Published in final edited form as:
Curr Opin HIV AIDS. 2014 March ; 9(2): 115–125. doi:10.1097/COH.0000000000000034.

Concentrated HIV sub-epidemics in generalized epidemic settings

Frank Tanser[1,*], **Tulio de Oliveira**[1], **Mathieu Maheu-Giroux**[2], and **Till Bärnighausen**[1,2]

[1]Africa Centre for Health and Population Studies, University of KwaZulu-Natal, SA

[2]Department of Global Health and Population, Harvard School of Public Health, USA

Abstract

Purpose of review—A relatively neglected topic to date has been the occurrence of concentrated epidemics within generalized epidemic settings and the potential role of targeted interventions in such settings. We review recent studies in high-risk groups as well as findings relating to geographical heterogeneity and the potential for targeting 'high-transmission zones' in the ten highest HIV prevalence countries in sub-Saharan Africa and the world.

Recent findings—Recent studies have confirmed earlier findings that, even in the context of generalized epidemics, men who have sex with men (MSM) have a substantially higher prevalence than the general population. Estimates of prevalence of HIV among people who inject drugs (PWID) in sub-Saharan countries are rarely available and, when they are, often outdated. We identified recent studies of sex workers (SW) in Kenya and Uganda. In all three cases – MSM, PWID and SW – HIV prevalence estimates are mostly based on convenience. Moreover, good estimates of the total size of these populations are not available. Our review of recent studies of high-risk populations defined on the basis of geography showed very high levels of both new and existing infections in Kenya (slums), South Africa (peri-urban communities) and Uganda (fishing villages).

Summary—Recent empirical findings combined with evidence from phylogenetic studies and supported by mathematical models provide a clear rationale for testing the feasibility, acceptability, and effectiveness of targeted HIV prevention approaches in hyper-endemic populations to supplement measures aimed at the general population.

Keywords

HIV epidemiology; incidence; key populations; spatial analysis; surveillance

Introduction

Globally, 34.0 million people were estimated to be living with HIV at the end of 2011.[1] Sub-Saharan Africa remains the most severely affected region, with nearly 1 in every 20 adults (5%) living with HIV and accounting for nearly 70% of the people living with HIV

Correspondence to: Frank Tanser, tanserf@africacentre.ac.za, Africa Centre for Health and Population Studies, University of KwaZulu-Natal, PO Box 198, Mtubatuba, 3935, South Africa.

worldwide. While some estimates suggest that the rate of new infections is declining in many African settings, HIV incidence remains unacceptably high.[1] Hence, meaningful reductions in HIV incidence in countries worst affected by the epidemic will require more efficient strategies and better use of declining levels of HIV funding. One of the striking features of the HIV epidemic has been the remarkable variation in disease burden not only across population sub-groups[2] regions and countries[1, 3, 4] but also at a sub-national level between provinces[5], districts,[6, 7] sub-districts and within sub-districts.[8–12] Epidemics are said to be "concentrated" if transmission occurs largely in clearly defined vulnerable groups such as sex workers (SW), men who have sex with men (MSM), and people who inject drugs (PWID). Conversely, epidemics are termed "generalized" if transmission is sustained by sexual behaviour in the general population (typically defined on the basis of population prevalence of >1%) and would likely persist despite effective programmes for vulnerable groups. Epidemics in Latin America, the Middle East, Europe, and Asia are 'concentrated', while the epidemics in most of southern and parts of eastern Africa are 'generalized'.[13] In generalized epidemics settings, some form of intervention needs to be provided to the general population whereas in a concentrated epidemic contexts, the goal is to achieve a high level of coverage of interventions in the most vulnerable groups.

A neglected topic to date has been the occurrence of concentrated epidemics in generalized epidemic settings and the potential role of targeted interventions to supplement measures aimed at the general population in such settings. Even in these so-called hyper-endemic communities, targeting efforts at settings where HIV transmission is most intense is crucial. However, in the context of a severe generalized African epidemic the value of targeted prevention interventions has seldom been considered. In some countries, notably Kenya and South Africa, substantial numbers of new infections, are estimated to occur among key populations at higher risk of infection including SW and their clients, PWID, MSM and the prison population in Kenya, contributing jointly to about 33% of new infections in Kenya and 26% in South Africa.[14] Despite the stage and severity of the epidemic in many African settings, recent work has revealed the remarkable variation in HIV prevalence and incidence across relatively small areas and within relatively homogenous populations, as well as across different distinct sub-populations.[8–12] These results have challenged the paradigm of a ubiquitous "generalized" epidemic in many countries. Given limited resources, clustering of infections in specific localities or population groups can decrease the average effectiveness of population-based prevention approaches. Conversely, targeted interventions are likely to lead to better prevention results for given resources, where HIV incidence clusters geographically or within sub-groups.[15] Indeed, mathematical models predict that focused interventions, have the potential to reduce HIV transmission in the wider community across low- and high-prevalence regions.[16] Thus, there is increasing recognition of opportunities for targeting of interventions to increase the effectiveness and cost-effectiveness of HIV prevention interventions supported by both theory and recent empirical findings. At the same time, many critical questions remain. Can the most-at-risk populations be effectively reached? Which interventions will be acceptable and attractive to different sub-populations? What are the costs of targeted interventions requiring potentially expensive approaches to identify and engage with most-at-risk populations?

In this article we sought to review findings from work published since 2012 on concentrated sub-epidemics in generalized epidemic settings. We selected the ten highest prevalence countries in the world where prevalence in the general population was >5% [1](Kenya, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe) and focussed our review on recent studies in three high-risk groups (SW, MSM, and PWID) as well as findings relating to geographical heterogeneity and the potential for targeting 'hot-spots' or 'high-transmission zones'. We further review recent findings from phylogenetic work to assess our knowledge regarding the extent to which transmission of HIV in the general population in these generalized epidemic settings is driven by contact with members of concentrated sub-epidemics.

Men who have sex with men (MSM)

Attention to MSM within generalized epidemics is relatively recent.[17] Studies published over the last two years have confirmed earlier findings that, even in the context of generalized epidemics, MSM have higher prevalence than the general populations.[18] Two South African studies recorded HIV prevalence of 27% and 11% among MSM as compared to 17% and 5% in men who had sex with women only.[1920] Incidence of HIV among MSM has been found to be notably higher than that of other high-risk populations and the general population (Table 1). In Kenya, incidence of HIV was of 6/100 PY in Kilifi and 10/100 PY in Nairobi.[22] Another study conducted in coastal Kenya found an HIV-1 incidence of 6/100 PY among men who have sex with men and women and 35/100 PY among men who have sex with men exclusively.[23]

Experience of stigma and discrimination by MSM could also exacerbate an already efficient transmission by contributing to high-risk behaviours.[24] For example, internalized homophobia has been associated with an increased risk of unprotected anal intercourse[25] and higher level of HIV misinformation,[26] whereas homophobic abuse was also significantly associated with being HIV infected.[21, 27] Further, stigma and discrimination could also increase barriers to testing HIV [28–31] and adherence to ART.[32]

Few studies have recently evaluated interventions for MSM in sub-Saharan countries but they mostly focused on their acceptability [33, 34] or on peer-outreach activities.[35] Qualitative interviews conducted in Kenya among MSM highlighted lack of health information, safe lubricants, condoms, and MSM-friendly health services as unmet needs.[36] Interviews with service providers also emphasized the lack of appropriate training to effectively deliver MSM-specific risk reduction counselling.[37] Interventions targeted at MSM in sub-Saharan Africa could face additional challenges that would limit their effectiveness, however, because such behaviours are often criminalized, culturally taboo, or because different high-risk groups often overlap.[38, 39]

People who inject drugs (PWID)

Estimates of prevalence of HIV among PWID in sub-Saharan countries are rarely available and, when they are, often outdated. This absence of good data is surprising because the total size of this high-risk population is potentially very large, with an estimated 1.7 million heroin users in Africa.[40] National key informants with expertise in PWID and HIV

estimated that prevalence of HIV among PWID was 36%–43% in Kenya and 42% in Tanzania (Table 2).[41] In Dar es Salaam (Tanzania), PWID recruited through snowball and targeted sampling were found to have a prevalence of HIV (35%)[42] much higher than that recorded for non-injecting drug users (12%). Further, there is high overlap between female PWID and sex work in Dar es Salaam, with an estimated 31% of female PWID engaging in commercial sex work as compared to less than 1% for males.[43]

Very little advances have been made to scale-up needle and syringe programs (NSP) and opioid substitution therapy (OST) in sub-Saharan Africa despite the proven effectiveness of such interventions in others parts of the world.[44] Important barriers to implementation include the criminalization of drug dependency and needle possession in some jurisdictions, and explicit policies against OST.[42, 44] Tanzania is currently at the forefront of harm reduction in sub-Saharan African with its recent implementation of a first NSP site, medication-assisted treatment, and 'sober houses' [41, 45] – mostly in the urban centre of Dar es Salaam. Given that PWID have been described as the high-risk group with the largest unmet needs,[46] there are important opportunities to reduce HIV burden among PWID through the implementation of evidence-based strategies.

Sex workers (SW)

Sex work, was as an early driver of many epidemics in sub-Saharan Africa.[47] A recent study estimates that 18% of all HIV infections in the general female population (aged 15+) are attributable to female sex work in sub-Saharan Africa. [48] Many African countries with generalized epidemics have documented HIV prevalence levels 3–10 times higher among populations of SWs, compared with the general population. In 26 countries with medium and high background HIV prevalence, 31% (95% CI: 30–31) of SW were HIV-positive and the odds ratio for infection was 12 (95% CI: 9–15). [49] The authors estimate the pooled HIV prevalence among female SW in sub-Saharan Africa is 37%.

We identified three recent studies of SW populations from Kenya and Uganda (Table 3). HIV prevalence was highest among SW in Kisumu at nearly 57% considerably less than 75% prevalence identified in the same location in 1997. These data suggest an urgent need to scale up access to quality HIV prevention programmes. The largest source of data on levels of infection among female SW in Africa comes from Kenya where in 2010, the Kenyan National AIDS and STI Control Program (NASCOP) developed a set of National Guidelines for HIV and STI Programmes for SW.[52] These guidelines were developed in response to the Kenya National HIV Strategic Plan, which identified that female SW as a population who are most at risk and that barriers existed that limited their access to health services. SW are a particularly vulnerable population in many African countries and hence careful considerations of the environments in which SW operate is needed. [49] In many African countries a large proportion of SW are also migrants placing them at even greater risk of infection. For example, in a survey of 1,653 female SW in Johannesburg Rustenburg and Cape Town (South Africa), 85% of SW were migrants and 46% were cross-border migrants.[53]

Geographical “risk spaces”

Our review of recent studies of high-risk populations defined on the basis of geography showed high levels of both new and existing infections in the five studies in Kenya (slums), South Africa (peri-urban communities) and Uganda (fishing villages) [Table 4]. For example, a study among informal peri-urban settlements showed an incidence of 15/100 person-years (PY) (95% CI: 10–20).[56] One of the main challenges of a strategy incorporating targeting of high risk individuals remains the identification of such individuals. The membership of a “risk group” is highly dynamic with many individuals moving into and out of high risk groups over the course of their sexual lives making targeting problematic.[59] However, despite the fact that the composition of these groups are continually changing, one of the most stable aspects of such groupings appears to be their geography.[60] Indeed, the notion of a “core group” in sexually transmitted diseases evolved from studies showing geographic clustering of infections.[61] This concept of “risk places” holds for HIV in many generalized epidemic settings as well.[62] In fact, far from experiencing “epidemic burn-out” as the epidemic has progressed, studies have consistently documented examples of “risk-spaces” that are characterised by substantially higher levels of new and existing infections in comparison to the surrounding populations over a duration of 15 years or more – for example, informal settlements near National Roads in KwaZulu-Natal South Africa [10, 63] and fishing villages in rural Uganda.[58, 64] In the absence of targeted interventions these differences are likely to persist into the future. The disproportionately large burden of HIV in urban slums/peri-urban informal settlements settings has received minimal attention to date.[65] Research from South Africa and some other African countries shows that the HIV prevalence in informal settlements or slum populations is double (or more) that in the non-slum population of the same city.[66] In our population-based HIV surveillance site in northern KwaZulu-Natal South Africa for example, one out of three sero-conversions observed over a seven-year period took place in peri-urban communities located along the National Road (where both HIV incidence and population density are high). [11] These communities occupy less than 6% of the study area. These findings imply that targeting the easy-to-reach peri-urban communities in close proximity to major transport routes – a strategy considered in early stages of the epidemic - could be highly cost-effective in reaching large proportions of people at risk of HIV acquisition in late-stage, ‘generalized’ epidemics.[67] One advantage of geographic targeting is that it is comparatively easy to execute. Targeting of “hidden populations” may be implicit in geographic targeting because particular most-at-risk populations may cluster in certain zones. Future research needs to establish the differential effectiveness and cost-effectiveness of geographic HIV intervention targeting compared to other targeting approaches, such as through social networks or particular facilities.

Phylogenetic analyses

Phylogenetic studies can reveal the extent to which the transmission of HIV in the general population is driven by contact with members of concentrated sub-epidemics and speak to the potential for any intervention directed at such groups to extend beyond the high-risk sub-populations.

The increase of transport connectivity and mobile populations may explain the hyper-endemic outbreaks experienced in eastern and southern Africa.[68] In a study in one community in rural coastal Kenya, multiple subtypes and recombinant forms were identified, suggesting that communities with high transport connectivity may have local HIV epidemics supported by a significant proportion of transmissions from outside communities. [69]Recently, molecular epidemiology studies were combined with detailed demographic information in order to identify sub-populations driving HIV sub-epidemics in Uganda. Transmission clusters combined with participant life histories revealed a high degree of sexual partner mixing in a high-incidence cohort in Ugandan fishing communities as only two of the five transmission clusters were from sexual partners.[70] Another study in Uganda that combined partnership histories and phylogenetic analysis of female SW identified partial sexual networks and multiple infections, suggesting mixing in these SW and their clients.[71] In the same country, another study suggested that the presence of super transmitters in early HIV infection contributed a disproportionate number of transmissions in a low-risk rural cohort.[72] These kinds of studies are currently being expanded to other large demographic sites in generalized epidemics in Africa, for example the Mochudi treatment as prevention (TasP) trial in Botswana and TasP trial at the Africa Centre in rural South Africa,[73] which has started to produce large molecular epidemiology datasets.

Evidence from Kenya shows that 34% of male SW who sell sex to men also had sex with a women in the previous 30 days.[74] The same pattern was observed in Tanzania and South Africa, where 37% and 50% of MSM reported having had a female sexual partner, respectively.[30, 75] Interventions targeting MSM thus has the potential to yield benefits for both the MSM and the heterosexual community, depending on the extent with which the two sexual communities are linked. Despite the potential contribution of MSM to HIV transmission in generalized epidemics, few phylogenetic studies have examined to which extent transmission is behaviourally segregated between MSM and the general population. A recent study conducted in coastal Kenya, using convenience sample of 84 MSM, suggested a weak link between MSM and the general population.[76]

Discussion

In reality, the HIV epidemic is composed of multiple sub-epidemics that make up the composite epidemic in any given population. Concentrated sub-epidemics exist within all generalized epidemic contexts, and addressing the sub-populations within these constituent epidemics will likely be key to substantially reducing population-level incidence. Our article has highlighted recent studies from hyper-endemic countries with generalized epidemics, documenting concentrated sub-epidemics among most-at-risk population sub-groups as well as by geographical “risk-spaces”.[60] These studies provide further clear examples of clustering of infections in sub-populations and geographies and imply that targeted prevention strategies could be effective in these hyper-endemic settings as a supplement to measures aimed at the general population. Whilst it is true that in these populations the HIV epidemic can be sustained by the general population (apart from the high risk populations), mathematical models show that maximum reductions in HIV incidence can be achieved by incorporating interventions that specifically target high risk populations.[16] The modelling results are supported by our review of recent phylogenetic analyses which have shown in

countries such as Uganda that infections generated within these concentrated sub-epidemics help fuel the rate of new infections in the general population. By implication, large reductions in incidence among the general population cannot be achieved without addressing the high levels of intra- and extra- transmission within these risk groups or risk spaces.

Some countries like Kenya have introduced intervention programmes that focus on most-at-risk groups, such as SW,[52.77] However, few countries in Africa have explicitly adopted a geographically focused approach to HIV prevention targeting high risk settings such as adopted by India.[78] This is set to change in the very near future. The new funding model of the Global Fund for example, aims to allocate funding for HIV within countries on the basis of identification of geographic areas of highest transmission.[79] A forthcoming report by UNAIDS emphasises the potential gains that might be achieved if countries took a more focussed approach at dealing with their HIV epidemic from identifying the geographic location where more new infections are occurring to focusing services toward key populations at increased risk to HIV.[80] The report provides examples from numerous countries around the world and suggests steps that countries should take to generate a more efficient and effective HIV response. The newly devised PEPFAR strategy for South Africa recognises the tremendous heterogeneity in the distribution of HIV outcomes at the sub-national and local levels.[81] The strategy allocates resources on the basis of a geographic prioritization of districts and focuses on those geographic regions and localities where most transmission is occurring and recognises that the key populations implicated in these sub-epidemics are vital to achieving large reductions in population-level incidence.

The allocation of resources to target some high-risk groups could be fraught with difficulties due to the considerable uncertainty in the estimation of the underlying population sizes of SW, MSM, and PWID. One reason for the lack of good data on these populations in sub-Saharan African countries is that stigma and discrimination make it difficult to identify them in population-based samples, such as in national representative household surveys or Health and Demographic Surveillance sites. In this sense, SW, MSM, and PWID remain largely ‘hidden populations’.[82, 83] Accurate estimation of the population size of such high-risk groups should be undertaken to ensure that sufficient resources are allocated to meet the HIV intervention needs in this region.[82, 84]Another important knowledge gap is the cost-effectiveness of targeted intervention strategies to these ‘hidden populations’. On the one hand, targeting can focus on people who can benefit most from an intervention, potentially increasing the effectiveness per intervention dollar. On the other hand, most-at-risk populations may also be most resistant to interventions and they may be difficult to identify and engage with, potentially reducing the intervention cost-effectiveness.

Research agenda

We have highlighted in this review a number of priority research areas. The first is the need to identify localities where disproportionately large numbers of transmissions are taking place and to characterize these risk-spaces using methodologies such as the “place-based” method.[62] At a country level there is a need to ensure that districts with overall high levels of infection receive a strong intervention response such as been adopted by India[78] (country districts are graded A–D. Grade “A” districts receive the full intervention response whereas

"D" districts only receive some elements of the package) and will be used by PEPFAR in South Africa.[80] At a more local scale there is a clear and urgent need to focus on informal settlements in urban slums and peri-urban populations and to assess what combination of interventions best work in these communities. In comparison to the other risk groups defined on the basis of behaviour, not only are these communities at overall high risk of infection, contain large populations and are relatively easy to access, but also contain higher numbers of individuals in other high risk groups such as SWs. Hence a systematic enumeration and characterisation of populations within these communities is vital.

Second, the empirical estimation of population sizes of hidden high-risk groups such as MSM and PWID is critical. Specifically, there is a knowledge gap on how best to sample and estimate the population sizes of these risk groups in a representative way. The respective robustness of respondent-driven sampling, snowballing, and capture-recapture methods should be assessed. Obtaining reliable and representative population size and HIV prevalence estimates will help raise awareness, allocate sufficient resources, and guide prevention efforts.

Third, conducting phylogenetic studies assessing the impact of high-risk groups and risk-spaces on overall transmission within generalized epidemics should be an important research focus. Such information would be crucial to inform mathematical models that could be used to estimate the impact of interventions targeted at risk groups on overall HIV epidemic dynamics and the cost-effectiveness of such prevention approaches. A recent review of mathematical models investigating the impact of interventions aimed at female SW highlighted that the preventive potential of this type of intervention has been under-researched in high prevalence settings.[16] Future research should focus on the development of spatially explicit, individual-based models of HIV transmission that allow for the highly uneven distribution of HIV transmissions across risk-spaces as well as risk groups.

Fourth, formative research with people belonging to risk groups on social and cultural acceptability of interventions is crucially important to ensure rapid uptake, effectiveness, and sustainability of interventions. Such studies among target groups should be complemented by conducting formative research in different countries on political, cultural, and structural constraints for interventions targeted at these risk groups, which are also commonly stigmatized, discriminated against, and abused.

Finally, the effectiveness and cost-effectiveness of prevention for most-at-risk groups needs to be established within the context of different cultural and institutional settings in sub-Saharan Africa. Rigorous impact evaluation of such interventions should thus accompany the scaling-up of targeted interventions for high-risk groups. Demonstrating impact could also help improve acceptability of interventions and alleviate the structural constraints faced by some of the potential interventions.

Conclusion

The occurrence of concentrated epidemics in generalized epidemic settings and the potential role of targeted interventions to supplement measures aimed at the general population in

such settings has been a neglected topic to date. Our review of the recent literature combined with empirical evidence from phylogenetic studies and supported by mathematical models suggest that targeted HIV prevention approaches aimed at specific geographic localities as well as other key high-risk groups could be effective in generalized epidemic settings as part of an overall combination approach.

Acknowledgments

FT and TB are supported by grant 1R01-HD058482-01 from the National Institute of Child Health and Human Development. MMG was supported by a Doctoral Foreign Study Award from the Canadian Institutes of Health Research. The authors gratefully acknowledge the helpful input from Nina Hasen (Office of the US Global AIDS Coordinator) and Mary Mahy (UNAIDS).

References

1. UNAIDS. Geneva: UNAIDS; 2012. UNAIDS Report on the global AIDS epidemic.
2. De Cock KM, Jaffe HW, Curran JW. The evolving epidemiology of HIV/AIDS. AIDS. 2012; 26(10):1205–1213. [PubMed: 22706007]
3. Asamoah-Odei E, Garcia Calleja JM, Boerma JT. HIV prevalence and trends in sub-Saharan Africa: no decline and large subregional differences. Lancet. 2004; 364(9428):35–40. [PubMed: 15234854]
4. Auvert B, Buve A, Ferry B, et al. Ecological and individual level analysis of risk factors for HIV infection in four urban populations in sub-Saharan Africa with different levels of HIV infection. AIDS. 2001; 15(Suppl 4):S15–S30. [PubMed: 11686462]
5. Shaikh N, Abdullah F, Lombard CJ, Smit L, Bradshaw D, Makubalo L. Masking through averages--intraprovincial heterogeneity in HIV prevalence within the Western Cape. S Afr Med J. 2006; 96(6):538–543. [PubMed: 16841139]
6. Kleinschmidt I, Pettifor A, Morris N, MacPhail C, Rees H. Geographic distribution of human immunodeficiency virus in South Africa. Am J Trop Med Hyg. 2007; 77(6):1163–1169. [PubMed: 18165541]
7. Coburn BJ, Okano JT, Blower S. Current drivers and geographic patterns of HIV in Lesotho : implications for treatment and prevention in Sub-Saharan Africa. BMC Med. 2013; 11
8. Wand H, Whitaker C, Ramjee G. Geoadditive models to assess spatial variation of HIV infections among women in Local communities of Durban, South Africa. International Journal of Health Geographics. 2011; 10:28. [PubMed: 21496324]
9. Wand H, Ramjee G. Targeting the hotspots: investigating spatial and demographic variations in HIV infection in small communities in South Africa. Journal of the International AIDS Society. 2010; 13(1):1–9. [PubMed: 20205768]
10. Tanser F, Bärnighausen T, Cooke GS, Newell ML. Localized spatial clustering of HIV infections in a widely disseminated rural South African epidemic. Int J Epidemiol. 2009; 38(4):1008–1016. [PubMed: 19261659]
11. Tanser, F.; Bärnighausen, T.; Newell, M. Conference on Retroviruses and Opportunistic Infections (CROI). Boston, MA: 2011. Identification of Localized Clusters of High HIV Incidence in a Widely Disseminated Rural South African Epidemic: A Case for Targeted Intervention Strategies.
12. Asiki G, Mpendo J, Abaasa A, et al. HIV and syphilis prevalence and associated risk factors among fishing communities of Lake Victoria, Uganda. Sexually Transmitted Infections. 2011; 87:511–515. [PubMed: 21835763]
13. Wilson D, Halperin DT. "Know your epidemic, know your response": a useful approach, if we get it right. Lancet. 2008; 372(9637):423–426. [PubMed: 18687462]
14. Gouws E, Cuchi P. Focusing the HIV response through estimating the major modes of HIV transmission: a multi-country analysis. Sexually Transmitted Infections. 2012; 88(Suppl 2):i76–i85. [PubMed: 23172348]
15. Aral SO, Cates W. Coverage, context and targeted prevention: optimising our impact. Sexually Transmitted Infections. 2013; 89:336–340. [PubMed: 23270932] Authors argue in this article that

population level reductions in HIV incidence require careful considerations of issues related to coverage, scale-up, prioritisation, and the importance of contextual characteristics. The uneven distribution of risks and outcomes is discussed and the authors concluded that interventions should be targetted to those most likely to transmit infection first.

16. Mishra S, Steen R, Gerbase A, Lo Y-R, Boily M-C. Impact of High-Risk Sex and Focused Interventions in Heterosexual HIV Epidemics: A Systematic Review of Mathematical Models. PLoS ONE. 2012; 7:e50691. [PubMed: 23226357] The authors of this study conducted a systematic review of mathematical models of heterosexual HIV transmission to examine if targetting prevention at high-risk groups is an effective strategy to reduce HIV transmission in the general population. They found that interventions targetted interventions have the potential to reduce overall transmission in both low- and high-prevalence settings.
17. Smith AD, Tapsoba P, Peshu N, Sanders EJ, Jaffe HW. Men who have sex with men and HIV/AIDS in sub-Saharan Africa. Lancet. 2009; 374(9687):416–422. [PubMed: 19616840]
18. Beyrer C, Sullivan P, Sanchez J, et al. The global HIV epidemics in MSM: time to act. AIDS. 2013
19. Dunkle KL, Jewkes RK, Murdock DW, Sikweyiya Y, Morrell R. Prevalence of consensual male-male sex and sexual violence, and associations with HIV in South Africa: a population-based cross-sectional study. PLoS Med. 2013; 10(6):e1001472. [PubMed: 23853554]
20. Eaton LA, Pitpitan EV, Kalichman SC, et al. Men Who Report Recent Male and Female Sex Partners in Cape Town, South Africa: An Understudied and Underserved Population. Arch Sex Behav. 2013; 42(7):1299–1308. [PubMed: 23519592]
21. Hladik W, Barker J, Ssenkusu JM, et al. HIV infection among men who have sex with men in Kampala, Uganda--a respondent driven sampling survey. PLoS One. 2012; 7(5):e38143. [PubMed: 22693590]
22. Price MA, Rida W, Mwangome M, et al. Identifying at-risk populations in Kenya and South Africa: HIV incidence in cohorts of men who report sex with men, and sex workers, and youth. J Acquir Immune Defic Syndr. 2012; 59(2):185–193. [PubMed: 22227488]
23. Sanders EJ, Okuku HS, Smith AD, et al. High HIV-1 incidence, correlates of HIV-1 acquisition, and high viral loads following seroconversion among MSM. AIDS. 2013; 27(3):437–446. [PubMed: 23079811]
24. Muraguri N, Temmerman M, Geibel S. A decade of research involving men who have sex with men in sub-Saharan Africa: current knowledge and future directions. SAHARA J. 2012; 9(3):137–147. [PubMed: 23237068]
25. Ross MW, Kajubi P, Mandel JS, McFarland W, Raymond HF. Internalized homonegativity/homophobia is associated with HIV-risk behaviours among Ugandan gay and bisexual men. Int J STD AIDS. 2013; 24(5):409–413. [PubMed: 23970711]
26. Tun W, Kellerman S, Maimane S, et al. HIV-related conspiracy beliefs and its relationships with HIV testing and unprotected sex among men who have sex with men in Tshwane (Pretoria), South Africa. AIDS Care. 2012; 24(4):459–467. [PubMed: 22084826]
27. Vu L, Tun W, Sheehy M, Nel D. Levels and correlates of internalized homophobia among men who have sex with men in Pretoria, South Africa. AIDS Behav. 2012; 16(3):717–723. [PubMed: 21484279]
28. Knox J, Sandfort T, Yi H, Reddy V, Maimane S. Social vulnerability and HIV testing among South African men who have sex with men. Int J STD AIDS. 2011; 22(12):709–713. [PubMed: 22174050]
29. Nel JA, Yi H, Sandfort TG, Rich E. HIV-untested men who have sex with men in South Africa: the perception of not being at risk and fear of being tested. AIDS Behav. 2013; 17(Suppl 1):S51–S59. [PubMed: 23054041]
30. Nyoni J, Ross MW. Factors associated with HIV testing in men who have sex with men, in Dar es Salaam, Tanzania. Sex Transm Infect. 2012; 88(7):483. [PubMed: 22745441]
31. Nyoni JE, Ross MW. Condom use and HIV-related behaviors in urban Tanzanian men who have sex with men: a study of beliefs, HIV knowledge sources, partner interactions and risk behaviors. AIDS Care. 2013; 25(2):223–229. [PubMed: 22788911]

32. Graham SM, Mugo P, Gichuru E, et al. Adherence to antiretroviral therapy and clinical outcomes among young adults reporting high-risk sexual behavior, including men who have sex with men, in coastal Kenya. AIDS Behav. 2013; 17(4):1255–1265. [PubMed: 23494223]
33. Singh K, Brodish P, Mbai F, et al. A venue-based approach to reaching MSM, IDUs and the general population with VCT: a three study site in Kenya. AIDS Behav. 2012; 16(4):818–828. [PubMed: 22198312] A venue-based HIV prevention study was conducted to assess the acceptability of voluntary counseling and testing among the general population and selected high-risk groups. Results of this study support the use of venue-based approaches to target men who have sex with men and injecting drug users. Further, few significant differences were found between those agreeing and declining to particpate.
34. Stephenson R, Rentsch C, Sullivan P. High levels of acceptability of couples-based HIV testing among MSM in South Africa. AIDS Care. 2012; 24(4):529–535. [PubMed: 22007940]
35. Geibel S, King'ola N, Temmerman M, Luchters S. The impact of peer outreach on HIV knowledge and prevention behaviours of male sex workers in Mombasa, Kenya. Sex Transm Infect. 2012; 88(5):357–362. [PubMed: 22332149]
36. Okall DO, Otieno FO, Nyikuri M, et al. Men who have sex with men in Kisumu, Kenya: support group membership and knowledge of HIV-risk factors. Cult Health Sex. 2013; 15(8):968–980. [PubMed: 23767414]
37. Taegtmeyer M, Davies A, Mwangome M, et al. Challenges in providing counselling to MSM in highly stigmatized contexts: results of a qualitative study from Kenya. PLoS One. 2013; 8(6):e64527. [PubMed: 23762241]
38. Johnston LG, Holman A, Dahoma M, et al. HIV risk and the overlap of injecting drug use and high-risk sexual behaviours among men who have sex with men in Zanzibar (Unguja), Tanzania. Int J Drug Policy. 2010; 21(6):485–492. [PubMed: 20638262]
39. Dahoma M, Johnston LG, Holman A, et al. HIV and related risk behavior among men who have sex with men in Zanzibar, Tanzania: results of a behavioral surveillance survey. AIDS Behav. 2011; 15(1):186–192. [PubMed: 19997862]
40. UNODC. Vienna, Austria: United Nations Office of Drugs and Crime; 2011. The Global Afghan Opium Trade: A Threat Assessment.
41. Petersen Z, Myers B, van Hout MC, Plüddemann A, Parry C. Availability of HIV prevention and treatment services for people who inject drugs: findings from 21 countries. Harm Reduct J. 2013; 10:13. [PubMed: 23957896]
42. Bowring AL, Luhmann N, Pont S, et al. An urgent need to scale-up injecting drug harm reduction services in Tanzania: prevalence of blood-borne viruses among drug users in Temeke District, Dar-es-Salaam, 2011. Int J Drug Policy. 2013; 24(1):78–81. [PubMed: 23036650]
43. Lambdin BH, Bruce RD, Chang O, et al. Identifying programmatic gaps: inequities in harm reduction service utilization among male and female drug users in Dar es Salaam, Tanzania. PLoS One. 2013; 8(6):e67062. [PubMed: 23825620]
44. Degenhardt L, Mathers BM, Wirtz AL, et al. What has been achieved in HIV prevention, treatment and care for people who inject drugs, 2010–2012? A review of the six highest burden countries. Int J Drug Policy. 2013 Authors of this article searched the recent literature and assessed coverage of key interventions and care services for people who inject drugs in the six countries that account for half of the global population of injecting drug users: China, Malaysia, Russia, Ukraine, Vietnam, and the USA. This study found that policy shifts toward evidence-based approaches has increased coverage of interventions in Asia and Ukraine but that punitive law enforcemnt approaches limited impact in the USA and Russia.
45. Ratliff EA, McCurdy SA, Mbwambo JK, et al. An Overview of HIV Prevention Interventions for People Who Inject Drugs in Tanzania. Adv Prev Med. 2013; 2013:183–187.
46. Wolfe D, Carrieri MP, Shepard D. Treatment and care for injecting drug users with HIV infection: a review of barriers and ways forward. Lancet. 2010; 376(9738):355–366. [PubMed: 20650513]
47. WHO. Geneva: World Health Organization; 2011. Preventing HIV Among Sex Workers in sub-Saharan Africa: A Literature Review.
48. Prüss-Ustün A, Wolf J, Driscoll T, Degenhardt L, Neira M, Calleja JMG. HIV due to female sex work: regional and global estimates. PLoS ONE. 2013; 8:e63476. [PubMed: 23717432]

49. Baral S, Beyrer C, Muessig K, et al. Burden of HIV among female sex workers in low-income and middle-income countries : a systematic review and meta-analysis. Lancet Infect Dis. 2012; 12:538–549. [PubMed: 22424777] This publication reports on the results of a meta-analysis of recent studies (2007–2011) of HIV prevalence among female sex workers in 50 countries. A total of 102 articles and surveillance reports are included, totalling 99,878 female sex workers. Overall HIV prevalence was 11.8% (95% CI: 11.6–12.0) among this high-risk group.
50. Vandepitte J, Muller E, Bukenya J, et al. Prevalence and correlates of Mycoplasma genitalium infection among female sex workers in Kampala, Uganda. J Infect Dis. 2012; 205:289–296. [PubMed: 22102734]
51. Vandenhoudt HM, Langat L, Menten J, et al. Prevalence of HIV and other sexually transmitted infections among female sex workers in Kisumu, Western Kenya, 1997 and 2008. PLoS ONE. 2013; 8:e54953. [PubMed: 23372801] Using a respondent-driven sampling, this study investigated prevalence of HIV and other sexually transmitted infections, as well as predictors of condom use, in female sex. Results show that HIV prevalence was 56.5% in 2008, lower than that found in an earlier survey conducted in 1997, and that reported condom use has increased between 1997–2008.
52. Ministry of Public Health and Sanitation. Nairobi, Kenya: Ministry of Public Health and Sanitation; 2010. The National AIDS and STIs Control Programme. National guidelines for HIV/STI programs for sex workers.
53. Richter M, Chersich MF, Vearey J, Sartorius B, Temmerman M, Luchters S. Migration Status, Work Conditions and Health Utilization of Female Sex Workers in Three South African Cities. Journal of immigrant and minority health / Center for Minority Public Health. 2012
54. Madise N, Ziraba AK, Inungu J, et al. Are slum dwellers at heightened risk of HIV infection than other urban residents? Evidence from population-based HIV prevalence surveys in Kenya. Health Place. 2012; 18:1144–1152. [PubMed: 22591621]
55. Kimani JK, Ettarh R, Ziraba AK, Yatich N. Marital status and risk of HIV infection in slum settlements of Nairobi, Kenya : results from a cross-sectional survey. African Journal of Reproductive Health. 2013; 17:103–113. [PubMed: 24069739]
56. Nel A, Mabude Z, Smit J, et al. HIV incidence remains high in KwaZulu-Natal, South Africa: evidence from three districts. PLoS ONE. 2012; 7:e35278. [PubMed: 22536364]
57. Opio A, Muyonga M, Mulumba N. HIV Infection in Fishing Communities of Lake Victoria Basin of Uganda - A Cross-Sectional Sero-Behavioral Survey. PLoS ONE. 2013; 8:e70770. [PubMed: 23940638]
58. Seeley J, Nakiyingi-Miiro J, Kamali A, et al. High HIV incidence and socio-behavioral risk patterns in fishing communities on the shores of Lake Victoria, Uganda. Sexually Transmitted Diseases. 2012; 39:433–439. [PubMed: 22592828]
59. Humblet O, Paul C, Dickson N. Core group evolution over time: high-risk sexual behavior in a birth cohort between sexual debut and age 26. Sexually Transmitted Diseases. 2003; 30(11):818–824. [PubMed: 14603088]
60. Fichtenberg CM, Ellen JM. Moving from core groups to risk spaces. Sex Transm Dis. 2003; 30(11):825–826. [PubMed: 14603089]
61. Rothenberg RB. The geography of gonorrhea. Empirical demonstration of core group transmission. Am J Epidemiol. 1983; 117(6):688–694. [PubMed: 6859024]
62. Weir SS, Pailman C, Mahlalela X, Coetzee N, Meidany F, Boerma JT. From people to places: focusing AIDS prevention efforts where it matters most. AIDS. 2003; 17(6):895–903. [PubMed: 12660537]
63. Abdool Karim Q, Abdool Karim SS, Singh B, et al. Seroprevalence of HIV infection in rural South Africa. AIDS. 1992; 6(15):35–39. [PubMed: 1543564]
64. Pickering H, Okongo M, Ojwiya A, Yirrell D, Whitworth J. Sexual networks in Uganda: mixing patterns between a trading town, its rural hinterland and a nearby fishing village. Int J STD AIDS. 1997; 8(8):495–500. [PubMed: 9259497]
65. Thomas L, Vearey J, Mahlangu P. Making a difference to health in slums: an HIV and African perspective. Lancet. 2011; 377:1571–1572. [PubMed: 21550480]

66. Rehle T, Shisana O, Pillay V, Zuma K, Parker W. National HIV incidence measures-new insights into the South African epidemic. South African Medical Journal. 2007; 97(3):194. [PubMed: 17440667]

67. Abdool Karim SS. Commentary: Spatial clustering of HIV infection: providing clues for effective HIV prevention. International Journal of Epidemiology. 2009; 38:1016–1017. [PubMed: 19406907]

68. Tatem AJ, Hemelaar J, Gray RR, Salemi M. Spatial accessibility and the spread of HIV-1 subtypes and recombinants in sub-Saharan Africa. AIDS. 2012:1–11. [PubMed: 21971356]

69. Hué S, Hassan AS, Nabwera H, et al. HIV type 1 in a rural coastal town in Kenya shows multiple introductions with many subtypes and much recombination. AIDS research and human retroviruses. 2012; 28:220–224. [PubMed: 21770741]

70. Nazziwa J, Njai HF, Ndembi N, et al. Short communication: HIV type 1 transmitted drug resistance and evidence of transmission clusters among recently infected antiretroviral-naive individuals from Ugandan fishing communities of Lake Victoria. AIDS Res Hum Retroviruses. 2013; 29(5):788–795. [PubMed: 23173702]

71. Ssemwanga D, Ndembi N, Lyagoba F, et al. HIV type 1 subtype distribution, multiple infections, sexual networks, and partnership histories in female sex workers in Kampala, Uganda. AIDS Res Hum Retroviruses. 2012; 28(4):357–365. [PubMed: 21749285]

72. Kapaata A, Lyagoba F. HIV-1 Subtype Distribution Trends and Evidence of Transmission Clusters Among Incident Cases in a Rural Clinical Cohort in Southwest Uganda, 2004–2010. AIDS Res Hum Retroviruses. 2013

73. Granich R, Gupta S, B Suthar A, et al. Antiretroviral therapy in prevention of HIV and TB: update on current research efforts. Current HIV Research. 2011; 9(6):446–469. [PubMed: 21999779]

74. Mannava P, Geibel S, King'ola N, Temmerman M, Luchters S. Male sex workers who sell sex to men also engage in anal intercourse with women: evidence from Mombasa, Kenya. PLoS One. 2013; 8(1):e52547. [PubMed: 23300978]

75. Arnold MP, Struthers H, McIntyre J, Lane T. Contextual correlates of per partner unprotected anal intercourse rates among MSM in Soweto, South Africa. AIDS Behav. 2013; 17(Suppl 1):S4–S11. [PubMed: 23054039]

76. Bezemer D, Faria NR, Hassan A, et al. HIV Type 1 Transmission Networks Among Men Having Sex with Men and Heterosexuals in Kenya. AIDS Res Hum Retroviruses. 2013

77. Needle R, Fu J, Beyrer C, et al. PEPFAR's evolving HIV prevention approaches for key populations--people who inject drugs, men who have sex with men, and sex workers: progress, challenges, and opportunities. J Acquir Immune Defic Syndr. 2012; 60(Suppl 3):S145–S151. [PubMed: 22797736]

78. Geneva, Switzerland: NACO – National AIDS Control Organisation, Country Progress Report: UNGASS India, 2010; p. 95

79. Globa Fund. The Global Fund’s New Funding Model: Fourth Replinishment (2014–2016), 2013.

80. UNAIDS. Geneva: UNAIDS; 2013. Hotspots: Connecting people to local HIV services.

81. PEPFAR. South Africa HIV Prevention Framework—2013–2017, 2013.

82. Okal J, Geibel S, Muraguri N, et al. Estimates of the size of key populations at risk for HIV infection: men who have sex with men, female sex workers and injecting drug users in Nairobi, Kenya. Sex Transm Infect. 2013; 89(5):366–371. [PubMed: 23761166]

83. Khalid FJ, Hamad FM, Othman AA, et al. Estimating the Number of People Who Inject Drugs, Female Sex Workers, and Men Who Have Sex with Men, Unguja Island, Zanzibar: Results and Synthesis of Multiple Methods. AIDS Behav. 2013

84. Baral S, Phaswana-Mafuya N. Rewriting the narrative of the epidemiology of HIV in sub-Saharan Africa. SAHARA J. 2012; 9(3):127–130. [PubMed: 23237066]

Key points

- Concentrated sub-epidemics exist within all generalized epidemic contexts.
- Substantial reductions in population-level HIV incidence in generalized epidemics might be achievable with interventions targeted at geographically defined “risk spaces” (such as informal settlements) as well as most-at-risk population groups (such as MSM, PWID and SW).
- The empirical estimation of population sizes of hidden high-risk groups will be critical. There is currently a knowledge gap on how best to sample and estimate the population sizes of these risk groups in a representative way.
- The feasibility, acceptability, effectiveness, and cost-effectiveness of prevention interventions for most-at-risk groups needs to be established within different cultural and institutional contexts in sub-Saharan Africa. Rigorous impact evaluation of such interventions should accompany the scaling-up of targeted interventions for most-at-risk groups.

Curr Opin HIV AIDS. Author manuscript; available in PMC 2015 March 01.

Table 1

Review of studies published since 2012 that assessed either prevalence or incidence of HIV among men who have sex with men in the ten countries in sub-Saharan Africa with the highest HIV burden.

Authors	Country (city or region)	Sample	Design	Sample Size	Outcome	Results
Hladik et al. (2012) [21]	Uganda (Kampala)	Men who have sex with men	Respondent-driven sampling	300	HIV prevalence	14% (95% CI: 8–20%)
Dunkle et al. (2013) [19]	South Africa (Eastern Cape and KwaZulu-Natal provinces)	Men from eligible households	Cross-sectional	1,220	HIV prevalence	27% (95% CI: 17–40%) as compared to 17% (14–20%) among men who reported non male-on-male contact
Eaton et al. (2013) [20]	South Africa (Cape Town)	Men who have sex with men and women and men who have sex with women	Convenience sample	1,203	Self-reported HIV prevalence	11% of MSMW versus 5% for MSW
Price et al. (2012) [22]	Kenya (Kilifi and Nairobi) and South Africa (Cape Town)	Volunteers	Convenience sample of volunteers	327	HIV incidence	7 per 100 person-years (95% CI: 5 to 9).
Sanders et al. (2013) [23]	Coastal region of Kenya	Men who have sex with men, men who have sex with men and women, and men who have sex with men exclusively	Combination of convenience sample and respondent driven sampling	449 MSM 372 MSMW 77 MSME	HIV incidence	MSM overall: 9 per 100 person-years (95% CI: 7–11) MSMW: 6 per 100 person-years (95% CI: 4–8) MSM: 35 per 100 person-years (95% CI: 24–52)

Table 2

Review of studies published since 2012 that assessed either prevalence or incidence of HIV among people who inject drugs in ten countries of sub-Saharan Africa with the highest HIV burden.

Authors	Country (city or region)	Sample	Design	Sample Size	Outcome	Results
Petersen et al. (2012) [41]	Kenya Tanzania	Person who inject drugs (PWID)	Information collected from key national contacts who were experts in IDU and HIV (supplemented with literature search)	Not applicable	HIV prevalance	Kenya: 36%–43% Tanzania: 42%
Bowring et al. (2013) [42]	Tanzania	People who inject drugs (PWID) and non-injecting drug users (NIDU)	Targeted sampling and snowball	PWID: 267 NIDU: 19	HIV prevalence	PWID: 34.8% (95% CI: 29%–41%) NIDU: 12% (7%–18%)

Table 3

Review of studies published since 2012 that assessed either prevalence or incidence of HIV among sex workers in the ten countries in sub-Saharan Africa with the highest HIV burden*.

Authors	Country (city or region)	Sample	Design	Sample Size	Outcome	Results
Vandepitte et al (2012) [50]	Uganda (Kampala)	Female Sex workers	Cross-sectional	1025	HIV prevalence	36.9% (95% CI 34–40)
Baral et al (2012)[49]	Kenya (Nairobi)	Female Sex workers	Meta-analysis of 9 studies	7544	HIV prevalence	45·1% (95% CI 44.0–46.2)
Vandenhoudt et al (2013) [51]	Kenya (Kisumu)	Female Sex Workers	Cross-sectional	481	HIV prevalence	56.5% (95% CI 52.0–61.6).

*An additional study [22] was not included due to the small numbers of sex workers included for HIV incidence measurement

Table 4

Review of studies published since 2012 that assessed either prevalence or incidence of HIV among in geographically defined “risk-spaces” in ten countries in sub-Saharan Africa with the highest HIV burden.

Authors	Country (city or region)	Sample	Design	Sample Size	Outcome	Results
Madise et al (2012)[54]	Kenya (Nairobi)	Slum residents	Cross-sectional data from the Kenya Demographic and Health Survey	3048	HIV prevalence	11.8% (95%CI 10.7, 13.0) comparative estimates for non-slum urban residents was 5.3% and rural residents was 6%
Kimani et al 2012[55]	Kenya (Nairobi)	Slum residents	cross-sectional population-based survey nested in an ongoing Demographic Surveillance System in two urban slums	2721	HIV prevalence	11.5% (95%CI 10.3, 12.7)
Nel et al (2012)[56]	South Africa (Ladysmith) South Africa (Edenvale) South Africa (Pinetown)	Peri-urban residents	Sexually active women 18–35 years	2773	HIV prevalence	42.0% (95% CI 38.5, 45.5) in Ladysmith, 46.1% in Edendale (95% CI 43.1, 49.1), and 41.3% (95% CI 38.0, 44.6) in Pinetown
				900	HIV incidence	14.8/100 person-years (PY) (95% CI 9.7, 19.8) in Ladysmith, 6.3/100 PY (95% CI 3.2, 9.4) in Edendale, and 7.2/100 PY (95% CI 3.7, 10.7) in Pinetown
Opio et al (2013)[57]	Uganda (Lake Victoria Basin)	Residents of fishing villages	A cross-sectional survey of 46 fishing communities was conducted in respondents age 15–59 years	911	HIV prevalence	Men = 25% (95%CI 19, 31) Women = 21% (95%CI 16,25)
Seeley et al (2012)[58]	Uganda (Lake Victoria Basin)	Residents of fishing villages	Prospective cohort study	1000	HIV incidence	Overall incidence rate of 4.9 (95% CI = 3.8 to 6.3) per 100 PYAR.