**Appendix 1 Characteristics of individual studies included.**

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| --- | --- | --- | --- | --- |
| **No**  | **ID** | **Estimation method** | **Key populations** | **Study settings** |
| **1** | [E B Hook](https://pubmed.ncbi.nlm.nih.gov/?term=Hook+EB&cauthor_id=8654510) et al. | Capture-recapture | The key populations | The United States |
| **2** | [M C Buster](https://pubmed.ncbi.nlm.nih.gov/?term=Buster+MC&cauthor_id=11213560) et al. | Capture-recapture | PWID | Amsterdam |
| **3** | Ruiz MS et al. | Capture-recapture | PWID | Washington DC |
| **4** | Apodaca K et al. | Capture-recapture | MSM | Uganda |
| **5** | Karami M et al. | Capture-recapture | FSW | Tehran, Iran  |
| **6** | Doshi RH et al. | Capture-recapture | PWID, MSM, and FSW | Kampala, Uganda |
| **7** | Li G et al. | Capture-recapture | MSM | Beijing, China |
| **8** | Sulaberidze L et al. | Multiplier | MSM | Tbilisi, Georgia |
| **9** | Okal J et al. | Multiplier | PWID, MSM, and FSW | Nairobi, Kenya |
| **10** | Paz-Bailey G et al. | Multiplier | MSM and FSW | El Salvador |
| **11** | Burrell ER et al. | Multiplier | MSM | the United States |
| **12** | Rich AJ et al. | Multiplier | MSM | Metro Vancouver, Canada |
| **13** | Hiebert L et al. | Multiplier | PWID | Malaysia |
| **14** | Khalid FJ et al. | Delphi | PWID, MSM, and FSW | Unguja Island, Zanzibar |
| **15** | Okal J et al. | Delphi | PWID, MSM and FSW | Nairobi, Kenya |
| **16** | Bunjaku DG et al. | Mapping | PWID, MSM and FSW | Kosovo |
| **17** | Odek WO et al. | Mapping | FSW | Kenya |
| **18** | Wambura M et al. | Mapping | MSM and FSW | Tanzania |
| **19** | Lu F, Wang N et al. | Workbook | The key populations | China  |
| **20** | Ha NTT et al. | Workbook | PWID | Son La, Vietnam |
| **21** | Lansky A et al. | Workbook | heterosexual persons | the United States |
| **22** | Scholz SM et al. | Network scale-up | MSM | Germany |
| **23** | Baral S et al. | Network scale-up | MSM | Multiple countries |
| **24** | Guo J et al. | Network scale-up | MSM | Beijing, China |
| **25** | Ezoe S et al. | Network scale-up | MSM | Japan |
| **26** | Maghsoudi A et al. | Network scale-up | PWID and FSW | Iran |
| **27** | Wang J et al. | Network scale-up | MSM | Shanghai, China |
| **28** | Bengtsson L et al. | Respondent-driven sampling | MSM | Vietnam |
| **29** | Holland CE et al. | Respondent-driven sampling | MSM and FSW | Burkina Faso and Togo |
| **30** | Johnston LG et al. | Respondent-driven sampling | males who inject drugs | Myanmar |
| **31** | Carballo-Diéguez A et al. | Respondent-driven sampling | MSM | Buenos Aires |
| **32** | Buchanan R et al. | Respondent-driven sampling | PWID | Multiple countries |
| **33** | Lachowsky NJ et al. | Respondent-driven sampling | MSM | Vancouver, Canada |
| **34** | Overall AM et al. | Bayesian estimation | PWID | Scotland |
| **35** | Datta A et al. | Bayesian estimation | MSM | Côte d'Ivoire |
| **36** | Bao L et al. | Bayesian estimation | PWID | Bangladesh |
| **37** | Nakagawa F et al. | Stochastic simulation | HIV-positive MSM | UK |
| **38** | Chen H (2013) et al. | Laska-Meisner-Siegel estimation | MSM | Changsha, China |
| **39** | Chen H (2011) et al. | Laska-Meisner-Siegel estimation | MSM | One city in China |

**Appendix 2 The summary of population size estimation methods categories.**

|  |  |  |
| --- | --- | --- |
| **Categories**  | **Definition of categories** | **Methods** |
| Methods based on independent samples | Multiple independent sources of data are used to make the estimation. | capture-recapture method |
| multiplier method |
| Methods based on population counting | Traditional geolocation and counting measures are used to estimate the size of the key population. | Delphi method |
| mapping method |
| Methods based on the official report | The estimates are made by combining them with the official report. | workbook method |
| Methods based on social network | The key population is recruited from their social network. | respondent-driven sampling method |
| network scale-up method |
| Methods based on data-driven technologies | The key population size is estimated by data-driven technologies. | Bayesian estimation method |
| Stochastic simulation method |
| LMS estimation method |