Estimating sizes of key populations

Guide for HIV programming in countries of the Middle East and North Africa

World Health Organization
Regional Office for the Eastern Mediterranean

UNAIDS

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WHO Library Cataloguing in Publication Data

World Health Organization. Regional Office for the Eastern Mediterranean

Estimating sizes of key populations: guide for HIV programming in countries of the Middle East and North Africa / World Health Organization. Regional Office for the Eastern Mediterranean

p.

ISBN: 978-92-9022-131-9

ISBN: 978-92-9022-154-8 (online)

1. HIV infections - epidemiology - Middle East - Africa, Northern 2. Vulnerable Populations - statistics & numerical data 3. Decision Making 4. Data Collection - methods 5. Risk Factors I. Title II. Regional Office for the Eastern Mediterranean III. Joint United Nations Programme on HIV/AIDS (UNAIDS)

(NLM Classification: WC 503.4)

Design by Permanent Impressions. Printed by the WHO Regional Office for the Eastern Mediterranean.

Contents

Foreword

As the world commits to the ambitious goal of ending AIDS as a public health threat by 2030, evidence-based planning, implementation and monitoring of the response to HIV becomes, more than ever, dependent on our granular knowledge of the situation. To achieve this goal, the WHO Eastern Mediterranean Region needs to overcome the challenge presented by the invisibility of key population groups in which the HIV epidemic is most likely to thrive, and from which it can spread. Several countries of the Region have documented concentrated epidemics among men who have sex with men and among people who inject drugs. In addition, HIV prevalence rates among female sex workers can reach as much as 10-fold the rate in the general population. However, the size of those population groups, and hence their contribution to the epidemic in each country, is often unknown.

Identifying the key population groups, their locations and their size helps in understanding and prioritizing the current needs for HIV prevention, diagnosis, treatment and care services. It also helps in projecting future needs for those services. Subsequently, countries become empowered to plan and set meaningful and ambitious targets in pursuance of the global goal. This evidence-based planning and target setting is indispensable for soliciting political support and mobilizing resources by substantiating the challenges and qualifying the strategic response.

This publication presents guidance and a decision-making tool for HIV programming by addressing one of the essential components of strategic information: population size estimation. A range of existing resources has been published by various agencies and institutions giving guidance on conducting population size estimations. This guide builds on and complements them by presenting guidance on how to plan population size estimations which respond flexibly to the needs of different countries, and how to implement them in a way that delivers the results most efficiently even where resources are limited.

I trust that this guide and decision-making tool will help our Region substantiate and visualize its progress, and will facilitate informed decision-making to boost the response in meeting its commitments in regard to HIV. I strongly encourage countries and partners to use it. It will undoubtedly contribute to moving the Region further towards ending AIDS by 2030.

Dr Ala Alwan
WHO Regional Director for the Eastern Mediterranean

Foreword

A few months ago the United Nations General Assembly gathered world leaders and representatives in a high-level meeting to endorse a bold and ambitious Political Declaration on HIV and AIDS: "On the Fast Track to Accelerate the Fight against HIV and to End the AIDS Epidemic by 2030". This declaration comes as a follow-up to a target set by the Agenda for Sustainable Development of ending the AIDS epidemic by 2030 and finishing the unfinished business of the Millennium Development Goals. The declaration recognizes that a one-size-fits-all approach is not appropriate to diverse epidemics. It emphasizes the importance of a population/location approach with regional differentiation, encouraging countries to focus on the populations, locations and interventions that will deliver the greatest impact – from women and adolescent girls and boys, to key populations and to humanitarian and conflict settings.

Fast-tracking the AIDS response depends on the ability of communities and local authorities to plan and lead their AIDS response according to the realities of the epidemic on the ground and on the political courage and commitment to focus resources and programming on the epidemic areas. To be able to do that, national and local programme managers need to have the information necessary to make strategic decisions. In the Middle East and North Africa, as well as in many other parts of the world, this includes information on key affected populations. Estimating the size of these populations is a necessary step in planning and monitoring effective programmes for HIV prevention and access to testing and treatment for these populations.

UNAIDS has put HIV strategic information at the core of its mandate and is helping national and local AIDS authorities to strengthen the systems for generation and use of such information. The availability of data, especially on key populations, has always been a challenge in our region and the UNAIDS Regional Support Team for the Middle East and North Africa is working with all partners to address the technical and political gaps in this regard and to strengthen the strategic information and data systems at all levels.

The UNAIDS/WHO Working Group on Global HIV/AIDS and STI Surveillance has developed and published guidelines on estimating the size of populations most at risk for HIV. The current guide and decision-making tool should be seen as a companion to the guidelines and not as a replacement.

Our support to countries and communities for estimating the size of key populations at risk for HIV does not end with this publication. Rather, this decision-making tool provides a better framework for such support.

Dr Yamina Chakkar
Director, Regional Support Team for the Middle East and North Africa
UNAIDS, the Joint UN Programme on HIV/AIDS

Preface

The size of populations with specific risk factors and behaviours is one of the most important components of HIV surveillance. Not only is size a critical determinant of the likely extent of HIV spread and the contribution of different key populations to new HIV infections, it is also crucial for defining programme resource needs and setting priorities and targets.

Estimating the sizes of key populations most at risk for HIV is challenging because it involves counting people who are hidden, or whose activities are hidden. It is particularly challenging in countries of the World Health Organization (WHO) Region for the Eastern Mediterranean and the UNAIDS Middle East and North Africa Region[1] (EM/MENA region), where conservative social and religious values can mean harsh judgment, increased levels of stigma and severe punishment for people engaging in behaviours that can expose them to HIV. Despite the challenges, many countries in the EM/MENA region have taken steps to understand more about people who are at risk for HIV, including estimating their numbers. However, more guidance is needed on how to collect size estimation data and use it to improve the effectiveness of HIV programming.

There are methodological guidelines for conducting size estimates of key populations; to produce reliable estimates for different purposes, however, guidance on estimation techniques is not always sufficient. The guidance presented here builds on the 2010 size estimation guidelines from the WHO/UNAIDS Working Group on HIV/AIDS/STI Surveillance.[2] It contains further directions on how to plan and implement size estimation activities in the EM/MENA region, including practical guidance for deciding which methods to use where and among whom, as well as how to use the data to obtain the kind of size estimates required for specific purposes.

The guide is part of the efforts by the WHO and UNAIDS to support countries in the EM/MENA region in planning and implementing activities to collect strategic information to understand the epidemic and the response at country level. It is aimed at providing decision-makers, programme managers and partners in the Region with the best quality of guidance in population size estimation.

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1 The following countries are part of the combined WHO Eastern Mediterranean Region and the UNAIDS Middle East and North Africa Region (EM/MENA) region: Afghanistan, Algeria, Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen.

2 WHO/UNAIDS Working Group on HIV/AIDS/STI Surveillance. Guidelines on estimating the size of populations most at-risk to HIV. Geneva: World Health Organization; 2010.

Acknowledgements

This publication was originally drafted by Tobi Saidel (WHO consultant) with additional contributions to conceptualization, writing and review from Virginia Loo (WHO consultant), Gabriele Riedner and Matti Parry (WHO Regional Office for the Eastern Mediterranean) and Jesus Maria Garcia-Calleja (WHO headquarters). Ali Feizzadeh (UNAIDS), Mostafa Shokoohi, AliAkbar Haghdoost and Mohammad Reza Baneshi (WHO Collaborating Centre for HIV surveillance, Kerman University of Medical Sciences), and Ivana Bozicevic (WHO Collaborating Centre for HIV Strategic Information, Andrija Stampar School of Public Health, University of Zagreb School of Medicine) made further contributions in conceptualization and review. Hamida Khattabi and Joumana Hermez (WHO Regional Office for the Eastern Mediterranean) provided additional review.

Chapter 1

Rationale for determining local and national size estimates

1.1 Overview

The most common purposes for which size estimates of key populations are needed include:

- advocacy
- national level resource mobilization
- HIV estimation and projection
- geographic prioritization of the response
- national level target setting
- local level programme planning, target setting and monitoring.

All of these activities are important at some point in the resourcing, planning and management cycles of HIV responses, not only at local and national levels but also at the global level. However, these activities do not all require the same kinds of size estimates. As we shall see, for some activities (e.g. advocacy or resource mobilization) rough estimates that fit into a broad range will suffice, while for others (e.g. target setting for local programmes in a particular city or town) more precise estimates are needed. It is important to recognize that the level of effort required for obtaining size estimates that are sufficiently accurate for the task at hand will not be the same for all activities. So deciding what kind of size estimate is needed and understanding how accurate the number needs to be will be key aspects of planning for size estimation. Planning strategically to gather data that will be useful for multiple purposes will be another key aspect.

The size estimation methodologies described in this guide are mainly used for producing direct estimates of key populations in specific locations. In this guide the term "direct size estimates" is used for population size estimates that are based on data collected in defined local areas and involve either a mapping (census or enumeration) or survey-based activity covering the key population being estimated.

Because collecting census and survey data requires substantial commitment of time, resources and capacity, such estimates are usually available for only a few selected locations within a country. Since countries also need national-level size estimates of key populations, an algorithm must be found for using data from the areas for which direct size estimates have already been made to extrapolate values for areas where there are no local data. In this guide, estimates that are derived by some process of extrapolation are referred to as "extrapolated size estimates".

The first three activities listed above (advocacy, resource mobilization and estimates and projections) generally require national estimates, while the last three (geographic prioritization and programme planning, target setting and monitoring programme coverage) generally require some type of local estimates (either rough or more precise). Each of these activities is described in more detail below.

1.2 Activities requiring national level size estimates

Advocacy

In some countries, the act of acknowledging or recognizing the existence of key populations (e.g. by the government or other public health authorities) remains a challenge. In such situations, even rudimentary evidence about the magnitude of a key population can be a crucial starting point for generating political support (as a forerunner to actually mounting a response and mobilizing sufficient resources), especially since HIV may be competing for resources and attention with other equally pressing health problems. In such cases, rough estimates of key population size will generally suffice. At a later stage, building political will among local authorities will benefit from similar kinds of advocacy and will also benefit from population size estimates of key populations for these specific local areas.

National level resource mobilization

Increasingly there is a demand for size estimates for key populations as a prerequisite, or justification for obtaining funding/resources for HIV programming and for setting overall funding levels. This applies to mobilizing domestic resources as well as international donor funding.

HIV estimation and projections

Estimates and projections of the number of people infected with HIV are usually calculated using computer modelling software (e.g. Spectrum). In more generalized epidemics, the estimates can be made on the basis of general population size and prevalence data. However in low level and concentrated epidemics, such as the kind found in the EM/MENA region, the level of infection is too low in the general population, so estimates of the burden of HIV must be derived on the basis of size estimates and HIV prevalence of key populations. When estimates and projections are done for a whole country, the size estimates of key populations need to be representative of the country. When the burden of HIV is estimated for a more localized area (e.g. where key populations are concentrated), then the population size estimate data need to be representative only for that area.

One of the challenges for countries with low level concentrated epidemics is obtaining nationally representative data for both population size estimates and HIV prevalence. Because the epidemics are localized, data collection efforts need to focus primarily on locations where risk is concentrated. In such situations it is important to realize that while national level figures should reflect the entire country, it is not necessary to collect detailed data everywhere. Considering the purposes for which the data will be used, a robust national figure based on detailed data from some locations and extrapolated data from others will generally suffice.

1.3 Activities requiring local level size estimates

Geographic prioritization of the response

Aligning resources with needs depends on an understanding of epidemic potential and disease burden in different locations within the country. The size of key populations is one of the major determinants of both of these. For prioritization geographically, what is important is relative differences between population sizes in different geographic areas. For this purpose, it is enough to have rough size estimates derived using rapid methods and/or proxy data.

National level target setting

All countries have a need to monitor their national level programme, even though many programme activities take place in only a subset of locations. Some type of national estimate that includes either rough or precise estimates for all areas of the country is required for national level target setting. An estimate that is based on precise estimates from high burden areas, combined with extrapolated data from remaining areas can be used to develop robust national estimates. As national programmes mature and extend to more localities, the precision of national estimates may improve because they will be based on detailed data from more locations. However, detailed data from all locations is not required to produce robust national estimates.

Local programme planning, target setting and monitoring programme coverage

When intervention programmes are being planned for key populations in particular cities, town or localized areas, programme managers need size estimates of key populations to plan for front-line service delivery. Among other things, these estimates are needed to set targets for programme activities such as numbers of:

- key populations to be reached by peer educators or outreach workers;
- condoms needed;
- needles and syringes needed;
- appointments for sexually transmitted infection checks needed;
- slots at detoxification, methadone maintenance or other rehabilitation services needed;
- HIV test kits and counsellors needed.

For this type of local planning and target setting, more precise direct size estimates are required.

1.4 Programme monitoring

After programmes have been functioning for a period of time (e.g. 6 months or a year), size estimates will also be needed to measure how comprehensively the population has been reached. For example, some questions that might need to be answered would be:

- What proportion of key population members have been reached by peer educators or outreach workers?
- What proportion of key population members have been tested for HIV and know their results?

Monitoring programme coverage for a specific geographic location can be done by using either routine programme monitoring data for individuals (as the numerator) and direct size estimates (as the denominator) or survey data. However, conducting surveys frequently is resource intensive and time consuming, and therefore using routine monitoring with size estimations is often more feasible.

1.5 Ethical considerations

The behaviours that put people at risk of HIV infection may be sensitive, stigmatising or illegal, and gathering information on these behaviours must be carried out with caution. Any study design involving subjects from these groups must include strong considerations towards protecting their privacy and confidentiality. Participation in research must always generate more benefit than harm to participants, and these benefits should be judged in relation to the engagement needed in the study. Additional safeguards should be considered in regard to underage participants. For detailed guidance on ethical considerations please refer to *Guiding principles on ethical issues in HIV surveillance*.

Chapter 2

Framework for decision-making on the type of size estimation and data needed

Most countries require both national and local level size estimates for key populations. As a minimum, national size estimates are needed for global reporting. However, understanding the size and characteristics of key populations in different locations within a country is the first step in planning a more targeted and effective response.

Most size estimation data are collected locally, but are used for both local and national purposes. Collecting local data requires resources and cannot be done everywhere. This guide introduces a framework that is designed to help programme managers make resource-appropriate decisions about how and where to collect data to achieve multiple size estimation objectives. The framework (Fig.1.) helps to understand the types of data needed to develop both local and national size estimates.

The framework illustrates how for some national level purposes, e.g. advocacy, resource mobilization and modelling (including estimates and projections), crude national size estimates are sufficient, whereas for local level programme planning, more precise local estimates are needed. With crude estimates there may be a relatively wide margin of error but for some purposes this can be tolerated without greatly impacting conclusions or decisions drawn from the data. For example, if the purpose of the estimate is to obtain data for advocacy to convince policy-makers that there are a sizable number of men

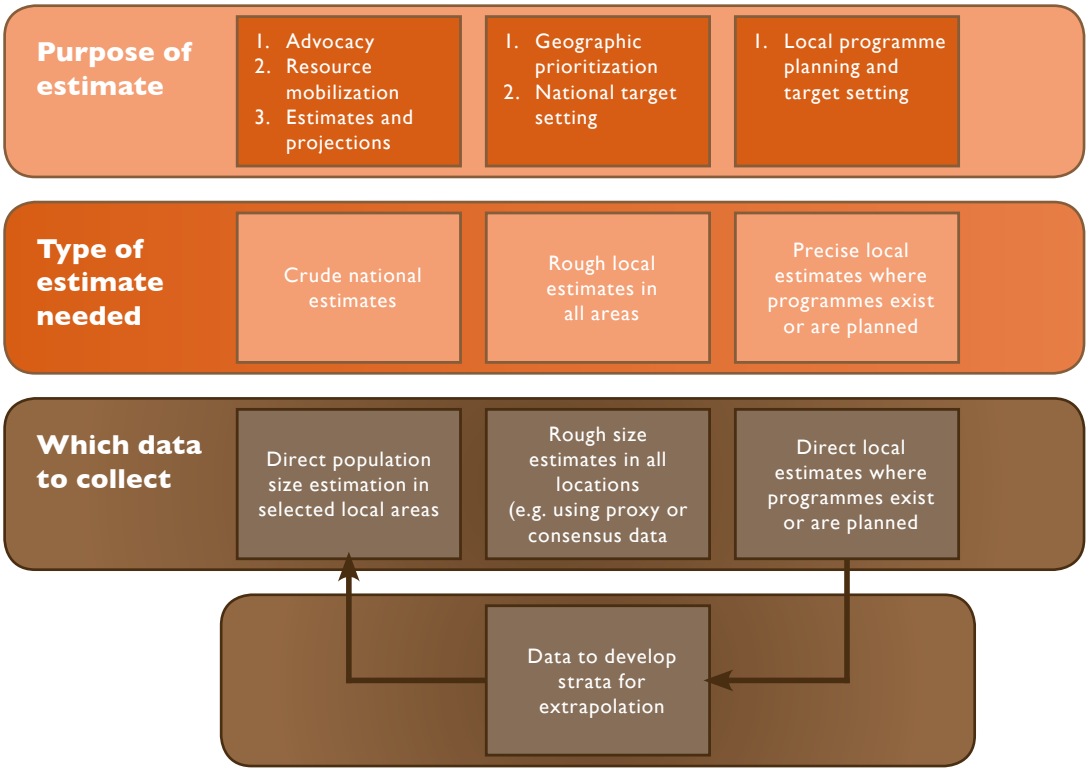

Figure 1 Framework for developing local and national size estimates for key populations

who have sex with men in the country requiring services, it may not matter whether the estimated number ends up being 1% or 2% of the population: either way, it is a large enough number to provide the necessary evidence. On the other hand, if the purpose of the estimate is to plan services in a particular city, then an over- or under-estimate of the same magnitude would potentially have large resource implications. In this situation, more precise local information is required.

The key difference between crude and precise estimates is the level of effort that goes into collecting the data. Crude national estimates can be obtained without collecting direct size estimation data everywhere in the country. By prioritizing direct size estimation data collection in a few well selected locations using one of the established methodologies (described in Chapters 3–7 of this guide) and applying appropriate extrapolation techniques, crude national estimates can be produced. Conversely, crude estimates obtained through extrapolation may be too inaccurate for planning and monitoring local programmes. In these situations, more precise local size estimates are required.

A third type of estimate mentioned in the framework is rough local size estimates. Similar to crude national estimates, rough local estimates are obtained using less-precise methods (e.g. proxy data, or consensus methods such as key informant interviews or wisdom of the crowd). They may have a wider margin of error, but still be sufficient for some purposes such as setting national targets, prioritizing geographic locations in need of programmes, and developing strata for extrapolation. For such purposes, the relative order of the estimates is key rather than their absolute values. Using crude estimates for national level target setting is not ideal, but as programmes mature and data become available in more locations, the estimates can be improved.

Chapter 3

Size estimation process

The planning process for developing local and national estimates is based on the framework. It involves a series of recommended steps for planning which data to collect and where to ensure that multiple size estimation objectives can be met (Box 1).

Box 1. Planning process for developing local and national estimates based on framework

Plan initial assessment (Level 1)

- Review country context and population size estimation activities that have been done in the past
- Decide for which populations size estimates are needed
- Define units to use as geographic zones for size estimation
- Develop criteria based on data that are available (or can be rapidly gathered) for each zone that will allow for grouping the zones into high, medium and low strata

Conduct initial assessment (Level 1)

Select geographic zones for size estimation (Level 2)

- Compile data on criteria selected during planning (Level 3)
- Use criteria to group zones into high, medium and low strata
- Prioritize and select zones within each stratum for direct size estimation data collection (taking programme needs, national level extrapolation needs, and available resources into account). Zones with existing or planned programmes should be prioritized, but a few strategically selection zones should also be selected for extrapolation purposes.
- Decide on method for direct size estimation in each selected zone (e.g. mapping, multiplier, capture–recapture)

Conduct direct size estimation data collection activities (Level 2)

Carry out activities in selected zones, and include data for correction factors

Build local size estimates (Level 2)

Develop local size estimates based on direct data collection by applying correction factors and triangulating with available local data

Build national size estimates (Level 2)

Use extrapolation algorithms to use local estimates to extrapolate within each stratum and at the national level.

Chapter 4

Initial assessment

4.1 Overview

The initial assessment is a systematic process used to inform choices about which data to collect, in which locations, on which populations, and by what methods so that in the end the country collects size estimation data that satisfies multiple purposes.

The initial assessment is intended to help overcome a common problem: the data needed to develop size estimates are generally available in only a small number of geographic areas. Typically, these data come from the highest burden areas where services are located or where size estimates have been developed previously. This will likely produce inflated key population size estimates if applied to the whole country. Some data are therefore required from lower burden areas for extrapolation purposes. While the idea of collecting data everywhere is appealing, it is not practical, and ultimately not necessary. A systematic process for strategically selecting locations for additional data collection is therefore needed.

The systematic process informs not only any immediate data collection exercise, it can also be used to leverage a longer-term national size estimation strategy by placing the country in a position where it is able to take advantage of future data collection efforts (e.g. mapping and key population surveys) to further strengthen the estimates.

4.2 Planning the initial assessment

Review previous population size estimates

Previous population size estimates are reviewed to determine what approaches have been used in the past and to become familiar with any limitations that may have arisen. Previously collected data are assessed to establish their usefulness for local estimates or whether they can be used in triangulation with newly collected data.

Assess the role and context of key populations

The populations that play the biggest role in most low and concentrated epidemics generally include people who inject drugs, men who have sex with men and sex workers and their clients. The extent to which these populations appear to play an important role in the spread of HIV in different locations and the feasibility of collecting data on them without causing undue harm must be assessed as part of the planning process. Useful sources will be any existing mapping data, case reporting data for HIV and sexually transmitted infections, data from key population and general population surveys, qualitative studies, and information from civil society organizations and/or nongovernmental organizations working with the population. Based on this information, a decision can be made about which key population size estimates are needed.

Define units to use as geographic zones

Geographic zones to be used need to be defined for developing local estimates and to function as the building blocks for developing national size estimates. A geographic zone may coincide with a political administrative unit, such as a governorate, province, state or district, or it may span several adjoining administrative units, for example a coastal belt or remote mountainous region. It may be a large city within a district or a unit corresponding to geographic areas of a certain size, e.g. 50 000 people in a contiguous geographic area may constitute one unit. The selected location should be meaningful as a unit and distinguishable, and basic information on demographics and geography should be available. Information on social indicators such as those described below may also be useful for planning estimation.

Identify criteria to use in developing strata

The criteria/social indicators used need to be identified for population size estimation. A primary outcome of the initial assessment is the strategic selection of locations for primary data collection to facilitate extrapolation to a national or subnational (e.g. regional) level while simultaneously supporting programme needs. Because data cannot be collected everywhere, efforts must be made to group geographic units with similar characteristics into strata so that data from at least one unit in each stratum can be collected and used to extrapolate to other units within the same stratum. The units should be grouped on the basis of pre-identified criteria that are likely to distinguish between places with high and low (or if possible, high, medium and low) epidemic potential. Examples of criteria include: general population size, population density, presence of commercial or industrial hubs that attract male migrant labour, proximity to international borders where sex trafficking or illegal drug trafficking occur, number of arrests related to sex work or drug use, quantity of drugs seized by law enforcement, etc. Information on reported HIV infections and the presence of HIV-related key population interventions can also be used. Rough estimates of key population sizes (e.g. in the order of 100, 1000, 10 000) may also be useful for ranking and categorizing.

The criteria should be developed and agreed upon by people who are knowledgeable about the country. Ideally criteria for which data from all geographic units (zones) are available, or can be obtained, should be used to enable a systematic process for grouping locations into strata.

4.3 Conducting the initial assessment

Compile data on criteria

Compiling data on criteria may be a simple desk exercise at the central level, but if resources and time permit, it will ideally also involve talking to local key informants and/or conducting rapid local assessments. The challenge with this is in identifying appropriate key informants in all areas. It is unlikely that there will be nongovernmental organizations or service providers for key populations in many parts of the country, but in some countries there are local public health officers who are responsible for HIV and AIDS activities within their jurisdictions. Because these officials may not always be aware of key populations or their risk practices, getting information from these types of key

informants may require both direct and indirect questions. For example, a direct question might be: How large is the sex worker population in this district? But an indirect question that tries to get at the same information would involve asking about the presence of the types of venues associated with sex work or male labourers in the area.

Use criteria to group zones into strata

Once the data on the criteria have been gathered, they should be compiled in a spreadsheet where they can be used to categorize areas into the desired strata. Approaches to categorizing may be qualitative or quantitative.

For quantitative criteria (e.g. number of reported HIV cases, size of the population, number of drug arrests), the data can be ranked in order of size and cut-off points can be established to assign the areas to the appropriate stratum. For example, if there are to be three strata, the top third can be placed in the high stratum, the middle third in the medium stratum and the bottom third in the low stratum. Thresholds can also be used, e.g. any area with more than 1000 reported infections is assigned to the high stratum and areas with fewer than 100 are assigned to the low stratum. Although this is a quantitative grouping, the process used is subjective and relies on the judgment of those viewing the data (see Table in Chapter 10 of this guide for an example).

If the criteria are qualitative (e.g. proximity to border areas, presence of industries that attract male migrant labour), points can be given to each and these are then summed to produce a weight (e.g. one point for areas with a major border crossing, one point for areas with major transport routes used by truckers, one point for areas with industries that attract male migrants, and so on). The points can then be added up and strata created on the basis of number of points. Depending on their importance, some criteria might be given a higher weighting than others. For example, in countries where HIV infection is prevalent among long distance truck drivers, then two or three points could be given for the transport route criterion instead of one. Although this approach is basically qualitative, it introduces an element of quantification by attempting to assign weights on the basis of how indicative or predictive of level of risk the criteria are thought to be.

Zones within each stratum are prioritized and selected for direct population size estimation data collection: this is again a judgment call on the part of those responsible for implementing size estimation activities. In addition to the scoring and weighting system, and the need for data for extrapolation purposes, the decision should also take into account ongoing data collection plans as well as programme needs and available resources. It may be possible to dovetail data collection for size estimation with other planned data collection activities, e.g. mapping, in places with programmes that are starting up or ongoing, or surveys that are planned in the context of surveillance or monitoring and evaluation. Taking advantage of these activities is resource-efficient, however they will tend to exist in those areas which have the highest epidemic potential, so it is important to remember that some data will also be needed from lower priority areas to use as a basis for extrapolation.

The selection process will also be driven by the availability of technical capacity and financial resources, and should be done in a way that balances available resources with the utility of the data (see Chapter 10 for an example).

Decide on method for direct size estimation in each selected zone

The main methods for direct size estimation include mapping, survey-based multipliers, capture–recapture and network scale-up. Proxy respondent is a new method based on network scale-up, but is simpler to implement. Although it is still under development, it is another approach that can be considered.

Chapters 6 to 9 of this guide provide an overview of these methods and reviews their relative strengths and weaknesses under various circumstances. As mentioned, ongoing data collection plans in the context of surveillance or programme implementation should feature prominently in the decision on where to collect data. In most situations it will not make sense to conduct special surveys (such as surveys to obtain a multiplier) solely for the purpose of size estimation. Mapping is likely to be one of the more realistic options for obtaining size estimates in many situations. However, it should be done only when it will not have negative consequences for the population being mapped. It must also be recognized that behaviours that can increase exposure to HIV, such as commercial sex and casual sex between multiple male partners, are often not observable in locations that can be mapped, or when they are observable, the observations may only include the more active, high-risk subset of the population whose size is being estimated.

4.4 Collecting data required for direct size estimates

Once the initial assessment is complete and decisions have been made about where and among whom to collect size estimation data, it is time to proceed with the development of data collection protocols and arranging the necessary support (e.g. logistical, technical, community). These issues are further elaborated in Chapters 6 to 9 of this guide and are also described in a number of publications (see Further reading).

When developing data collection procedures, it is important to consider the types of adjustments that will be required to transform the data into usable population size estimates. There are many potential adjustments that may need to be made; more information on correction factors is given below.

4.5 Developing local estimates

Building estimates

Building local size estimates once data have been collected is the next step in the process. This involves more than just tallying the results for those who were directly counted. The method will likely produce a point estimate and possibly a confidence interval. However, this is not the end of the process.

Apply correction factors

There are several factors which can affect direct size estimates, especially when mapping methods are used. These factors should be identified and accounted for in the data collection methodology so that adjustment factors can be applied at the time of analysis.

Among the things to plan for if mapping is done are:

- *double counting* – people who move around may be counted in more than one site, so a downward adjustment of the mapped number is required;
- *frequency of being present at mapped sites* – people who are present less frequently may be less likely to be counted so an upward adjustment of the mapped number is required;
- *invisibility* – people who conduct risk activities out of public view (e.g. contacting sex partners by phone or Internet) are less likely to be counted so an upward adjustment of the mapped number is required;
- *population turnover* – this is important if an annual figure is needed (i.e. number of people in the key population over a year) because mapping data tend to under-represent people with less frequent risk behaviours, so an upward adjustment is required.

If the multiplier method is being used to generate size estimates, double counting is not likely to be an issue. However, frequency of being present at sites included in the sampling frame may be an issue if time location cluster sampling surveys are being used and invisibility may also be an issue for the same reasons.

Assess bias

Point estimates must be assessed for bias to inform and justify direct local estimates. Data have to pass the reality test, i.e. seem plausible to the informed observer, as there are many factors that can introduce bias. So it is important to identify and document all possible biases and account for their potential impact on the numbers. This is not a statistical process, but rather one that is based on examination of the evidence and the judgment of the study team and local experts who are familiar with the situation on the ground. Accounting for bias may be a matter of widening the range around the point estimate to reflect the level of uncertainty.

Other adjustments

In some cases it may also be necessary to adjust for areas that were not included in data collection. For example, if the "units" used for stratification were districts but data collection was only possible in a portion of a district (e.g. the urban portion), it may be necessary to adjust the data so that they represent the entire district before extrapolating the results to other districts.

4.6 Developing national estimates

Extrapolation

Local size estimates are an end in themselves when the purpose is local in nature, however, they are also the building blocks for developing regional and national size estimates. The key to developing good national estimates is to avoid extrapolating indiscriminately when direct estimates are available in a limited number of areas. Extrapolation is not an exact process, but it can be made more robust through careful consideration of how to use information from areas where data have been collected to reasonably approximate the situation in areas where data have not been collected. The process of stratification described in the section above on the initial assessment is designed to achieve this objective.

One common approach to extrapolation is to apply the data strictly on the basis of population proportions. For example, if direct size estimates in a local area suggest that between 0.1% and 0.3% of men are men who have sex with men, the same proportion can be applied to the male population in areas within the same stratum. If local data are available from several locations, sometimes it makes sense to take the average across those locations before extrapolating. If this option is used, consider the effects of any extreme values and decide whether to remove outliers. An example of extrapolating estimates for national use is given in Chapter 10.

Validation and triangulation

Once extrapolation within strata is complete, stratum-specific estimates can be summed to determine a national estimate. The resulting estimates must be validated against other available data (e.g. estimates done by other methods, numbers of key population members already reached by programmes, etc.). It may be necessary to make further final adjustments. Key populations may be defined differently for different programme needs (elaborated in Chapter 5). This should be reflected in the design of population size estimate exercises, but adjustments to data at the last stages of the process may also be necessary. This can result in the use of different numbers from the same exercise depending on the purposes they are used for.

Chapter 5

Cross-cutting issues

5.1 Overview

This section of the guide provides an outline of issues related to the main size estimation methods employed in the context of the EM/MENA region. Specifically, the methods covered are:

- mapping
- capture–recapture
- multiplier
- network scale-up
- general population surveys.

The direct size estimation methods described in this guide are summarized in Annex 1.

5.2 Defining key populations

Common considerations

Before discussing the specifics of each method, it is important to consider some issues that cut across all methods. The most important of these is how to define key populations in the EM/MENA region in a way that is appropriate for the purpose. The key populations addressed in this guide include people who inject drugs, men who have sex with men, sex workers, and their clients. The definitions recognized in various United Nations documents tend to employ a broad definition of these groups as listed below; these are, however, wide-ranging categories, which must be refined and operationalized for data collection and data use:

- *people who inject drugs* – men or women who have injected any time within the previous 12 months (not including for medical purposes);
- *sex workers* – males, females or trans-gender persons (individuals whose gender identity and/or expression of their gender differs from social norms related to their gender at birth) who receive money or goods in exchange for sex, either regularly or occasionally;
- *men who have sex with men* – males who have sex with males regardless of whether or not they have sex with women or have a gay or bisexual identity.

The term key population is used to describe a group of people who are at increased risk of being exposed to HIV because they have frequent risky sex, or because they share injecting equipment (needles, syringes or other injecting paraphernalia) on a regular basis. Defining these groups more specifically can be challenging because we know that risk behaviour is a continuous spectrum, and defining cut-offs can seem arbitrary. It is also true that behaviour is not constant so there is no exact or perfect way to define groups. We cannot say that people who have risky sex or share injecting equipment on

an infrequent basis have no risk and should not be addressed by prevention programmes. However, within an epidemiological context, those with significantly higher levels of risk of acquiring and transmitting HIV will make the biggest impact on the epidemic, so they should be prioritized for both prevention and care and treatment activities. Consequently, the definitions used for each group may explicitly address more-frequent risk behaviour.

Because it is not always easy to distinguish or separate out the people with higher and lower risk, programme managers and people running interventions for key populations often prefer to use more inclusive definitions of the population. For instance, "men who had anal or oral sex with other men at least once during the previous year" is an inclusive definition which, if used for population size estimation, will produce a larger number than if a more restrictive definition is used, e.g. "men who had anal sex with other men during the previous one month" or "people who inject drugs on a daily basis".

When it comes to population size estimation, more-inclusive definitions are appropriate for some purposes and not for others. When the purpose is advocacy (i.e. providing evidence that the population exists) or resource mobilization (applying for programme funding), a more inclusive definition is often desirable. However, when estimating and projecting the number of people likely to be infected with HIV, an inclusive definition may produce overestimates, with the end result that programmes will be unable to meet treatment targets and resources will be wasted. Overestimating the number of people in need of prevention services can lead to similar problems, such as programmes not being able to meet outreach service provision targets (e.g. needle and syringe exchange, or provision of opiate substitution therapy). In such cases it may be better to use the more restrictive definition.

While there are no hard and fast rules, Table 1 illustrates possible effects of using more- or less-inclusive definitions for different size estimation purposes.

The inherent tensions over whether to use more-inclusive or more-restrictive definitions of key populations is well recognized, and there is no easy solution. By definition, more inclusive definitions are appropriate for some purposes and less appropriate for others. Ultimately, the same set of data will likely be used for all the purposes mentioned in Table 1. At any rate, those who collect and use the data should be cognizant of the effects of the definitions they choose, and be should be prepared to make the necessary adjustments at the time the numbers are being applied for the various size estimation purposes. Bearing this in mind, it is important to anticipate the types of adjustments that will be needed and to collect the required data at the time of primary data collection (see the sections on developing local and national estimates in Chapter 4 of this guide). It is also important to note that to some extent the definition will be limited by the methodology. For example, when size estimation data are collected through mapping of physical locations, people who engage in risky behaviour less often may be underrepresented because they go to the sites less frequently.

Table 1. Effect of using more/less inclusive definitions for population size estimation

Purpose	More inclusive definitions • Anal/oral sex in previous year • Injected in previous year • Sold sex in previous year	More restrictive definitions • Anal sex in previous month • Injected in previous month • Sold sex in previous month
Advocacy	Helpful for convincing policy-makers to pay attention and allocate resources for this population (as long as numbers are not misleading)	
Resource mobilization	Helpful for attracting donor support	
Modelling	Can result in gross over-estimate of people living with HIV/AIDS and new infections, particularly if used in combination with prevalence data from high risk subsets of key populations	Will lead to more realistic estimates of people living with HIV/AIDS and new infections by mode of transmission
Geographic prioritization	Both are okay if prioritization is in relative terms, as long as similar definitions are used everywhere	
National target setting	May overestimate the number of people that can be reached by programmes	Will help insure that the highest risk subset is prioritized for services
Planning local service delivery	Providing services to individuals across a broad spectrum of risk is a good thing to do if resources permit	
Monitoring local coverage		Will help ensure that the highest risk subset is prioritized for services

People who inject drugs

It is helpful to estimate sizes for male and female populations separately. This is to provide maximum flexibility in the way the numbers are used for different purposes. Patterns of accessing services, willingness to be contacted by a nongovernmental organization, and general visibility often differ considerably for males and females who inject drugs. The way the data are used to estimate numbers of people living with HIV and to assess epidemic potential may also differ, depending on circumstances. For example, there may be substantial overlap between injecting drug use and commercial sex, which would require specifically tailored interventions. In these situations, it is helpful to have separate size estimates for each sex.

As discussed in the section above on defining key populations, people who inject infrequently are not likely to constitute a large reservoir of new infection. So for epidemiologic purposes, the frequent injectors are the most relevant. A more narrow definition (e.g. those who injected in the previous one month) will help maintain the focus on regular (i.e. frequent) injectors. By the same token, due to high levels of relapse, it can also be useful to include estimates of people who inject drugs who are currently on opioid substitution therapy or drug treatment programmes as a subpopulation. To the extent that people enrolled in these programmes are likely to have been heavy injectors

in the recent past, their numbers are relevant for assessing both the potential for HIV to spread (epidemiologic focus) and for ensuring adequate resources are available to maintain them in harm reduction programmes (programmatic focus). Similarly, in some settings it may be important to also include non-injecting drug users if they are thought to be at risk of starting to inject.

Men who have sex with men

For epidemiologic purposes, frequency of exposure to HIV, rather than identity, is the most important feature. This means that men who have sex with the highest numbers of male partners most frequently have a greater risk of acquiring and transmitting HIV. In some countries of the EM/MENA region, men who identify as gay and who prefer to have sex with men may not be able to exercise this preference, and have very few, or infrequent, male anal sex partners. The challenge is therefore in identifying the highest risk subset (e.g. those who have had a male anal sex partner in the previous month).

Moreover, in some EM/MENA countries, being gay or having sex with men is particularly stigmatized and is also illegal, making access to services very difficult. One strategy for improving this situation for men who have sex with men may be to reach out to a broader cross-section of men. When the size estimate is used for this purpose, a more inclusive definition may be important.

The term men who have sex with men is all-inclusive, but it is frequently important to have separate size estimates for certain subgroups, e.g. for transgender males or for male sex workers, because their exposure to HIV might be different. When different services are planned for specific subgroups of men who have sex with men, it is important to adapt the direct population size estimation method selected so that separate estimates can be made.

Female sex workers

The EM/MENA region differs from other regions because brothel-based sex work is less common, and the term prostitute is sometimes used laxly to include women who have pre-marital or extramarital sex. Focusing on women with the highest risk of exposure to HIV is an important consideration, and it is important to focus on the behaviours as opposed to the labels. Using a more restrictive definition (e.g. women who have exchanged sex for money in the previous one month) will help with identifying the subset of women who should be the focus of HIV prevention and treatment efforts.

Depending on what the size estimate will be used for, women of all nationalities, regardless of legal status or language spoken should be included: many countries in the EM/MENA region have foreign sex workers.[3]

Clients of male/female sex workers

Clients of male and female sex workers are not always considered as a key population, despite being the largest exposed population and the population with the highest number of new infections in some countries.

[3] This may vary depending on what the size estimation will be used for (e.g. planning for prevention services may include foreigners, but estimating people living with HIV/AIDS for treatment needs may not).

Clients of sex workers are typically defined as men who bought sex in the previous year, though the frequency of buying sex and the number of different sex worker partners will affect the amount of exposure and potential for acquiring and transmitting HIV. If general population surveys are the method used to estimate the size of the sex workers' client population, there will be some flexibility on how sizes can be defined for different purposes. This can be helpful for modelling, where the population size and frequency of exposure to different commercial partners can have a huge influence on the level and trajectory of the epidemic.

5.3 Requirements for data collection

Most of the requirements for collecting size estimation data on members of key population are similar for the various methods (with the exception of network scale-up, which does not require direct contact with key population members).

The research team must have established a reasonable degree of rapport and trust with key population members (especially any who are influential leaders within the community).

Specifically, the following elements should be in place, ideally with a technical advisory group made up of key stakeholders to provide oversight.

- The study team should be comprised of entities or individuals who have good rapport with the key populations of interest.
- There should be evidence that members of key population are willing to participate in, and cooperate with, data collection efforts.
- There should be reasonable assurances that data collection will not pose a danger or bring unwanted attention to the population that is being evaluated. This may involve an assessment of human rights issues and the legal environment affecting key populations in the country.
- Professionals with appropriate expertise must be available to develop data collection protocols and standard operating procedures and to train others on the same.
- Staff with research experience must be available to lead and supervise the fieldwork (preferably with representation from the key population).
- Staff with appropriate skills in managing data and guiding others on data analysis and report writing must also be made available.

5.4 Dealing with international mobility

Addressing international mobility is a challenging area for population size estimates in the EM/MENA region. Key population members contribute to HIV transmission and are part of the risk environment whether they are engaging in risk at home or in another country. Many EM/MENA countries are host to foreign migrants, who sometimes buy or sell sex. In addition, many citizens of these countries prefer to buy sex when they are away from home and do so while traveling for work or holidays.

In previous size estimation exercises, countries within the EM/MENA region have made different decisions about whether and how to count non-national key populations in their size estimates. Ideally key population members should receive services both in their country of origin and in the countries they migrate to for work, tourism or other

purposes. For this reason, they should be included in size estimates, particularly those that are used to plan prevention programmes and deliver services, both in their own countries and in the countries where they engage in risk behaviours. In practice, this can be problematic. When foreign migrants have no legal status in the country, or when they must undergo mandatory testing and risk deportation if found to be HIV positive, they may be more likely to evade efforts to be counted. In other cases, EM/MENA countries do not offer treatment services to non-nationals, so they prefer not to include foreigners in key population size estimates used to forecast treatment needs.

A good solution is to estimate the sizes for both national and non-national key populations separately. This allows for maximum flexibility in the way the numbers are used.

5.5 Adapting size estimation methods to the virtual world

It is now becoming much more common for key populations to make contact "virtually" instead of at physical sites. For example, sex workers solicit clients through brokers or remote communication such as phone or Internet. Through the proliferation of smart phones and other access points to the Internet, more and more men who have sex with men are using social media apps to find male sexual partners rather than (or in addition to) going to physical venues. These developments put greater limitations on size estimation methods which require contact with the population (i.e. census, multiplier methods using data from time location cluster samples, and capture–recapture). At the same time, they offer new possibilities as Internet -based applications may reach parts of the population that have previously been unreachable. Different communities use different means of communication, and the usage of different Internet services varies. Specific local level knowledge is needed in the planning stage to determine which approaches are appropriate in the setting.

The main options for obtaining population size estimates which include the non-venue-based segment of the population include:

- multiplier methods with respondent-driven samples, either those conducted online or with physical respondent-driven sampling centres;
- virtual mapping of web-based sites used by the population of interest;
- crude estimation of the exclusively non-venue-based segment of the population from key informants.

Mapping, multiplier and network scale-up methods can all be adapted to virtual social environments, and some implications of this are briefly described below under each method. However, much work remains to develop and establish reliable methods of population size estimation in virtual environments.

Chapter 6

Census-taking methods for estimating key population sizes

6.1 Circumstances when it is appropriate to use census-taking methods

Census-taking (also known as mapping) is a method used to directly count members of a key population by observing or interacting with them in locations/venues where they engage in risk behaviours. This is a good method for estimating the size of the visible portion of a key population, i.e. the subset that can be found at physical locations and that can be identified as comprising persons who engage in the behaviour that defines the key population (e.g. men and women selling sex, men and women injecting drugs and men having sex with men).

Examples of subgroups which are not easily estimated using census-taking methods include:

- the subset of men who have sex with men who only gather in private homes and who share information via word of mouth;
- the subset of sex workers whose clients contact them through brokers or via mobile phone, and who do not solicit clients from physical locations;
- the subset of people who inject drugs who inject in private homes, or who get their drugs and injecting equipment from friends or family rather than directly from dealers;
- clients of sex workers (in general, the size of this population is difficult to estimate using census methods because it is hard to distinguish men who buy sex from those who do not).

If these less visible subgroups represent a large proportion of the key population, mapping or census-taking methods may greatly underestimate the size of the total group.

Census data can be collected through specific studies planned primarily for the purpose of estimating the size of a key population. However, it is preferable to integrate the activity into mapping studies that are already being conducted for other purposes, such as identification of hotspots for outreach interventions, or sampling frame development for bio-behavioural surveys. With some advance preparation, these mapping exercises can serve the additional purpose of size estimation, thereby making the endeavour more resource-efficient.

6.2 Overview of census-taking methods

Mapping using the census method involves visiting all known sites in a defined geographic area, developing estimates for each individual site and then summing those estimates to create a total across all the sites. This may involve conducting a head count of key population members at each site, as observed by the team conducting the mapping, or it may involve estimates given by key informants (people who are found at the site itself

or who are familiar with the network of people associated with the site), or ideally some combination of the two.

To generate the list of sites, it may be possible to obtain a starting list from existing sources. For example, sex workers may operate at certain types of restaurants or guest houses that are required to be registered or obtain certain types of licenses. If so, a list of these establishments may be available as a starting point, which can be added to using key informants at each known site to identify other sites.

6.3 Data to be collected during the field work

This will include:

- a list of all the sites where the key populations are known to gather;
- a count of the number of key population members at each site (with each virtual space if mapping Internet or social media sites) at the time the team is visiting as well as an estimate of the number frequenting the site/space over the previous week (the latter number will be based on data from key informants and, to the extent possible, multiple visits to the site during the period when the census is ongoing);
- data for making adjustments for factors that can lead to over- or under-estimates.

6.4 Potential for over- or under-estimation

There are many factors that can lead to over- or under-estimation when using census methods. Some of these are listed below.

- *Double counting* – People who move around may be counted in more than one site, so a downward adjustment of the mapped number is required.
- *Frequency of being present at mapped sites* – Those who are present less frequently may be less likely to be counted so an upward adjustment of the mapped number is required.
- *Misclassification* – This occurs when data collectors misread cues, gestures and appearances that identify members of key populations; an upward or downward adjustment of mapped numbers may be required.
- *Invisibility* – People who conduct risk activities out of public view (e.g. contacting sex partners by phone or Internet or in locations that are hidden from view) may be unlikely to be counted so an upward adjustment of the mapped number is required.
- *Population turnover* – This is important if an annual figure is required (i.e. number of people in the key population over a year) because mapping data tend to under-represent people with less frequent risk behaviour.

Table 2 provides some examples of circumstances that might lead to over- or under-estimation of the size of key populations when using census methods. These are issues that cannot be totally avoided, but being aware of them and collecting data to make adjustments can help mitigate the effects. It is important to be aware of these factors and collect data to make adjustments whenever possible.

Table 2. Factors that can cause bias with census methods

Population	Situations that may lead to over-estimation	Situations that may lead to under-estimation
Female sex workers	• Sex workers make the circuit of several bars and clubs in an evening and they are counted at multiple sites • Women who work in dance clubs, bars or hair salons are counted as sex workers although some do not sell sex	• Women at solicitation sites are afraid of being stigmatized and are not willing to admit that they sell sex • Women who solicit sex less frequently may be less likely to be at the site when the mapping team visits • Agents or pimps refuse to cooperate with the mapping teams, so sex workers who work with them are not counted
People who inject drugs	• Drug users who do not inject are counted as people who inject drugs by census teams who cannot distinguish between injectors and other drug users	• The majority of people who inject drugs do so at sites which are identified by nongovernmental organizations: people who inject drugs at non-identified sites are not counted • People who inject less frequently may be less likely to be at the site when the mapping team visits
Men who have sex with men	• All men at a public park known to be a gay cruising site are counted as men who have sex with men although the park is frequented by both men who have sex with men and other men • Men who have sex with men cruising at multiple sites are counted more than once	• Men who have sex with men are afraid to be identified because of fear of being arrested or beaten, so they hide their identity even in gay cruising sites • Men who have sex with men looking for sexual partners at gay venues do not want to be recognized, so they stay only long enough to make contact with a sexual partner and then leave • Men who seek sexual partners less frequently may be less likely to be at the site when the mapping team visits
Clients of sex workers	• Men at a dance club or bar are all counted as clients of sex workers, although many of them never buy sex, and it is difficult to distinguish those who do from those who do not	• Clients of sex workers at solicitation sites (e.g. clubs) are difficult to identify, and do not admit to buying sex

Suggestions for information to be gathered from key informants when census data are being collected include:

- whether the time of the mapping team visit is at the standard peak time to help adjust for duplication and frequency of key population members visiting sites (requires agreement on "standard peak time" to be used across the area being mapped ahead of time);
- proportion of key population members who are likely to visit other sites during the standard peak time to help adjust for double-counting;
- proportion of key population members who do not visit sites at the standard peak time regularly (i.e. at least every week or two weeks) to help adjust for the likelihood of having been counted during the mapping;
- proportion of key population members who visit sites at other times, but not during the standard peak time (to help adjust for the proportion who may be missed if mapping takes place only at peak times);
- proportion of key population members who never visit sites (to help adjust for the hidden or less visible population who will be missed when mapping at physical sites) (Note: this includes sex workers who are apartment-based, who do not publicly solicit clients and are therefore difficult to map);
- proportion of mapped key population members who also visit virtual sites (via Internet or social media) to help adjust for overlap between mapping of physical sites and mapping of virtual sites.

If there is a survey planned for the same key population to be used in the mapping exercise, a question can be added to measure whether the respondents visited physical venues during the standard peak time in the previous week or two. Again this requires a common definition of standard peak time.

Chapter 7

Capture–recapture for estimating key population sizes

7.1 Circumstances when it is most appropriate to use capture–recapture

Field-based capture–recapture is a survey-based method of population size estimation. It involves visiting sites where key population members are known to congregate on two separate occasions, tagging all key population members found at the sites on each occasion, calculating the degree of overlap between key populations, and deriving a size estimate.

Field-based capture–recapture methods are useful for estimating sizes of key populations that are accessible in public venues.[4] As is the case with mapping and census approaches, it is most appropriate for visible subsets of the population, i.e. those who are identifiable and approachable. However, some population members do not gather at physical locations or venues; in this case capture–recapture will not provide estimates of population size (unless non-field-based methods are used).

Capture–recapture is well suited to populations that are highly mobile. The method is less appropriate for more stationary populations who frequent sites at fixed times according to fixed patterns (e.g. some brothel-based sex workers). In such cases, simple mapping and counting may be just as effective. Capture–recapture is also not appropriate for populations whose members are unlikely to overlap because they visit locations very rarely, or because they migrate in or out of the area.

There are two main assumptions associated with capture–recapture has: the population must be relatively stable with little in or out migration, and the probability of being tagged as part of the first capture must be independent of the probability of being tagged as part of the second capture.

Unlike mapping, where it is possible to observe and count individuals without necessarily interacting with them, capture–recapture requires direct contact with each member of the population being counted. Therefore it works best when the population feels comfortable being approached and asked questions about their behavioural risk. If population members feel threatened when approached, or if they will be harmed if their identity is disclosed through the capture–recapture process, this method should NOT be used. In some situations in the EM/MENA region, because of the extreme sensitivity and potential danger resulting from identifying people in public settings, the need to interact with people is a disadvantage of the method.

7.2 Overview of capture–recapture method

The field procedure for capture–recapture involves identifying physical locations, i.e. venues, where key population members are known to gather. Field teams visit all the

[4] Non-field-based methods can also be used for capture–recapture. These do not require that people be reachable in public venues.

sites in a first sweep, making contact with individual members, giving them a unique object marker of some kind (e.g. a small gift, an invitation or leaflet advertising an event, etc.). People who receive the object are considered "captured". After a short period, e.g. two weeks, the field teams visit all the venues again in a second sweep. During the second visit, teams again make contact with as many population members as possible, asking them whether they received the designated marker during the first sweep, and thereby identifying those who are "recaptured". Using a mathematical formula, the results from the first and second sweep are used to calculate a population size estimate. This formula is based on the probability of individuals being at the venue and captured at the time the field teams are doing the first and second sweeps.

As with census methods, a comprehensive list of all sites where key population members can be found is required as a first step. Depending how big the geographic catchment area is for the size estimate, significant fieldwork may be involved in creating these lists. Sometimes it is possible to start with an existing list, but the list should be updated at the outset so that new sites can be identified and sites that no longer exist can be removed.

Fieldwork must be completed in a short period of time, which, depending on the size of the population and the area, may require several teams working simultaneously, making it resource-intensive. Although it is theoretically possible to reduce the required resources by randomly selecting a subset of sites for each sweep, doing so can compromise the precision of the estimates, especially if there is not a lot of overlap between the sites in the first and second sweeps. High levels of mobility can also exacerbate the potential for error when using a subset of sites.

In some situations it may be possible to use non-field-based methods to implement capture–recapture. Non-field-based methods require two or more existing independent sources of data with perfectly matched identifiers. An example would be a list of people who inject drugs in rehabilitation centres matched with a list of people who inject drugs who had been arrested. Both lists must have unique identifiers that can be matched (e.g. name and ID number), and placement in a rehabilitation centre cannot be related to being arrested (e.g. if inmates were referred to the rehabilitation centre) lest the assumption of independence between the two data sources be violated.[5]

7.3 Data to be collected

During the field work, the following data need to be collected:

- list of all the sites where key population members are known to gather (along with some information about peak and lean times);
- dates and times when field teams visited the site during the first and second sweeps;
- number of eligible people who were tagged during the first sweep, ideally broken down by subgroup and site;
- number of eligible people tagged during the first sweep and retagged during the second sweep, ideally broken down by subgroup and site.

[5] Note: The multiplier method is similar to capture–recapture.

7.4 Adjustments for factors that can lead to over- or under-estimates

Most of the adjustments identified for census data do not apply for capture–recapture.

With capture–recapture, it is expected that people move around between sites. Counting the same person twice (i.e. duplication) is known as recapturing and is a built-in part of the method. However, the same person must not be counted twice during the same sweep.

Frequency of visiting sites is also less problematic with capture–recapture than with census-taking because there is no assumption that everyone will be tagged, and a person does not need to be tagged to be part of the estimate. The method assumes that some people will be tagged once, some people will be tagged twice, and some people will not be tagged at all. But the estimate will include all of these.

Misclassification (resulting when data collectors misread cues, gestures and appearances that identify members of key populations) is also less of a problem with capture–recapture. This is because there must be direct contact between the data collectors and the key population members, and the eligibility of the person must be confirmed before the person can be tagged.

Adjustments for population turnover and invisible population members (those who are not identifiable and approachable at venues) will be required, as for mapping.

7.5 Potential for over- or under-estimation when using capture–recapture

All eligible members should be tagged (counted) only once during each sweep. Duplicates (same individual being tagged or counted multiple times) and omissions (eligible people not being tagged or counted) can lead to over- or under-estimates of population size, and should be avoided. There is also a potential for underestimating when the less-visible portion of the population is missed.

If there is a possibility of questioning of key population members being tagged during a capture–recapture exercise, any information gathered may be useful for making adjustments related to the less-visible population. Suggestions for questions to ask include:

- the proportion of key population members who never visit sites (to help adjust for the hidden or less visible population who will be missed when mapping at physical sites);
- the proportion of key population members who also visit virtual sites (via Internet or social media).

Chapter 8

Multiplier method

8.1 Circumstances when it is most appropriate to use the multiplier method

The multiplier method involves using two overlapping sources of data from the same target population to derive population size estimates. The overlap is a marker or identifier that matches the members of the group to each other, either at the individual or the group level. A mathematical formula is applied using the matching information to estimate the size of the total population of interest.

When countries are planning to conduct surveys for surveillance or evaluation purposes among key populations, this is an appropriate opportunity to build in a survey-based multiplier. Although this requires some forethought and planning, it is not difficult, and adds very little cost. On the contrary, planning a special key population survey solely for the purpose of obtaining a population size estimate is not likely to be an efficient use of resources, and is not generally recommended.

8.2 Overview of the multiplier method

The multiplier method most commonly employs existing data (such as routine programme monitoring data) together with a survey of the population of interest as the two data sources where:

- data source 1 is a count or listing of unique key population members who accessed a particular service or received a particular object during a specific period of time (e.g. previous one month or previous six months);
- data source 2 is the percentage of the population that reports having accessed the service or received the object described in data source 1 during the same specified time period.

The main assumption of the multiplier method is that the two sources of data are independent of one another. That means the probability of being included in one source should not be related to the probability of being included in the other.

To avoid the possibility of data sources being mismatched, there should not be a lot of movement of the population (in or out) during the time period specified for the estimate.[6]

[6] Capture–recapture uses the same general formula and probability as the general multiplier method; it generates the two sources of data through field work, i.e. when conducting the first sweep to capture the population and the second sweep to recapture the population; it does not require unique identifiers either.

8.3 Data to be collected during the field work

The multiplier method relies on data that are collected as part of primary data collection efforts that are done for other purposes. Specifically the multiplier method requires:

- routine programme monitoring data and/or unique object data;[7]
- data from probability surveys among key populations designed to correspond to the routine monitoring data or the unique object data;
- data for making adjustments for factors that can lead to over- or under-estimates.

To be effective, the data sources used in the multiplier method must be well matched, i.e. the two sources should define the key population in the same way and use the same geographic boundary for inclusion. It is important to assess the quality of the available multiplier data, examining existing lists and counts to ensure that the information meets requirements. Specifically, the multiplier data must be assessed for its potential to be matched with survey data, by ensuring that a) the count includes only people who are eligible for the survey, and b) the survey question pertaining to the count is highly specific so that people are correctly classified as being part of the count or not. This can be challenging in areas where there are no specific services exclusively for key populations. Finding lists from service delivery records which can distinguish those patients/beneficiaries who are members of key populations is not always possible. For example, an HIV testing centre register may include only a list of people tested, but not indicate who is a sex worker or who is a client of a sex worker, etc. Similar restrictions apply with user data on users of Internet services. An outreach register may not distinguish people who inject drugs from people who inhale, smoke or take drugs orally. Furthermore, in the absence of unique identifiers, it may not be possible to eliminate duplicates from the count.

There are a number of factors to bear in mind for service-based multipliers. If using time-location sampling, it is best to use one that covers a recent time period, e.g. the previous one month (as opposed to previous six months or year) because time–location surveys are less likely to include people who engage in risk behaviours less frequently. This may cause them to be mismatched with service data covering longer periods. If using respondent-driven sampling, however, the same issue does not apply and options for time periods on service-based multipliers are more flexible. For example, if the survey is capturing men who had sex with men in the previous year, then the service-based multiplier can cover the previous year, or a shorter time period (previous month or six months).

As with capture–recapture, adjustments for duplication and frequency of visiting sites are not necessary for this method because they are taken care of through the sampling process. However, adjustments for population turnover and invisible population members (those who are not identifiable and approachable at venues) will be required, especially if using time–location sampling.

[7] Note that unique object marker data are not routine. The objects must be distributed specifically for the purpose of obtaining a size estimate using the multiplier method.

Table 3. Factors that can cause bias using the multiplier method for population size estimation

Situations that may lead to over-estimation	Situations that may lead to under-estimation
Programme-based multiplier: • People not eligible for the survey get included in the count • People less likely to be included in the survey (e.g. those who engage in risk behaviours less frequently) are included in the count • Duplicates get included in the count Unique object: • Not all objects are distributed but the calculation is made as if they were • Some objects are distributed to people who are not members of the key population • Survey respondents fail to report accessing the services or receiving the object even though they did receive it	Survey not random – respondents more likely to have received services or objects than people not included in survey • Survey respondents report accessing the service or receiving the object although they did not do so

8.4 Potential for over- or under-estimation with the multiplier method

The key to determining the usability of the estimate obtained through a survey-based multiplier lies in assessing the representativeness of the survey sample and the quality of the data used for the multiplier. Trying to determine the direction of likely biases in the data can be challenging. Table 3 lists some of the things to look for which can cause over- or under-estimation with this method.

8.5 Triangulating multiplier data and mapping data

As mentioned in the section on census-taking methods, data for making corrections to mapping data can be included in surveys of key populations by asking respondents about the following points.

- Has the respondent visited the types of sites included in the census/mapping during the standard peak time in the previous week or two? This can provide proxy data for frequency of visiting venues at peak times and likelihood of missing people during mapping exercises. The method requires defining the standard peak time for the area or zone where the data are being collected.
- If using time–location sampling, a question about whether the respondent also frequents virtual sites (using phone, Internet or social media) to meet partners/clients should be added. This can be used for making adjustments to virtual mapping data.
- If using respondent-driven sampling, respondents should be asked whether they find partners/clients at physical venues, or through phone, social media or other Internet sites, or all three.

Chapter 9

Network scale-up and proxy respondent

9.1 Circumstances when network scale-up methods are appropriate

Network scale up is a method used for estimating the size of a population of interest in a given geographic area using data from a general population survey. If the data come from a survey that is national in scope, the corresponding size estimates will also be national in scope.

This method is useful when it is expected that mapping and direct survey methods (capture–recapture or multiplier) will lead to difficulties identifying and accessing eligible respondents, and convincing them to participate in surveys and provide accurate information. In such situations, network scale-up can be a good way to obtain size estimates, and it can be done for several populations from a single survey. However, because general population surveys can be expensive, depending on the methodology used, AIDS programme managers should look for opportunities to collect network scale-up data as an add-on to existing surveys being conducted for other purposes.

9.2 Overview of network scale-up methods

Network scale-up involves conducting a general population survey and estimating a) the personal network size of each respondent, and b) the number of people known by respondents who engage in the behaviour of interest (e.g. injecting drugs, selling sex, or same-sex relations between men). With this information, the total size of the key population can be estimated. Because people are asked to provide information about others, rather than about themselves, responses may be less prone to social desirability bias.

Household surveys are normally used to obtain general population data. In some countries it may be possible to conduct general population surveys via telephone using random digit dialling. However, this might be difficult in the cultural context of the EM/MENA region because of the sensitivity of the questions. In the Islamic Republic of Iran, network scale-up surveys have been conducted using street-based sampling as a proxy for the general population (since household-based surveys have been found to have both sampling bias and information bias) (Personal communication, Ali Akbar Haghdoost, Kerman University, 2015).

Another method, known as the summation method, involves helping respondents list the people they know by category (e.g. family, neighbours, co-workers, friends) and then adding up all the categories to produce a total social network size.

9.3 Estimating the number of people in the network who belong to the population of interest

All methods of population size estimation are sensitive to the way the population being estimated is defined. Definitions are not always simple and straightforward, however, there is an added layer of complexity when the information is provided second hand, i.e. the people providing the information are not the ones engaging in the behaviour.

Female sex workers – In some countries of the EM/MENA region women who have sex outside the context of marriage, or who do not follow social norms with respect to male/female relationships, might be stigmatized and labelled as prostitutes by some even though they do not receive cash in exchange for sex on a regular basis. It is therefore very important to include specific questions that will help ensure that the estimates correspond to the relevant population, in this case by asking specifically about knowing women who receive cash in exchange for sex.

Men who have sex with men – In the case of men who have sex with men, if the definition of the population of interest is men who have had anal sex with other men in the previous six months, or even more specifically, men who have received cash in exchange for sex with other men in the previous six months, it would be extremely difficult for people outside their immediate network (or even within their network) to know this information about them. There may be a tendency for people to consider individuals whom they know to be gay, whether or not that person is actively involved with any male partners. On the other hand, some men who give the outward appearance of being straight, or even some who are straight (by their own definition), might still have sex with other men under certain circumstances. Again, it is difficult for a third party to know.

Clients of sex workers – Estimating the population size of male clients of sex workers by the network scale-up method might also be quite challenging because the behaviour is not necessarily something that men would be likely to talk about with others (outside perhaps a limited group). There may also be a category of men who buy sex when travelling outside the country (while on business travel for example), and it would be important to know where and from whom they bought sex (males, females, or both), in order to use the size estimates in a meaningful way.

In summary, poorly defined populations and subpopulations and failure to design data collection instruments that are tailored to the groups that are being counted can produce distorted estimates.

9.4 Data to be collected during the field work

Key data

The key pieces of data that must be collected from general population surveys are:

- estimated social network size of the respondent;
- estimated number of people known by the respondent who engage in the behaviour of interest;
- information that can be used for making adjustments for factors that can lead to over- or under-estimates.

Network size can be hard to estimate because the definition of what it means to "know" someone can have many interpretations. It is important to find a definition that can be commonly understood and explained to respondents in a standardized way. This will involve operationalizing the definition. For example, a person you know could be defined as "someone whose name you know, and who knows your name, and whom you have seen in the past two years and whom you could find if you needed to".

Data for making adjustments

Because network size is hard to estimate, sometimes additional questions can be put to the that will provide information for calibrating the size. This is done by asking respondents about populations whose sizes are already known (such as the number of people named Ahmed), and using that information to back-calculate a network size, which is then used to calibrate the information given by respondents.

Potential for over- or under-estimation with the network scale-up method

There are a number of potential biases which can affect population size estimates that come from network scale-up, including:

- *transmission bias* – respondent not knowing that people they know engage in the behaviours of interest;
- *response bias* – respondent not being willing to reveal information;
- *barrier effect* – social or physical barriers that make it less likely that some people will know people in the population of interest;
- poorly defined populations.

Chapter 10

Constructing national estimates step-by-step: an example

This chapter provides an example of the process for estimating the number of female sex workers in a large and diverse country. It goes through the following steps:

- initial assessment;
- selecting locations for collecting size estimation data using a stratified approach that will both provide data for local programmes and be useful for extrapolation to the national level;
- applying correction factors to locally collected data;
- identifying issues for using local size estimates for setting programme targets;
- extrapolating local data to develop national size estimates;
- adjusting national size estimates to obtain annualized figures for setting national targets and when using Spectrum.

10.1 Context

This example uses a country with a total population of approximately 24 million in 23 districts distributed in five governorates. Commercial sex has been determined to be one of the main drivers of the HIV epidemic. Funding has been received to support mapping and population size estimation of sex workers. There are programmes for sex workers already in place in seven districts, and integrated bio-behavioural surveys among sex workers planned in two governorates. The mapping data are needed to support local programmes and also to set national level targets. Funds are available to conduct mapping in approximately 8 districts. Rather than choosing the districts randomly, an initial assessment is first conducted to help identify which districts will provide the data needed at both the local and the national level.

10.2 Initial assessment

The goal of the initial assessment is to form strata to decide how to collect data in a way that reflects the national situation, without collecting data everywhere. Data are available on the size of the overall population by district from a census in 2010, however the investigators want to gather data that will give them rough estimates of the number of sex workers in each district to help them prioritize. They decide to interview key informants from each district to obtain rough estimates of the number of women who received money in exchange for sex in the previous one month. Each key informant is asked a multiple choice question about whether the number of sex workers is less than 100, between 100 and 1000, or more than 1000. They interview three different key informants from each district and use the average response. The districts are then classified as high, medium and low strata (Table 4). The high stratum comprises 6 districts that are estimated to have more than 1000 female sex workers. The medium stratum comprises 10 districts estimated to have between 100 and 1000 female sex workers and the low stratum comprises 7 districts estimated to have fewer than 100.

Table 4. Selection of districts for collecting direct population size estimation data: example

Governorate & district	Total population	No. of female sex workers (rough estimate)	Stratum	Programme for female sex workers present	IBBS survey planned for female sex workers	Selected for size estimation activities
G1 D1	853 475	> 1000	High	X	X	X
G1 D5	1 030 732	> 1000	High	X		X
G2 D8	647 821	> 1000	High	X		
G4 D16	2 288 254	> 1000	High			X
G4 D17	1 248 075	> 1000	High			
G5 D21	2 510 951	> 1000	High	X	X	X
G1 D2	976 987	100–1000	Medium	X		
G1 D4	554 348	100–1000	Medium			
G2 D7	645 866	100–1000	Medium	X		X
G3 D11	1 175 400	100–1000	Medium			
G3 D13	552 525	100–1000	Medium			
G3 D14	1 235 968	100–1000	Medium	X		X
G3 D15	1 923 089	100–1000	Medium			
G4 D18	1 022 002	100–1000	Medium			
G4 D19	2 075 478	100–1000	Medium			
G5 D23	1 335 024	100–1000	Medium			X
G1 D3	457 988	< 100	Low			
G2 D6	319 237	<100	Low			
G2 D9	232 995	< 100	Low			X
G2 D10	942 646	< 100	Low			
G3 D12	359 653	< 100	Low			
G5 D20	318 741	< 100	Low			
G5 D22	869 681	< 100	Low			
Total	23 576 936					

IBBS = Integrated biological and behavioural surveillance.

X = yes.

10.3 Selecting districts where direct size estimation data collection should be done

The investigators use the following techniques to strategically select the districts in a way that will allow for both local estimates and national level extrapolation.

- Of the eight districts to be mapped, they select the majority in the high stratum, because this will provide data to be used for setting local targets, and also for understanding more about the locations of the sex workers they need to reach.
- They also select the two districts where an integrated biological and behavioural surveillance is planned among sex workers so that they can build in a multiplier to

obtain independent size estimates for triangulation purposes, and also to obtain data to help in developing correction factors for the mapping data.
- They make the final selection of four districts from the high stratum, three from the medium and one from the low stratum for extrapolation purposes. This works out to approximately 65% of the total number of districts in the high stratum, 30% of the total number in the medium stratum, and 14% of those in the low stratum.
- For the medium and low strata, they try to distribute the chosen districts across governorates as much as possible.

The districts selected for size estimation are illustrated in Table 4. While conducting the mapping, the investigators collect data to make adjustments for mobility, frequency of attending sites and the hidden population.

10.4 Applying correction factors and using the data

Sequence

After conducting the mapping, an estimated number of female sex workers was obtained for each of the eight mapped districts. Correction factors are then applied to the mapped numbers. The order for applying corrections is:

1. mobility
2. frequency of visiting sites
3. hidden population
4. turnover.

After applying the mobility and frequency corrections, the resulting numbers will be compared to the number reached by the programme (in those districts where programmes were in place). These observations will be used for making decisions and recommendations on target setting. Adjustment for the hidden population is described in detail in Step 4 and the adjustment for turnover in Step 6.

Mobility correction factor

The first correction factor applied to the mapped numbers was for mobility. Counting the same person at more than one site can result in an overestimate of the population size. Data to correct for mobility can be collected during mapping. The main idea is to collect data on how many members of the key populations may have visited multiple venues during the times when the team was mapping. Key population members can visit two, three or even more venues if they are highly mobile. Street-based, and sometimes also bar-based, female sex workers may fall into this category.

One systematic approach for correcting for mobility is to use a standard peak time, agreed upon before data collection begins. The standard peak time should be a time when the this approach is used, the team should try to conduct mapping visits to the sites during the standard peak time (e.g. Friday night between 20:00. and 01:00.). However, if they do the mapping at a time that is not the standard peak time, they should still try to gather some information about the standard peak time at that site, to be used specifically

for the mobility and frequency corrections. In this way, the standard peak time serves as an anchor time for measuring mobility and frequency. The information to be gathered during mapping is:

- estimated number of key population members who are generally present at the site during the standard peak time;
- proportion of key population members expected to also go to other sites during the same standard peak time, and the number of additional sites they go to.

This information should be collected from key informants at the site who are members of the key population. The team should try to find at least one or two key informants who seem most able to provide reliable information. The calculation for the mobility correction is shown in Fig. 2.

Table 5 shows the correction factors for mobility and the corrected numbers after adjusting for mobility. When the mobility correction is applied for all 8 districts mapped, it results in a downward adjustment of the total number from 13 287 to 10 726, which is about a 19% reduction in the overall number.

Data required for calculation	No. or % of female sex workers at each site
Number of female sex workers observed in district D1 during the standard peak time (summed across all sites in the district)	2560
Proportion estimated to solicit at 2 sites during standard peak time	15%
Proportion estimated to solicit at 3 sites during standard peak time	22%
Assuming that each female sex worker who solicits at 2 sites spends 1/2 her time at each site, and each who solicits at 3 sites spends 1/3 of her time at each site, the adjustment for mobility is the total number of female sex workers in the district multiplied by the correction factor (1 minus 1/2 of the proportion who visited 2 sites, minus 1/3 of the proportion who visited 3 sites)	Mobility correction factor = 1 – (0.15/2) – (0.22/3) = 0.85 Thus, no. of female sex workers, corrected for mobility = 2560 × 0.85 = 2176

Figure 2 Calculation for mobility correction: example for district D1

Table 5. Mapped numbers of female sex workers in 8 hypothetical districts selected for size estimation after correcting for mobility

Governorate & district	Total population	Mapped number (female sex workers)	Correction factor for mobility	Mapped number corrected for mobility
G1 D1	853 475	2 560	0.85	2 176
G1 D5	1 030 732	2 060	0.76	1 566
G4 D16	2 288 254	2 288	0.90	2 059
G5 D21	2 510 951	4 970	0.79	3 926
G2 D7	645 866	576	0.76	438
G3 D14	1 235 968	430	0.74	318
G5 D23	1 335 024	304	0.57	173
G2 D9	232 995	99	0.71	70
Total	10 133 265	13 287		10 726

Correction for frequency of visiting sites

The next correction factor to be applied is to correct for under-representation of key population members who are absent from venues when the mapping team visits the sites. A mapping exercise can reasonably expect to count currently active key population members (e.g. active in the month). However, even to count the currently active population, if mapping teams visit sites during peak times, there will still be a certain percentage (large or small) who will not be at the sites at those times. The frequency correction is intended to account for that portion of the group which is otherwise visible (because they frequent mapped sites), but who are missed during mapping team visits.

Ideally this correction factor should be based on survey data which asks key population members from the same catchment area whether they have been to venues during the agreed upon standard peak time in the previous week. This survey information can then be used as a proxy for the proportion of people who would have been missed during mapping visits. For example, if 75% of people report that they went to venues during the standard peak time in the previous week, the correction factor would inflate for the 25% who were not soliciting at venues during the standard peak time during the mapping period. This assumes that female sex worker behaviour is roughly the same from week to week.

In the absence of survey data, the teams can ask key informants during mapping visits to estimate the proportion of key population members who they think do not appear at venues during the standard peak time. Although very rough, this figure can be used to correct for the portion of the group that is not observed during mapping visits. For example, if, on average, key informants say that 40% of people would not come to the sites at the standard peak time, then the number counted at peak time would be inflated to account for the 40% who would be missed. An example of the calculation is shown in Fig. 3.

Data required for calculation	Mapped number of female sex workers Proportion who solicited at mapped sites during standard peak time (as per survey data if available), or else as per estimates from key informants
Assumptions	Female sex workers weekly behaviour is roughly the same (i.e. they will generally solicit on the same days of the week)
Number of female sex workers observed in district D1 during the standard peak time (summed across all sites in the district)	Before mobility adjustment: 2560 After mobility adjustment: 2176
Estimated proportion of female sex workers who do not appear at venues during the standard peak time (as a proportion of all female sex workers who solicit at venues in the course of a week)	40%
Assuming that 40% of female sex workers would be missed during the standard peak time	Calculation for frequency correction for female sex workers who were not present at mapped sites during the standard peak time in D1: = 2176/(1 – 0.40) = 3627

Figure 3 Calculation for adjusting for frequency of visiting sites: example

Table 6 illustrates this correction and shows how the size estimates for the 8 mapped districts increases from 10 726 (after correcting for mobility) to 16 441 after correcting for frequency of visiting sites, an upward adjustment of approximately 53%.

Table 6. Mapped numbers of female sex workers in 8 hypothetical districts selected for size estimation after correcting for mobility and frequency of visiting sites

Governorate & district	Total population	Mapped number (female sex workers)	Mapped number corrected for mobility	Correction factor for frequency	Mapped number corrected for mobility & frequency
G1 D1	853 475	2 560	2 176	0.40	3 627
G1 D5	1 030 732	2 060	1 566	0.50	3 132
G4 D16	2 288 254	2 288	2 059	0.30	2 941
G5 D21	2 510 951	4 970	3 926	0.30	5 609
G2 D7	645 866	576	438	0.15	515
G3 D14	1 235 968	430	318	0.05	335
G5 D23	1 335 024	304	173	0.15	204
G2 D9	232 995	99	70	0.10	78
Total	10 133 265	13 287	10 726		16 441

10.5 Using local size estimates for targeting and measuring programme coverage

Comparing mapped data and programme data

The mapped number adjusted for mobility and frequency of visiting sites should serve as a good estimate for the currently active visible portion of the population (i.e. the portion that can be seen and identified at public venues). In many situations, this population will represent the group that is reachable by intervention programmes.

Once an adjusted size estimate for the visible portion of the population had been calculated, it is useful to compare this number to the number of people reached by the programme if the outreach data are available. Table 7 gives an illustration of this: it is clear that in some districts (D7, D14, D21) the number of key population members reached is greater than the size estimate for the district. There are a number of reasons why this can happen.

- The programme data may include people who were counted more than once.
- The programme may have reached some key population members who do not frequent mapped venues.
- The outreach programme may have used a broader definition of the population compared with the way it was defined for mapping, thus counting people who would not be counted in the mapping.

In this example it should be noted that the programme reports numbers reached over a 6-month period, whereas the mapping exercise covers only the current population. Because there is turnover of sex workers in this population, the 6-month cumulative number from the outreach data is likely to be greater than a currently active number from mapping data because some new people will likely enter the population each month.

At the same time, in 40% of the districts with both programme outreach data and mapping data, the number reached was far less than the size estimate (Table 7). This is likely to be a result of programme performance in these areas that is less than optimal.

Table 7. Comparison of mapped data, corrected data and programme data for female sex workers in 5 hypothetical districts

Governorate & district	Total population	Mapped no. (female sex workers)	Mapped no. corrected for mobility	Mapped no. (a) corrected for mobility & frequency	No. (b) reached by programme in previous 6 months	Difference (a – b)
G1 D1	853 475	2 560	2 176	3 627	2 787	840
G1 D5	1 030 732	2 060	1 566	3 132	1 517	1615
G5 D21	2 510 951	4 970	3 926	5 609	6 775	–1 166
G2 D7	645 866	576	438	515	619	–104
G3 D14	1 235 968	430	318	335	480	–145
Total	6 276 922	10 596	8 424	13 218	12 178	1 040

These results highlight some of the inherent problems in using size estimates for targeting and measuring programme coverage. One important message to take from this exercise is that it is important to verify that the time period covered by the estimates is taken into account. Since the mapping data represent the current population, a more direct comparison in terms of programme coverage would use the number of people reached by the programme in the previous month (as opposed to the previous six months). If the programme requires that targets are set for a longer period of time (e.g. one year instead of one month), then population turnover must be taken into account in the size estimates.

Adjusting for portion of the population who do not frequent venues

The next adjustment is done to account for the proportion of key population members who are actively engaging in risk behaviour, but who do not frequent venues at all. These people are sometimes referred to as the hidden, or less visible, portion of the key population. These may be people operating through personal networks (e.g. apartment-based sex workers in many countries of the EM/MENA region are hidden from view) or people who operate only via cell phones or Internet sites. To make the adjustment for the hidden population, an estimate of the proportion of key population members who never go to sites is needed. The mapped number can then be inflated to account for this invisible group.

In reality, it is difficult to obtain such an estimate. If data from a survey using respondent-driven sampling or an Internet-based survey are available, it may be possible to obtain rough estimates of the proportion of people who never go to venues, which can be used to inflate the data. Discussions with expert key informants can also be used to obtain rough estimates. Ideally the estimates should be obtained separately in each geographic zone because of the potential for variation.

The calculation is a simple inflation factor similar to the one used for the frequency adjustment. It inflates the mapped number to account for the invisible portion. For example, if the mapped number of female sex workers is 500 and the estimated invisible proportion is 40%, then the calculation is 500/(1–0.4), which comes to 833. The last column in Table 8 shows the size estimates with all three correction factors (mobility, frequency of visiting sites and hidden portion of the population) applied. This adjustment raises the number from 16 441 to 23 687, which is a 44% increase.

Table 8. Correction for hidden portion of the population of female sex workers in 8 hypothetical districts

Governorate & district	Total population	Mapped no.	Mapped no. corrected for mobility & frequency	Correction for hidden population (those who do not frequent venues)	Mapped no. corrected for mobility, frequency & hidden population
G1 D1	853 475	2 560	3 627	0.2	4 534
G1 D5	1 030 732	2 060	3 132	0.4	5 220
G4 D16	2 288 254	2 288	2 941	0.25	3 921
G5 D21	2 510 951	4 970	5 609	0.3	8 013
G2 D7	645 866	576	515	0.5	1 030
G3 D14	1 235 968	430	335	0.4	558
G5 D23	1 335 024	304	204	0.2	255
G2 D9	232 995	99	78	0.5	156
Total	10 133 265	13 287	16 441		23 687

10.6 Extrapolating local data to develop national size estimates

Once the local level estimates are finalized and agreed on, the data can be used to develop national estimates through an extrapolation process. There are a number of ways to do this, all of them involving calculating the proportion of the female population who sell sex in the districts that have mapping data. This is done by dividing the adjusted estimated number of sex workers in the district by the size of the female population age 15–49 years.[8]

There are multiple options for extrapolation. One option is to extrapolate to districts within strata by governorate. Those governorates that do not have any mapped districts within a given stratum can be matched to the governorate that is considered most similar in terms of HIV risk (e.g. predisposing factors for HIV, sociodemographic factors, geographic proximity), and the numbers for the districts with mapping data can be applied to the districts within the same stratum which have no data. A second, simpler, option is to apply stratum-specific data across all governorates to stratum-specific districts for which there are no data using the mean value for the population proportion (or median if there are extreme outliers). Both approaches can be tried and compared and if there are significant differences, a judgement call can be made to determine which size estimates correspond better with the ground reality.

An illustration of the extrapolation by strata across all governorates, i.e. using the first approach, can be seen in Table 9. In the districts that were predicted to be high (more than 1000 female sex workers), all those that were mapped did end up having more than 1000 female sex workers. The extrapolated values for all remaining districts in the high stratum also exceeded 1000 in all cases. The overall prevalence for the high stratum was 1.48%. In the medium stratum (predicted to have between 100 and 1000 female sex workers), all those that were mapped did fall in that range except D7, which had

[8] Note that for men who have sex with men, a similar process is followed, using the male population aged 15–49 years, or male population aged 15–59 years or male population over age 15 years, depending on available data and local context.

slightly more than 1000 female sex workers after adjustments. Among those districts with extrapolated data, several had more than 1000 female sex workers. The overall prevalence of sex work in the medium stratum was 0.30%. In the low stratum (estimated to have fewer than 100 female sex workers), only one district was mapped and it had 156 female sex workers. The overall prevalence of female sex workers in the low stratum was 0.20%. The national estimate of the prevalence of female sex workers was 0.61%, which should be taken as a crude figure for the country, with a fairly wide confidence interval. This number is robust enough to serve national level needs, but should not be used for target setting at the district level since some of the district-specific extrapolated values may be out by as much as 50–100% (or even more in some cases).

It is important to reflect the uncertainty of the numbers by making sure they are presented as a range. However, there is no statistical process for developing uncertainty bounds that would fit all types of size estimate. Some direct size estimation methodologies provide confidence ranges, but these cannot be directly extrapolated to national estimates.

In our example mapping is used to estimate the population size. The estimation process involved applying a number of correction factors, most of which resulted in upward adjustments to the mapped numbers. One option for developing a lower bound is to remove all upward correction factors and apply only the downward correction for mobility before doing the extrapolation. The mapped number, corrected for mobility, represents those people actually seen by the mapping team, and this can be considered a minimum number. There is no comparable method to derive the upper bound of the uncertainty range. However, for programming purposes, the point estimate can often be used as a realistic upper bound in terms of the target number of the population to be reached by the programme.

Table 10 illustrates how this calculation was carried out to give the minimum of 18 162, giving the national prevalence of sex workers among females aged 15–49 years as 0.27%. With the point estimate at 0.61% (Table 9), this is a wide range that reflects the uncertainty of the numbers, but it is robust enough to provide a realistic national estimate.

10.7 Adjusting for population turnover

A final correction factor to be applied is adjustment for population turnover. This factor should be used when it is desired to convert a current figure to an annual figure. Such an adjustment is appropriate for modelling people living with HIV (e.g. using Spectrum), and also for setting annual programme targets. In each case, the number of people who will be reached and/or exposed to HIV in the course of a year is required. To estimate the population turnover for this purpose, it is helpful to know something about how many new people the programme reaches each month, or what the turnover in the population is. For example, suppose the outreach workers in the programme reach about 600 people per month, and on average approximately 25 of these are new each month, i.e. around 300 per year (25 × 12). Then, every year it can be expected that 900 sex workers will be reached. Another way of calculating this is to determine the average amount of time a person works as a sex worker. This information is sometimes available in surveys, or it can be gathered from key informants. The calculation for a 2-year average duration of sex work in a group of 600 (current) sex workers is shown in Fig. 4.

Table 9. National estimates for female sex workers using extrapolation across governorates: example

Governorate & district	Total population	Female population aged 15–49 years	Mapped number, corrected for mobility, frequency and hidden population	Population proportion, corrected for mobility, frequency and hidden population (%)	Extrapolated number	Size estimate (mapped + extrapolated)	Stratum-specific population prevalence (%)
G1 D1	853 475	221 903	4 534	2.05		4 534	
G1 D5	1 030 732	237 068	5 220	2.20		5 220	
G2 D8	647 821	200 824			2 972	2 972	
G4 D16	2 288 254	869 536	3 921	0.45		3 921	
G4 D17	1 248 075	349 461			5 172	5 172	
G5 D21	2 510 951	652 847	8 013	1.23		8 013	
Subtotal[a]	8 579 308	2 531 639		1.48	8 144	29 832	1.18
G1 D2	976 987	244 246			732	732	
G1 D4	554 348	171 847			515	515	
G2 D7	645 866	167 925	1 030	0.61		1 030	
G3 D11	1 175 400	352 620			1 057	1 057	
G3 D13	552 525	171 282			513	513	
G3 D14	1 235 968	259 553	558	0.22		558	
G3 D15	1 923 089	461 541			1 384	1 384	
G4 D18	1 022 002	224 840			674	674	
G4 D19	2 075 478	601 888			1 805	1 805	
G5 D23	1 335 024	387 156	255	0.07		255	
Subtotal[b]	11 496 687	3 042 898		0.30	6 680	8 523	0.28
G1 D3	457 988	137 396			261	261	
G2 D6	319 237	70 232			133	133	
G2 D9	232 995	79 218	156	0.20		156	
G2 D10	942 646	377 058			716	716	
G3 D12	359 653	111 492			211	211	
G5 D20	318 741	76 497			145	145	
G5 D22	869 681	234 813			446	446	
Subtotal[c]	3 500 941	1 086 706		0.20	1 912	2 068	0.20
Grand total	23 576 936	6 661 243	23 687		16 736	40 423	0.61

[a] High stratum: rough estimate > 1000 female sex workers. [b] Medium stratum: rough estimate 100–1000 female sex workers. [c] Low stratum: rough estimate < 100 female sex workers.

Table 10. Lower uncertainty bounds and point estimates: example

Governorate & district	Female population aged 15–49 years	Mapped no. lower bound	Population proportion[a] (%)	Lower bound extrapolated	Lower bound size estimate[b]	Stratum-specific population prevalence (lower bound) (%)	Population size (point estimate)[c]	Stratum-specific population prevalence (point estimate)[c] (%)
G1 D1	221 903	2 176	0.98		2 176		4 534	
G1 D5	237 068	1 566	0.66		1 566		5 220	
G2 D8	200 824			1 245	1 245		2 972	
G4 D16	869 536	2 059	0.24		2 059		3 921	
G4 D17	349 461			2 167	2 167		5 172	
G5 D21	652 847	3 926	0.60		3 926		8 013	
Subtotal[d]	2 531 639	9 726	0.62	3 412	13 139	0.52	29 832	1.18
G1 D2	244 246			342	342		732	
G1 D4	171 847			241	241		515	
G2 D7	167 925	438	0.26		438		1 030	
G3 D11	352 620			494	494		1 057	
G3 D13	171 282			240	240		513	
G3 D14	259 553	318	0.12		318		558	
G3 D15	461 541			646	646		1 384	
G4 D18	224 840			315	315		674	
G4 D19	601 888			842	843		1 805	
G5 D23	387 156	173	0.04		173		255	
Subtotal[e]	3 042 898	928	0.14	3 120	4 049	0.13	8 523	0.28
G1 D3	137 396			124	124		261	
G2 D6	70 232			63	63		133	
G2 D9	79 218	70	0.09		70		156	
G2 D10	377 058			339	339		716	
G3 D12	111 492			100	100		211	
G5 D20	76 497			69	69		145	
G5 D22	234 813			211	211		446	
Subtotal[f]	1 086 706	70	0.09	906	976	0.09	2 068	0.20
Grand total	6 661 243	10 726		7 487	18 164	0.27	40 423	0.61

[a] Corrected only for mobility [b] Mapped plus extrapolated number. [c] See Table 9. [d] High stratum: rough estimate > 1000 female sex workers.
[e] Medium stratum: rough estimate 100–1000 female sex workers. [f] Low stratum: rough estimate < 100 female sex workers.

Data required for calculation	No. of current sex workers (e.g. women who have sold sex in the previous month)
Average duration of selling sex	Female sex workers weekly behaviour is roughly the same (i.e. they will generally solicit on the same days of the week)
Assumptions	Turnover constant throughout the year
Current estimated no. of sex workers (according to method used, e.g. mapping, etc.)	600
Average duration of selling sex	2 years
Turnover every: • 2 years • 1 year • 1 month	 600 300 25
Adjusted estimate: (no. exposed over a 1-year period)	600 + (12 × 25) = 900

Figure 4 Adjusting for population turnover: example calculation

In our example for developing an annualized national figure out of a current figure, the range for the final national prevalence of female sex workers among females aged 15–49 years, with and without turnover, is shown in Table 11. This example assumes the average duration of selling sex is 2 years. Clearly, the difference between a current figure and an annual figure can be great, depending on turnover. So it is important to consider which number is more appropriate for the purpose.

Table 11. Prevalence of female sex workers among women aged 15–49 years: example

Population & period	Lower bound		Point estimate	
	No.	%	No.	%
National				
Current	18 164	0.27	40 423	0.61
Annualized	27 243	0.41	60 611	0.91
District 1				
Current	2 176	0.98	4 534	2.04
Annualized	3 264	1.47	6 798	3.06

Chapter 11

Making use of size estimates

The process described in this guide aims to provide methods to produce size estimations for different purposes. As discussed earlier, the estimates derived through these methods are for the purpose not merely of deriving a single number but rather to develop a basic understanding of the distribution of the population examined. The method presented includes considerations of representativeness on a national level while still being adaptable to meet programme needs. While the sampling is not random, and the estimates obtained are not accurate at the level a general population census would be, the tools presented here offer a means to assess these uncertainties systematically.

Different uses of the data require different corrections to be made, and the numbers can be adapted to suit different needs. For example, in designing services for men who have sex with men, an inclusive national estimate is useful for estimating the needs of such a programme. This number should include corrections for the populations not present at mapping sites. However, in more detailed planning and target setting for outreach activities, a lower estimate with fewer corrections may be used as a more realistic estimate of the population that is reachable with the intervention.

The stratification of geographic areas offers a basis for refining estimates as more data become available. A crude national estimate can be improved by adding more directly observed size estimations as these are conducted for programmatic purposes, and this model makes it possible to include local studies even if they are done outside nationwide efforts.

To understand the role of key populations in the HIV epidemic we need knowledge of three areas: the size of the population, the HIV prevalence, and behaviours that increase the risk of HIV transmission along with their associated transmission patterns within and between populations. All of these parameters vary greatly between areas, and interventions should be adapted to national contexts. Collecting data on any of these items is laborious, but expanding data collection efforts to cover these areas can provide great synergies. Researchers are therefore encouraged to include size estimation in local level data collection efforts, and to use the methodology described in this guide to make use of the collected data for a variety of purposes.

Annex I

Summary of appropriateness, requirements, strengths and limitations of each direct size estimation method

Summary of appropriateness, requirements, strengths and limitations of each direct size estimation method

Method	When is this method appropriate?	Requirements for collecting the data	Strengths	Limitations
Census taking (also known as mapping)	When more precise local size estimates are required for programme planning and monitoring When data collection can be integrated into ongoing strategic information activities, such as hotspot mapping by nongovernmental organizations in the context of programme planning	Good rapport with the key population of interest Willingness of key population members to participate Proactive efforts to ensure that data collection will not bring harm to key population members Availability of professionals with appropriate expertise to design and lead the study	Focus on subset of key population that is reachable by programmes Provides credible lower limit of population size estimate Does not require direct contact with each key population member; can be based on observations and key informant interviews	Resource intensive Potential for under-estimation when less- visible portion of key population is missed Potential for over-estimation due to mobility and double counting Potential for under-estimation of people who engage in risk behaviours less frequently Potential misclassification of key population members when based on observation only May bring unwanted attention or be dangerous for key population, depending on legal environment
Field-based capture–recapture	Well suited for key populations that are highly mobile nongovernmental organizations in the context of programme planning	Same requirements as for census-taking Ability to visit every site in a short amount of time	Requires fewer steps to implement than census methods Less opportunity for misclassification bias since each person's eligibility must be confirmed by the data collectors	Resource intensive Subject to bias if assumption of independence between two sweeps is violated Fieldwork must be completed in a short period of time to avoid violating assumption of little migration in or out Requires direct contact with each key population member being counted (risk of disclosing identity of the person) Potential for under-estimation when less-visible portion of key population is missed

Summary of appropriateness, requirements, strengths and limitations of each direct size estimation method (concluded)

Method	When is this method appropriate?	Requirements for collecting the data	Strengths	Limitations
Multiplier	When surveys among key populations are planned for other purposes (e.g. surveillance or monitoring and evaluation), a multiplier can be integrated with little added cost	Same requirements as for census-taking, plus: Planned probability survey of key populations Availability of appropriate programme data to use as multiplier	Uses available data sources	The two data sources must be independent otherwise results can be very biased Data sources must define the population in the same way Poor quality data for either source one or source two can lead to significantly biased size estimates
Network scale-up	Most useful when the conditions required to work directly with key populations (good rapport, willingness of key populations to participate, assurances that data collection will not harm the population) cannot be met Also useful when identifying and accessing key population members are expected to be difficult	Resources and technical capacity to conduct general population survey	Data can be collected for several key populations in the same survey A single survey can provide data that are national in scope Data are thought to be less prone to social desirability bias (people asked about friends' behaviours rather than their own)	Requires general population survey, which is labour intensive Average personal network sizes difficult to measure Potential for bias (transmission bias, response bias and barrier effects)

Further reading

WHO/UNAIDS Working Group on HIV/AIDS/STI Surveillance. Guidelines on estimating the size of populations most at-risk to HIV. Geneva: World Health Organization; 2010.

WHO/UNAIDS Working Group on HIV/AIDS/STI Surveillance. Guiding principles on ethical issues in HIV surveillance. Geneva: World Health Organization; 2013.

WHO/UNAIDS Working Group on HIV/AIDS/STI Surveillance. Estimating the size of populations at risk for HIV: issues and methods. Arlington: Family Health International (FHI); 2003 (UNAIDS/03.36E).

Training manual on methods for size estimation of key at-risk populations in the Asia-Pacific Region. Geneva: UNAIDS; 2009.

University of California San Francisco, UNAIDS. Estimating the size of populations most at risk to HIV infection: participant manual version 1.0. Geneva: UNAIDS; 2010.

Estimating the sizes of key populations at higher risk of HIV is challenging when it involves counting people who are hidden, or whose activities are hidden. The guidance presented here builds on the 2010 size estimation guidelines from the WHO/UNAIDS Working Group on HIV/AIDS/STI Surveillance. It contains further directions on how to plan and implement size estimation activities, including practical guidance for deciding which methods to use where and among whom, how to use the data to obtain the kind of size estimates required for different purposes and how to derive national population size estimates from local estimates. This document is aimed at supporting countries in the region in planning and implementing activities to collect strategic information in order to understand the epidemic and the response at country level.