincoln-Peterson method yields

$$P = \frac{n \times s}{t} = \frac{150 \times 445}{7} = 9,536$$

Where,

P is the total population size

n is number of captures

s is number of recaptures

t is matches

In brief, using 7 matches between 445 reports, and an initial sample of 150 respondents, yields a population estimate $P = 9,536$.

Analysis: For the sake of having the study fully anonymous, we did not collect the exact names and phone contacts of participants and those MSM they have contact with (reports). This makes the matching process complex and poses some errors in the estimation. Using the marginal and joint probability of the six items used to build the unique code; we estimated the plausible range of error in distinguishing the matched cases and did a sensitivity analysis to reproduce a range for the population size of MSM.

We also applied the following formula to estimate the standard error for the population size:

$$SE_P = \sqrt{\frac{n \times s \times (n - t) \times (s - t)}{t^3}} = \sqrt{\frac{150 \times 445 \times 143 \times 438}{7 \times 7 \times 7}} = 3491$$

For our illustrative example, the SE for p is equal to 3491 which leave us a 95% confidence interval for P as 2,694 to 16,378.

CI95% for P = $9536 \pm 1.96 \times 3491 = 2,694$ to 16,378

Method 4: The Wisdom of the Crowd Method

The participants in the IBBS survey were asked about their best estimate and range for the number of MSM in Tbilisi, Batumi or Kutaisi. Such an approach produces a measure of the perception of community members of the population size of MSM. Using the Giles' estimator (in RDS analyst software), we calculated the median for the point, minimum and maximum number of MSM reported by study participants.

Method 5: Handcock's RDS based method

This approach uses a successive sampling approximation to RDS to leverage information in the ordered sequence of observed personal network sizes. The inference uses the Bayesian framework, allowing for the incorporation of prior knowledge. (Handcock et al. 2014)

West (West 1996) proposed a model for estimating the number of oil fields based on the sizes of the known fields. Under successive sampling, larger units (i.e. oil fields) tend to be sampled earlier. The same concept applies to RDS sampling where participants with higher social connections had a higher chance to be recruited earlier than others who are more isolated. This is of course dependent on the total number of people in the community. This approach leverages the information in the decreasing size of sampled units (in RDS, it is called degree or social connectedness) over time to make inference about population size. It uses a super-population model-based formulation within a Bayesian inferential framework by positing a prior distribution over population size.

Here, we used the estimates from the prior PSE as the size of MSM in Tbilisi, Batumi and Kutaisi. Given such prior and the likelihood of observed successive decrease in degree of recruited participants in the RDS data, we developed the posterior distribution of MSM population size in Tbilisi. The calculation was done by RDS Analyst Software (v.3.1.1).

Ethical Issues

The study protocol and instruments were approved by the Institutional Review Board of the National Center for Disease Control and Public Health (certificate IRB0000215, Protocol #2018-038).

The basic principles of ethics in human research as stated by the Declaration of Helsinki were followed throughout this project. The ethical issues that have been taken into consideration were:

- Participation in these surveys was voluntary. Participants were free to withdraw at any time and were informed that refusal or withdrawal would not affect services they would normally receive.
- No names were recorded. All documentation is anonymous, linked only by a study code.

- The data collectors conducting the survey were trained in discussing sensitive issues and protecting participants' confidentiality and human rights.

Results

Network Scale-Up estimates

Average Social Network Size

Based on 22 “known size” population groups we calculated average network size for Tbilisi and Batumi, also for Kutaisi we used network size from the previous survey, that was conducted in general population in Kutaisi in 2016 in order to calculate number of People who inject drugs in Georgia. Results are presented in the Table 3 below.

Table 3 -average social network size of people living in Tbilisi, Batumi and Kutaisi

Mean of Network size Estimations	Total	Male-Adult 15- 64	LL	UL
Tbilisi	176	56	42	71
Batumi	219	70	54	87
Kutaisi	137	44	31	57

Transparency and popularity bias

From the MSM IBBS survey, transparency bias and popularity ratio were estimated. Transparency bias for MSM was estimated as 28.8% (95%CI, 25.9-31.7%) in Tbilisi, 29.7% (95%CI, 25.9%-33.5%) in Batumi and 21.2% (95%CI, 17.6-24.7%) in Kutaisi.

Table 4 Transparency ratio in Tbilisi, Batumi and Kutaisi

	Transparency ratio		
	Point Est.	LL	UL
Tbilisi	28.8%	25.9%	31.7%
Batumi	29.7%	25.9%	33.5%
Kutaisi	21.2%	17.6%	24.7%

Network size of participants in IBBS surveys is biased (over-estimate the truth). In compare to general population, we found that MSM network size is 2 to 3 times higher. As there is no evidence that MSM has a different network size than the general population, we decided to use the ratio of 1 or 100% for popularity ratio.

Number of people who had meal and any contact were similar, so, we combined the analysis together.

NSU population size estimates

Our analysis revealed that total number of MSM population varies from the lowest estimate of 600 MSM in Kutaisi and the highest estimate 5,100 MSM in Tbilisi. (see Table 5 below).

Table 5 MSM population size estimation

	MSM Population			MSM Prevalence % (15-64y)		
	Point Est.	LL	UL	Point Est.	LL	UL
Tbilisi	5100	3700	7700	1.37%	1.00%	2.07%
Batumi	800	600	1200	1.53%	1.14%	2.29%
Kutaisi	600	400	1000	1.33%	0.88%	2.21%

Socio-demographic characteristics of General population and MSM recruited in IBBS surveys

MSM population

The median age of the recruited MSM was from 25y to 27y in three cities. About half of the population surveyed represented age groups less than 25 years. Almost all participants were Georgian. Every third respondents in Tbilisi reported having higher level of education, while in Batumi and Kutaisi quarter of the respondents mentioned the same. Marital status of respondents varied in three cities, the lowest proportion of married MSM was in Batumi (5.9%), and the highest 21.4% was in Kutaisi. Majority of respondents reported having temporary or permanent work in all cities.

Table 6 IBBS study population characteristics (RDS-A population estimations)

Characteristics	Tbilisi N=300	Batumi N=172	Kutaisi N=149
Age (median)	25y	26y	27y
≤ 24 y	50%	47.2%	41.6%
25-34 y	26.6%	35.8%	29%
≥ 35 y	23.5%	17%	29.3
Georgian	99%	100%	100%
Higher education	36.1%	25%	26.5%
Married	8.2%	5.9%	21.4%
Permanent work	46.2%	38.5%	42%
Temporary work	17.2%	30.5%	34.7%

General population

In household survey among general population we recruited 61.5% and 57% females in Tbilisi and Batumi respectively. All participants were between 18-49 years with median age 32 in Tbilisi and 34 in Batumi and almost all were Georgian. More than half of survey population reported having higher level of education and were occupied, 48.9% in Tbilisi and 62.6% in Batumi were married.

Table 7 Household survey population characteristics

Characteristic	Tbilisi N=1,000	Batumi N=500
Female	61.5%	57%
Male	38.5%	43%
Median age	32y (18-49)	34y (18-49)
Georgian	93.5%	99.2%
Higher education	53.6%	50.4%
Married	48.9%	62.6%
Occupied	59.9%	55%

Multiplier population size estimates

Below we present results of multiple multiplier methods combining unique object, service and mobile/web application data. Mobile and web application multiplier data calculation showed higher estimates of MSM population in all cities compared to service and unique object multiplier. The only exclusion of the abovementioned scenario was Batumi, where multiplier method using MambaApp calculated lowest size. It should also be mentioned here, that no one in Kutaisi reported using MambaApp.

Table 8 MSM population estimates based on multiplier methods

	MultiplierType	Est	LL	UL
Tbilisi	Service	3219	2676	4068
	UniqueObject	1682	1347	2320
	MambaApp	3760	2372	8434
	HornetApp	2755	2012	3962
	GeyromeoApp	9369	6623	15535
	GrindrApp	8748	7528	10348
Batumi	Service	785	635	1067
	UniqueObject	737	608	981
	MambaApp	448	341	706
	HornetApp	4110	3129	6092

	GeyromeoApp	1899	1295	3634
	GrindrApp	2719	2201	3643
Kutaisi	Service	564	449	785
	UniqueObject	579	427	911
	HornetApp	1997	1050	8555
	GeyromeoApp	1622	852	6789
	GrindrApp	1251	1026	1595

Capture-recapture estimates

Using the six-identifier categorical variables and the telefunken code, we identified 113, 45 and 48 matches between the two rounds in Tbilisi, Batumi and Kutaisi respectively. Method revealed the lowest estimate for Kutaisi at 4,400 and highest 10,000 in Tbilisi.

Table 9: MSM population size estimation based on Capture-recapture method

	match #	capture	recapture	MSM Population			MSM Prevalence % (15-64y)		
				Point Est.	LL	UL	Point Est.	LL	UL
Tbilisi	113	267	1335	10000	7100	13000	2.69%	1.91%	3.50%
Batumi	45	156	780	7900	4300	11600	15.07%	8.20%	22.12%
Kutaisi	48	128	640	4400	2700	6200	9.73%	5.97%	13.71%

Wisdom of the Crowd

MSM participant in the IBBS survey, on average, estimated the adult MSM population size as 7,500 with a range from 5,000 to maximum 9,000 in Tbilisi, 140 with a range from 100 to maximum 170 in Batumi and 150 with a range from 135 to maximum 160 in Kutaisi respectively (Table 10).

Table 10 - Population size of MSM using Wisdom of the Crowd Method

City	PSE_P	PSE_LL	PSE_UL
Tbilisi	7,500	5,000	9,000
Batumi	140	100	170
Kutaisi	150	135	160

Handcock's method estimates

The Handcock's RDS based method, having the previous population size estimates as the prior distribution of population size, estimated the size of adult MSM as 4,342 in Tbilisi, 488 in Batumi and 510 in Kutaisi. The results presented below.

Table 11 - Prior and posterior knowledge about the population size of adult MSM in three cities

	MSM Population						MSM Prevalence % (15-64y)		
	Prior_Point	Prior_LL	Prior_UL	Point Est.	LL	UL	Point Est.	LL	UL
Tbilisi	5,100	3,243	9,088	4,342	1,455	27,727	1.2%	0.4%	7.5%
Batumi	719	456	1,282	488	242	1,935	0.9%	0.5%	3.7%
Kutaisi	620	393	1,105	510	218	2,983	1.1%	0.5%	6.6%

Data Synthesis and Triangulation

For data synthesis and triangulation, we used a new open source tool - Anchor Multiplier developed by the Institute for Global Health Sciences at the University of San Francisco in April, 2018. We applied all method estimates separately for each city in the tool.

Tbilisi

Two methods estimates Handcock's and Mamba multiplier were dropped from the analysis, while calculating population size in Tbilisi. We ended up to adjusted MSM population prevalence as 1.85% (CI 95% 1.34-2.44) of 15-64y male population. See Table 12 below

Table 12 MSM population estimates, Tbilisi 2018

Tbilisi	Mean	Lower	Upper	Population (Mean)	Population (Lower)	Population (Upper)
Anchored Multiplier Variance Adjusted	1.85	1.34	2.44	6,875	4,968	9,087
Prior PSE	1.37	0.87	2.44	5,100	3,243	9,088
NSU, Tbilisi	1.37	1.00	2.07	5,100	3,700	7,700
Service multiplier	0.87	0.72	1.09	3,219	2,676	4,068
UO multiplier	0.45	0.36	0.62	1,682	1,347	2,320
Grindr	2.35	2.03	2.78	8,748	7,528	10,348
Hornet	0.74	0.54	1.07	2,755	2,012	3,962
GayRomeo	2.52	1.78	4.18	9,369	6,623	15,535
WOC	2.02	1.35	2.42	7,500	5,000	9,000
CRC	2.69	1.91	3.50	10,000	7,100	13,000

Batumi

Running Batumi calculation tool dropped five data points from analysis. (Handkock, Capture-recapture, mobile and web application estimates). Adjusted Prevalence of MSM in was 1.31%(CI95% 0.77-1.99) of 15-64y male population in Batumi.

Table 13 MSM population estimates, Batumi 2018

Batumi	Mean	Lower	Upper	Population (Mean)	Population (Lower)	Population (Upper)
Anchored Multiplier Variance Adjusted	1.31	0.77	1.99	689	405	1,045
Prior PSE	1.37	0.87	2.34	719	456	1,228
NSU, Batumi	1.53	1.14	2.29	800	600	1,200
Service multiplier	1.5	1.21	2.04	785	635	1,067
UO multiplier	1.41	1.16	1.87	737	608	981
Mamba	0.85	0.65	1.35	448	341	706
WOC	0.27	0.19	0.32	140	100	170

Kutaisi

As presented in table below, adjusted proportion of MSM population in Kutaisi was estimates as 1.69% (CI95% 1-2.54) of 15-64y male population. Analysis dropped four data points (Handkock, Capture-recapture, mobile and web application estimates)

Kutaisi	Mean	Lower	Upper	Population (Mean)	Population (Lower)	Population (Upper)
Anchored Multiplier Variance Adjusted	1.69	1.0	2.54	763	452	1,149
Prior PSE	1.37	0.87	2.44	620	393	1,105
NSU, Kutaisi	1.33	0.88	2.21	600	400	1,000
Service multiplier	1.25	0.99	1.74	564	449	785
UO multiplier	1.28	0.94	2.01	579	427	911
Grindr	2.77	2.27	3.53	1,251	1,026	1,595
WOC	0.33	0.3	0.35	150	135	160

Other cities and Georgia

Extrapolation of population size for other cities and the whole Georgia is based on specific assumptions, such as:

- Proportion of MSM of 15-64 years old in other urban areas in Georgia is the same as the pooled weighted mean of Tbilisi, Batumi and Kutaisi estimates

- Proportion of MSM in other semi-urban and rural areas in Georgia is the same as lowest rate among the studied urban areas (Batumi estimate).

There are approximately 18,500 MSM in Georgia, with lower acceptable bound of 12,100 and an upper acceptable bound is 26,200 MSM. This overall estimate suggests that the prevalence of MSM in Georgia is 1.55% (acceptable interval 1.01%-2.19%) of the adult male population. Final estimation for whole country see in the Table 14 below.

Table 14 MSM Population size estimation Georgia, 2018

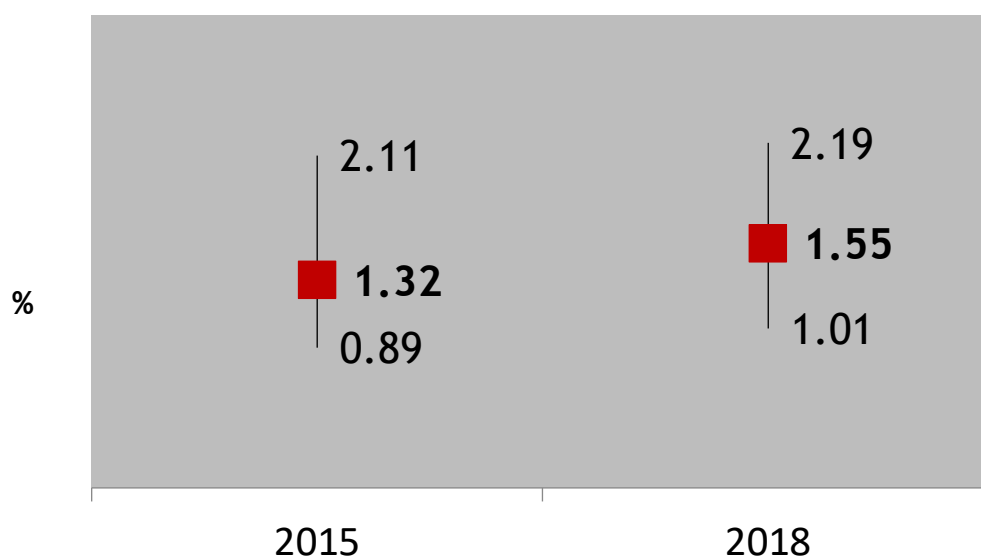
City	All male 15-64	Prevalence	95% CI		MSM size		
		Point - estimate	Lower bound	Upper bound	Point - estimate	Lower bound	Upper bound
Tbilisi (capital)	371,701	1.85%	1.34%	2.44%	6900	5,000	9,100
Batumi	52,431	1.31%	0.77%	1.99%	700	400	1,000
Kutaisi	45,220	1.69%	1.00%	2.54%	800	500	1,100
Telavi	18,177	1.77%	1.26%	2.28%	300	200	400
Poti	13,387	1.77%	1.26%	2.28%	200	200	300
Zugdidi	33,125	1.77%	1.26%	2.28%	600	400	800
Rustavi	41,011	1.77%	1.26%	2.28%	700	500	900
Gori	39,533	1.77%	1.26%	2.28%	700	500	900
The remainder of Georgia	581,873	1.31%	0.77%	1.99%	7,600	4,500	11,600
Total	1,196,459	1.55%	1.01%	2.19%	18,500	12,100	26,200

Discussion

Our study revealed that the current estimates do not differ from the previous 2015 study that was based on the two city PSE findings (Tbilisi and Batumi). The 2015 study estimated 17,200 MSM with the range of 11,700 – 27,600.

According to the newest 2018 study data, population size estimates suggest between 1.01% and 2.19% of adult males in Georgia are MSM: 18,500 (12,100 – 26,200) from which 6,900 MSM are estimated in Tbilisi, 700 in Batumi, 800 in Kutaisi and 10,100 in other areas of Georgia.

Figure 1 MSM population prevalence 2015-2018 15-64 male population in Georgia



Considering the high HIV prevalence among MSM- 21.5% (CI95%.16.2-26.7%) in Tbilisi, 15.6% (CI95%.9.2-22.1%) in Batumi and 9.6% (CI95%.5.1-14.2%) in Kutaisi according to the recent IBBS survey, it is estimated, that 1,483(CI95%.810-2,429) in Tbilisi, 109(CI95%. 37-221) in Batumi and 77(CI95%.26-156) in Kutaisi HIV infected MSM are living in above mentioned cities.

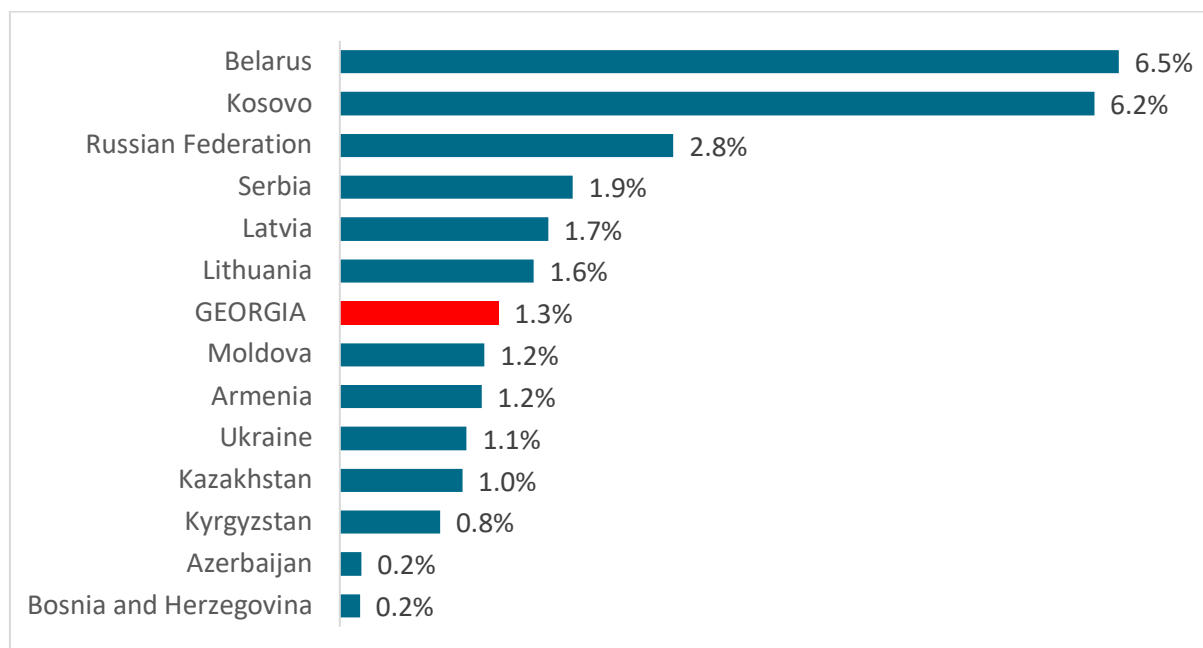
The national response to HIV/AIDS currently needs better information on the number of people at risk to appropriately plan interventions, allocate resources and track preventive program coverage. The MSM population is considered to be hard to reach group globally and is very well hidden in Georgia. Therefore, there is need to plan interventions so that MSM population access to HIV treatment and prevention services be improved.

Georgia estimates is comparable (1.3%) to the regional MSM population estimates. As per there was not available MSM prevalence data for the countries, we used World Bank data⁵ for adult male population and ECOM 2018⁶ report combining the latest available data of MSM population size in figures.

⁵ World bank data on male population. Available <https://data.worldbank.org/indicator/SP.POP.TOTL.MA.ZS>

⁶ Eurasion coalition on male health; HIV among MSM in Eastern Europ and central Asia, epidemiological review 2018

Figure 2 MSM population prevalence among adult (15y and above) male population in EECA countries



Besides the robustness of the final MSM population size estimation based on applying multiple methods and triangulation the study has several limitations:

1. Size estimation exercises generally cannot estimate the proportion of MSM who are truly hidden and/or MSM who do not even acknowledge that they are MSM. These MSM may not be counted in any data source, including data collected through this study. In this sense, these estimates are likely an underestimation of the MSM population size in Georgia.
2. Adult male population denominators from Census projections by the National Statistical Department were used. These are not actual census numbers; actual census numbers may vary from projections and thus would influence the estimates.
3. Size estimates from only three areas (Tbilisi, Batumi and Kutaisi) of Georgia were available. Because the MSM population size in a large urban area of Georgia was estimated using data from very few areas (the three cities), the estimates presented here come with additional assumptions and therefore greater uncertainty.
4. The quality of the estimate derived from the website and mobile applications is only as good as quality of data that was used to produce that estimate.
5. The accuracy of NSU estimates is very dependent on the accuracy of responses we got from the study participants, the quality of the data source for the real size of known population sizes, the transparency of MSM behaviors among the networks and the random mixing of MSM in the community. We tried to adjust for some of the biases while some of the bias parameters were hard to measure.

Recommendations

There are many factors negatively influencing on key population access to HIV preventive services including stigma, homophobia and fear of public exposure. So, it is critical to understand that different MSM sub-populations could not be reached with the standard HIV preventive package, but technics tailored to their diverse behavior should be applied in order to achieve successful response to HIV epidemic. These technics include outreach, individual counselling, internet-based & community-based interventions and peer education or similar peer-based interventions etc.

From the different PSE methods unique object and service multiplier estimates provide more close estimates of MSM who could be more effectively reached with the outreach activities. Use of multiple methods would allow arriving at more acceptable estimates. In addition, multiplier is a relatively low-cost method among other PSE methods, and it can easily incorporated into future IBBS studies among MSM population in Georgia.

Population size estimation studies play a significant role in measuring and understanding the impact and magnitude of the HIV epidemic at national, regional and global level. Without proper population size estimates it would become challenging to plan and implement prevention, care and treatment programs in today's resource-constrained settings. And the last but not the least PSE studies are designed to evaluate programs effectiveness and assess whether progress planned has been achieved.

Annex 1- Survey questionnaires

1. NSU questionnaire for Household survey

Questionnaire

Section A . for interviewers	
Interviewers code: _____	City: _____
Date of interview: ____/____/____ (dd/mm/yy)	
Interview started: _____(hr:m)	interview finished: _____(hr:mm)

Section B. Demographic Data

1. **How old are you?** (year)
2. **Sex** male - 1 female - 2
3. **Ethnicity** Georgian - 1 Armenian - 2 Azeri - 3 other -4 no response - 99

4. **What is the highest level of education you attended?**

Never attended school	1	go to 6
Uncompleted primary education	2	go to 6
Completed primary education	3	go to 6
Uncompleted secondary education	4	go to 6
Completed secondary education	5	
Initial vocational program	6	
Secondary vocational program	7	
Bachelor or equivalent	8	
Master or equivalent	9	
Doctor or equivalent	10	

5. **Are you a student?**

Student of secondary professional program	1
Student of higher professional program	2
Undergraduate student	3

Masters student	4
Doctoral student	5

6. What is your current marital status?

Single	1
Married	2
Divorced	3
Widowed	4
No response	99

7. What is your current occupation?

Occupied	1	
<i>If yes</i>	Self employed	1.1
	Employed	1.2
Unemployed	2	
<i>If yes</i>	housewife	2.1
no response	99	

Section C. Number of people you know with specific name

- Now, I want you to recall and write down the number of people with specific name that you know. These people should be
 - [People that you know them by sight and name, and who also know you by sight and name]
 - AND
 - **Version 1** [People that you had some contact with either in-person, over the phone or internet (e.g.: e-mail, Skype, chat through social networks) in the last 2 years]
 - **Version 2** [People that you had shared a meal or drink with in the last 2 years, including family members, friends, coworkers, or neighbors, as well as meals or drinks taken at any location, such as at home, at work, or in a restaurant]
 - AND
 - [People of all ages who lives in Georgia].

Example: Suppose we are asking you to recall the number of people you know with the “first name of Elena” in last 2 years? Take your time and try to recall the overall number of people you know having “Elena” as first name. Let’s say you recall/count 11 people with the first name of Elana. Perfect! First, you should exclude famous people that you know about, but who do not know about you. So, you should not consider ElenaSatine, as she doesn’t know about you! ☺. Then, exclude those who are not living in Georgia. Here, as all Elena that you know are living here in Georgia, you should not exclude anyone. And last, of those 10 people with the fist name of Elena, exclude anyone (let’s say 3) whom you did not contact with over the last 24months either in-person, phone or internet. So, the number of people you may write down is 7 (11 – 1 – 3 = 7).

Important notes:

- We know it is not an easy task. Please do your best to recall as much as you can.
- If at the end, you could not recall anyone from the mentioned group, write 0.

Groups	description	answer
1.	How many people do you know with the “first name of Mamuka” ?	_____ person(s)
2.	How many people do you know with the “first name of Luka” ?	_____ person(s)
3.	How many people do you know with the “first name of Zurab, or Zura, or Zuka or Zuriko”?	_____ person(s)
4.	How many people do you know with the “first name of Vazha” ?	_____ person(s)
5.	How many people do you know with the “first name of Sophiko, or Sophio or Sopho” ?	_____ person(s)
6.	How many people do you know with the “first name of Manana” ?	_____ person(s)
7.	How many people do you know with the “first name of Shorena” ?	_____ person(s)
8.	How many people do you know with the “first name of Nino, or Niniko, or Nina” ?	_____ person(s)
9.	How many people do you know with the “first name of Maya” ?	_____ person(s)
10.	How many people do you know with the “first name of Davit, or Dato, or Datuna, or Datiko” ?	_____ person(s)

Now I will ask you the number of people you know.

Again, I am asking about

- [People that you know them by sight and name, and who also know you by sight and name]
AND
- **Version 1** [People that you had some contact with either in-person, over the phone or internet (e.g.: e-mail, Skype, chat through social networks) in the last 2 years]
- **Version 2** [People that you had shared a meal or drink with in the last 2 years, including family members, friends, coworkers, or neighbors, as well as meals or drinks taken at any location, such as at home, at work, or in a restaurant]
AND
- [People of all ages who lives in Georgia].

Groups	Question	answer	
		overall	Only male
1.	How many people do you know, who were married in 2017 year?	_____ persons	_____ male
2.	How many teachers do you know?	_____ persons	_____ male
3.	How many people do you know, who died in 2017 year?	_____ persons	_____ male
4.	How many people do you know, who died due to cancer in 2017 year?	_____ persons	_____ male
5.	How many people do you know, who were injured or died in road accidents in 2017?	_____ persons	_____ male
6.	How many students in higher education institutions do you know?	_____ persons	_____ male

- [People that you know them by sight and name, and who also know you by sight and name]
AND
- **Version 1** [People that you had some contact with either in-person, over the phone or internet(e.g.: e-mail, Skype, chat through social networks) in the last 2 years]
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AND
- [People of all ages who lives in Georgia].

groups	description	Answer (write the number of people you know)					
		overall	Sex		Age group (year)		
			male	female	<18 y	18-30y	>30 y
1	Some people use drugs, some of them use drugs by injection. How many people do you know who inject drug? (Injecting drug user is a person who inject narcotic drug without medical indication)	—	—	—	—	—	—
2	How many men do you know who are clients of female sex workers? (those men who pay for having sex with female sex workers)		—		—	—	—
3	In general men have sex with women, but there are some men who have sex with men. How many men do you know who have sex with other men? (They may also have sex with women)		—		—	—	—
4	How many female sex workers do you know? (Women who exchange sex for money)			—	—	—	—

Have you participated in the survey that is conducted by Curatio International foundation and Bemoni Public Union in September-October 2018?

1.yes 2. No 88. Dont know/dont remember 99. No response

2. NSU bias adjustment questionnaire integrated in IBBS MSM survey

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8.	How many people do you know with the “first name of Nino, or Niniko, or Nina” ?	_____ person(s)
9.	How many people do you know with the “first name of Maya” ?	_____ person(s)
10.	How many people do you know with the “first name of Davit, or Dato, or Datuna, or Datiko” ?	_____ person(s)

Now I will ask you the number of people you know.

Again, I am asking about

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AND
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- **Version 2** [People that you had shared a meal or drink with in the last 2 years, including family members, friends, coworkers, or neighbors, as well as meals or drinks taken at any location, such as at home, at work, or in a restaurant]
AND
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Group s	Question	answer	
		overall	Only male
1.	How many people do you know, who were married in 2017 year?	_____ persons	_____ male
2.	How many teachers do you know?	_____ persons	_____ male
3.	How many people do you know, who died in 2017 year?	_____ persons	_____ male
4.	How many people do you know, who died due to cancer in 2017 year?	_____ persons	_____ male
5.	How many people do you know, who were injured or died in road accidents in 2017?	_____ persons	_____ male
6.	How many students in higher education institutions do you know?	_____ persons	_____ male

3. Unique object Multiplier questionnaire integrated in IBBS MSM survey

Unique Object

1. In the previous 2 months, did you receive a bracelet?	1. Yes 2. No <i>go to</i> →0 88. Don't Know <i>go to</i> →0 99. Decline to answer <i>go to</i> →0
2. Can you show it to me?	1. Yes <i>go to</i> →5 2. I do not have it with myself 99. Decline to answer
3. Can you describe it to me?	1. The description was correct 2. Incorrect description 99. Decline to answer
4. Is this the bracelet you received? (show it to them)	1. Yes 2. No 99. Decline to answer
5. How many bracelets did you receive?	_____ #
6. When did you receive this bracelet?	_____ weeks ago
7. Where did you receive this bracelet?	_____

<p>8. Who did you receive this bracelet from? (only one answer)</p>	<p>1. Friend 2. Sex partner 3. Social worker 4. Person from the same district 5. Co-worker 6. Stranger</p>
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4. Service multiplier questionnaire integrated in IBBS MSM survey

Service use

9. Have you received service in „health cabinet“ during last 6 months? (specify health room, which is located in ... Service use means, that you received VCT- Voluntary Counseling and Testing on HIV and/or STI testing and/or STI treatment)

Address of “health cabinet”

Tbilisi- 5 Lubliana str.

Batumi- 33 Khimshiashvili str.

Kutaisi- 2 Otskheli str.

yes -----1

no -----2

don't know-----88

no response-----99

5. Web/mobile application use multiplier questionnaire integrated in IBBS MSM survey

Mobile / Web Apps Section

<p>10. Do you use Grindr mobile apps?</p>	<p>1. Yes 2. No <i>go to</i>→0</p>
<p>10.1. Did you logged into Grindr mobile apps for last two weeks?</p>	<p>1. Yes 2. No 88. Don't Know 99. No Response</p>
<p>11. Do you use Hornet mobile apps?</p>	<p>1. Yes 2. No <i>go to</i>→0</p>
<p>11.1. Did you logged into Hornet mobile apps for last two weeks?</p>	<p>1. Yes 2. No</p>

	88. Don't Know 99. No Response
12. Do you use Mamba.ru website?	1. Yes 2. No <i>go to</i> →0
12.1. Did you logged into Mamba.ru website during last month?	1. Yes 2. No 88. Don't Know 99. No Response
13. Do you use Gayromeo.com website?	1. Yes 2. No <i>go to</i> → Section R
13.1. Did you logged into Gayromeo.com website during last month?	1. Yes 2. No 88. Don't Know 99. No Response

6. Network size questionnaire integrated in IBBS MSM survey

Now I am going to ask you some questions about your social network. Please take your time to carefully think about these questions. I am going to ask you to give me some estimates about the number of men who have sex with men that there are in Tbilisi and the number of men who have sex with men that you personally know. Please give me your best estimate. You do not need to give me anyone's names.

#	Question	response
1	How do you think how many MSM is living in Tbilisi?	
2	How many of them do you know personally and the same time they know you by name?	
3	How many of them are above 18 years?	
4	How many of them have had homosexual contacts during last 12 months?	
5	How many of them have you seen during last 1 month?	
6	How many of them have you seen during last 3 months?	
7	How many of them do you think you can bring to participate in the research?	
8	Would you choose the same person for participation in the study who has given you the coupon? (In case he had not received it before)	1. yes 2. no

9	Why did you agree to participate in the study (More than once answer is allowed)	1. Monetary incentive 2. Influence of the person who gave the coupon to me 3. The study topic is interesting/ useful for me 4. I had plenty of free time 5. Other (indicate) _____
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7. Capture-recapture questionnaire integrated in IBBS MSM survey

Section G. Matching names for capture-recapture

Now, I am going to ask you some questions about some appearance characteristics like height, weight, hair and eye color and also race. Moreover, I will ask you about your list 4 digits of your phone number (just last 4) and record it as coded number (telefunken). For example, for any phone numbers which end in 1234, it is Odd-Even-Even-Low-Low-Low (explain how you did it and why).

A mix of these six variables will be used to assign you a unique non-identifying code, which later will be used in analysis. Nobody can use this code to identify you or your friends.

Variables	response	0. The participant own info.
Telefunken Code	0; 1; 2; 3; 4L 5; 6; 7; 8; 9H 0; 2; 4; 6; 8O 1; 3; 5; 7; 9E	
Approximate height	High.....H Middle.....M Short.....S	
Approximate weight	Obese.....O Normal.....N Thin.....T	
Hair color	Dark.....D Light.....L Ginger/red....G No hair.....N	
Ethnicity	Georgian.....G Azeri.....Z Armenian.....A Other.....O	

I want to ask the same questions from five MSM contacts whose you have their phone number in your phone's directory. Using a randomized list of alphabet letters, I will help you to choose them by random among your entire contact list. Please tell me their approximate height, approximate weight, hair color, eye color, and race/ethnicity and telefunken code:

Variables		Contact 1	Contact 2	Contact 3	Contact 4	Contact 5
Telefunken Code	0; 1; 2; 3; 4L 5; 6; 7; 8; 9H 0; 2; 4; 6; 8O 1; 3; 5; 7; 9E					
Approximate height	High.....H Middle.....M Short.....S					
Approximate weight	Obese.....O Normal.....N Thin.....T					
Hair color	Dark.....D Light.....L Ginger/red.....G No hair.....N					
Ethnicity	Georgian.....G Azeri.....Z Armenian.....A Other.....O					

8. Wisdom of crowd questionnaire integrated in IBBS MSM survey

Now I am going to ask you some questions about size of men who have sex with men in Tbilisi. Please take your time to carefully think about these questions.

1. Earlier you mentioned that _____ men who have sex with men live in Tbilisi. What are minimum and maximum estimates? Minimum: _____ Maximum: _____
2. How many of them are 18 year and over?

Overall: _____

Minimum: _____

Maximum: _____

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