Chapter 8

Tailoring the Local HIV/AIDS Response to Local HIV/AIDS Epidemics

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INTRODUCTION

In the 30 years since the global appearance of the human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS), we have come extraordinarily far in our fight against it. We know its physical routes of transmission and how to prevent infection at the individual level, and we have proven intervention strategies at the population level. Yet, despite global declines in modeled incidence, measured incidence remains high in cohort studies and is growing within certain demographic groups. This concerning trend underscores the need to thoroughly examine how local and national HIV/AIDS epidemics are sustained.

Knowledge of epidemic and transmission dynamics will help HIV/AIDS programs invest in the right interventions. Proven interventions exist for both concentrated and generalized epidemics. For example, simple targeted interventions for concentrated epidemics have been implemented at scale with considerable durability in numerous contexts. Targeting resources and interventions to the right people and the right places is also essential. More than one key population may drive a concentrated epidemic, and new infections within a generalized or mixed epidemic come from multiple demographic groups and behaviors within the general population. Geographic targeting and hotspot mapping can assist in identifying both geographic areas of elevated transmission and high-risk groups. Epidemic modeling software, such as Optima, can help identify the right mix of interventions and financial allocations, resulting in cost-effective programming.[1]

This chapter reviews factors to consider when tailoring the local response to a local epidemic. It explores transmission dynamics in concentrated, generalized, and mixed epidemics, while acknowledging the complexity and variation within these distinctions. It also addresses interventions shown to work in different contexts and discusses how program science can assist in reaching the right people in the right places, providing examples of successful implementation. Finally, it elaborates on what Optima software is and how it can improve allocative and implementation efficiency.

KNOW YOUR EPIDEMIC: TRANSMISSION DYNAMICS

A thorough understanding of the heterogeneity of HIV transmission, between and within epidemics, is the first step in a targeted response. This understanding includes appreciating transmission dynamics at national and subnational levels, across geographic regions, and within different demographics, as well as the risk factors sustaining transmission.

Distinguishing between concentrated, generalized, and mixed epidemics is helpful for understanding transmission dynamics.

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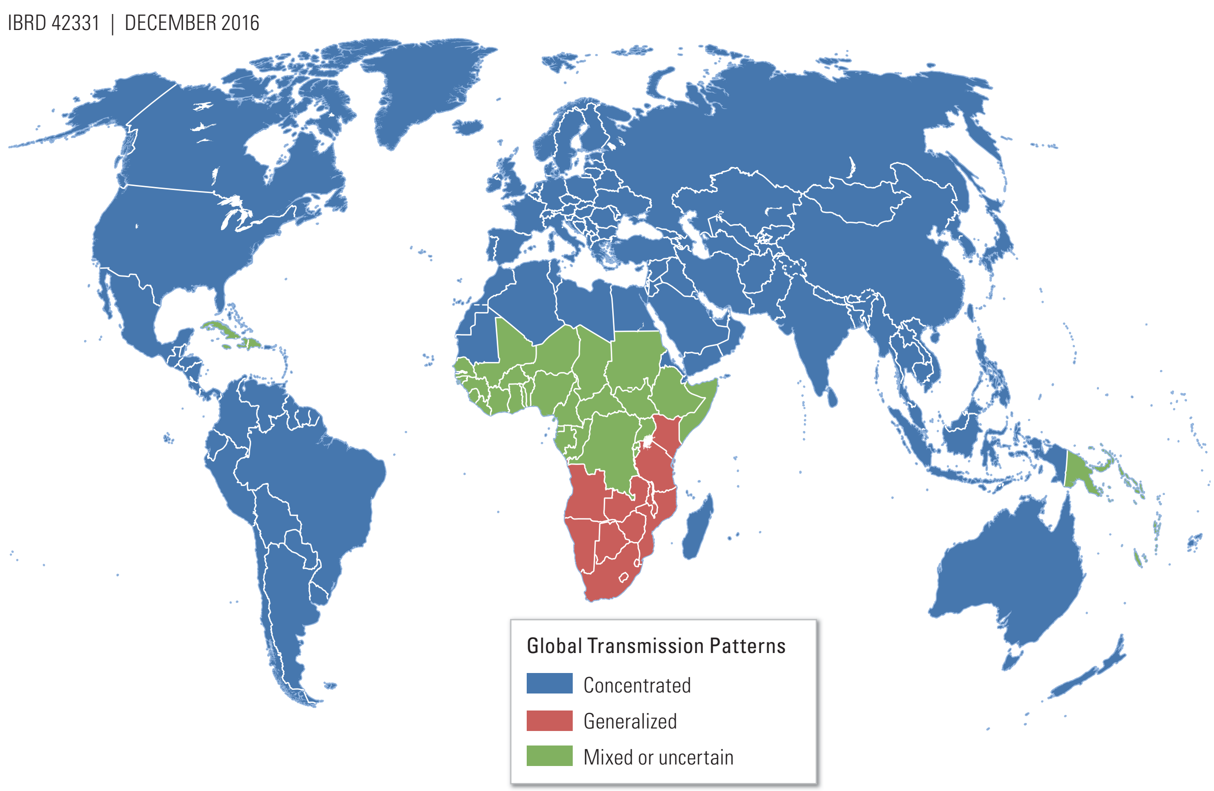
- An epidemic is *concentrated* if "HIV has spread rapidly in one or more defined subpopulation but is not well established in the general population" (WHO 2013). In this context, protecting key populations, such as injecting drug users (IDUs), men who have sex with men (MSM), and sex workers, would significantly mitigate the epidemic.
- An epidemic is *generalized* if transmission at a level to sustain the epidemic would occur even if key populations were protected from infection, as when "HIV infection is firmly established in the general population" (WHO 2013).
- An epidemic is *mixed* if transmission would be sustained by both key populations and the general population and would continue even if transmission in either population were stopped. Mixed epidemics are essentially one or more concentrated epidemics within a generalized epidemic.

Previously, concentrated and generalized epidemics were distinguished from one another based on HIV prevalence in key populations or the general population. Prevalence of more than 5 percent in key populations and less than 1 percent in the general population (prevalence in pregnant women as a proxy) indicated a concentrated epidemic, whereas prevalence of more than 1 percent in the general population indicated a generalized epidemic (UNAIDS/WHO Working Group on Global HIV/AIDS and STI Surveillance 2000). While this approach is a simple numerical way of defining epidemics, it does not address what the transmission dynamics are, how these epidemics are sustained, where the majority of new infections are occurring, and where target prevention activities are in place. For example, Wilson and Challa (2009) demonstrate that three African epidemics have HIV prevalence of more than 1 percent in the general population, but they are not all considered generalized because of the source of new infections.

Most epidemics are concentrated (map 8.1). However, the global burden of HIV/AIDS is heaviest in Sub-Saharan Africa, where 24.7 million people live with the disease and 1.5 million new infections occur each year (more than 70 percent of the global total for existing and new infections) (UNAIDS 2014b). Most HIV/AIDS epidemics in Sub-Saharan Africa are generalized or mixed transmission (Wilson and Halperin 2008).

Map 8.1 Global HIV Transmission Dynamics



Source: Wilson and Halperin 2008.
Note: HIV = human immunodeficiency virus.

Concentrated Epidemics

Concentrated HIV/AIDS epidemics are occurring primarily in Asia; Australasia; Europe; the Middle East; and North, Central, and South America. They are sustained through key populations, which are at much higher risk for infection (figure 8.1). A targeted approach acknowledges and addresses the factors and behaviors that are putting these key populations at increased risk.

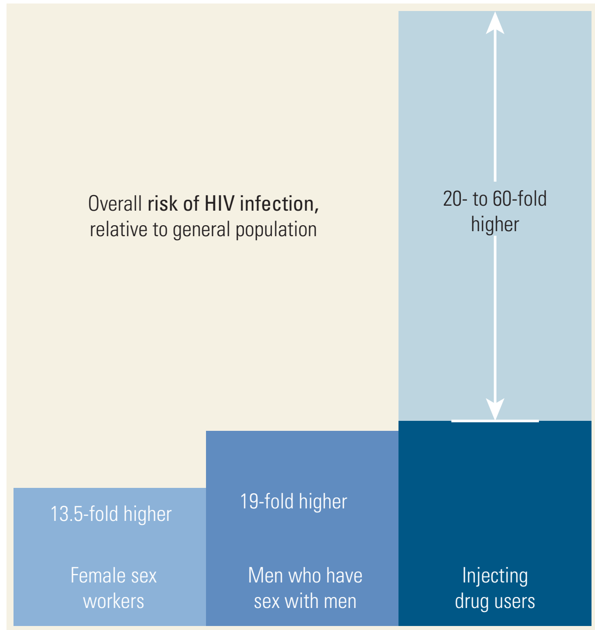
Sex Workers

Female sex workers have a risk of HIV infection that is 13.5 times higher than that of the general population (Baral and others 2012). Globally, HIV prevalence is higher among sex workers than among the general population. It is 12 times higher in 110 countries with available data and at least 50-fold higher in 4 countries (UNAIDS 2014b). In 16 Sub-Saharan African countries, female sex workers have a pooled HIV prevalence of 37 percent (Kerrigan and others 2013); these countries include Swaziland, where as many as 70 percent of sex workers are living with HIV/AIDS (figure 8.2).

Biological, behavioral, and structural factors put sex workers at greater risk of contracting HIV and other sexually transmitted infections (STIs). Compared with the general population, sex workers have more sexual partners and more concurrent sexual partners, are more likely to use injection drugs (Johnston and Corceal 2013; Lau and others 2008; Needle and others 2008; UNAIDS 2006; Zohrabyan and others 2013), and are more often subject to violence (Decker and others 2014; Deering and others 2013). It is common practice for police to arrest individuals because they are carrying condoms and then to confiscate them, further compromising the ability of sex workers to protect themselves (Ireri 2012; Maseko and Ndlovu 2012; Open Society Foundations 2012; WHO 2012). Furthermore, discrimination and stigma discourage sex workers from seeking health services, including HIV testing (King and others 2013; Scorgie and others 2011).

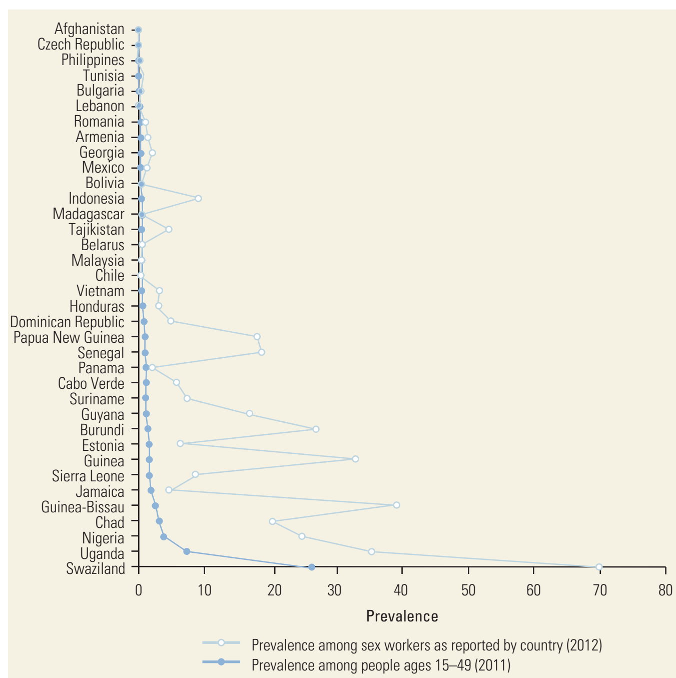
The spectrum of sex work is especially complex in Sub-Saharan Africa, where sexual transactions often occur in the context of poverty and inequality. Sex work involves both those who identify themselves as professionals and those who do not but who do engage in informal sex work and transactional sex. In Burkina Faso, some nonprofessional sex workers (bar waitresses and mobile traders) have higher HIV prevalence than some professional sex workers (roamers), despite fewer reported sexual partners (2.6 and 3.3 clients per week for waitresses and traders, respectively, versus 18.6 for professional roamers) (Nagot and others 2002).

Figure 8.1 HIV Risk in Key Populations Relative to the General Population



Sources: Baral and others 2012; UNAIDS 2014b.
Note: HIV = human immunodeficiency virus.

Figure 8.2 Prevalence of HIV among Sex Workers versus General Population



Source: UNAIDS (Joint United Nations Programme on HIV/AIDS). 2012. *UNAIDS Report on the Global AIDS Epidemic 2012.* Geneva.
Note: HIV = human immunodeficiency virus.

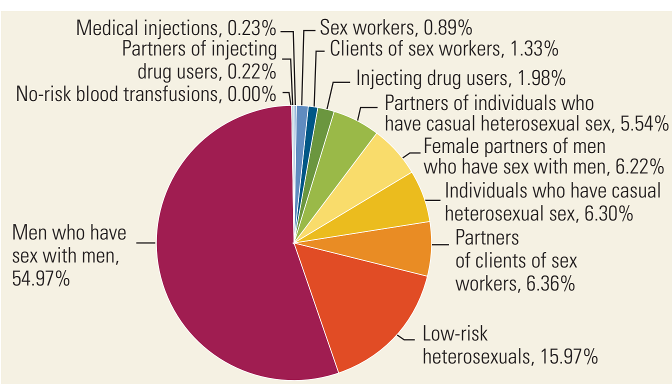
Men Who Have Sex with Men

MSM is another key population in concentrated epidemics. They are 19 times more likely to be living with HIV/AIDS than the general population, with prevalence of 6 percent to 15 percent (UNAIDS 2014b). Epidemics have been spreading among MSM in many settings, even in high-income settings with good coverage of antiretroviral treatment (ART) (Sullivan and others 2009). MSM account for the largest share of new infections in Latin America and the Caribbean (33 percent in the Dominican Republic, 56 percent in Peru) (figure 8.3) and for a substantial percentage of new infections in other parts of the world (Gouws and Cuchi 2012). In Ghana, 8 percent to 18 percent of new infections occur in MSM (UNAIDS and World Bank 2012).

Biological and behavioral factors multiply the risk among MSM at both individual and population levels. The estimated risk of acquiring HIV is 18 times greater through anal than through vaginal sex (Grulich and Zablotska 2010). Frequent casual sex with multiple partners is relatively common among MSM. In larger networks, as the number of partners increases, so does the incidence of unprotected sex (Choi, Gibson, and others 2004; Choi, McFarland, and others 2004; Kelly and others 2010). In these situations, acute infections may be more prevalent, driving higher incidence, because acutely infected individuals have higher viral loads and are more infectious.

Sexual and other risk factors also play a role. MSM may have sex with both men and women (and may even be in long-term heterosexual marriages or partnerships, especially in the global South). Drug use is also associated with riskier sexual practices. In Bangkok, HIV prevalence among MSM rose from 2009 to 2011 with the use of amphetamine-type stimulants (Colfax and others 2010; Freeman and others 2011; van Griensven and others 2009).

Figure 8.3 Sources of New HIV Infections in Peru



Source: UNAIDS and OPS 2009.
Note: HIV = human immunodeficiency virus.

Injecting Drug Users

An estimated 13 percent of the 12.7 million IDUs worldwide are infected with HIV; IDUs have, on average, 28 times greater HIV prevalence than the general population, ranging from 1.3 to 2,000 times greater in 74 countries (UNAIDS 2014b). Outside of Sub-Saharan Africa, an estimated 30 percent of new infections come from IDUs; in many countries in Asia, Eastern Europe, and the Middle East, IDUs are driving the national epidemic (Mathers and others 2008; UNAIDS 2014b). In the Islamic Republic of Iran, more than two-thirds of new infections occur in IDUs and their sexual partners (figure 8.4).

IDU-driven epidemics exhibit much heterogeneity. In 30 countries reporting gender-specific data, HIV prevalence is higher among female than among male IDUs (UNAIDS 2014b). This enhanced risk may be due to high rates of sex work among female IDUs (Blouin and others 2013). IDUs under age 25 are also at comparatively high risk for HIV infection, with a prevalence of 5.2 percent.

Shared needles are a main risk factor for infection, although sexual transmission between IDUs and their non-IDU partners can play a small to major role depending on context. Modeling of epidemics for the period 2010–15 showed that HIV infection due to unprotected sex among and with IDUs was 5 percent of total HIV incidence in Nairobi, Kenya, and Karachi, Pakistan, but 15 percent to 45 percent in Odessa, Ukraine (Strathdee and others 2010).

Generalized Epidemics

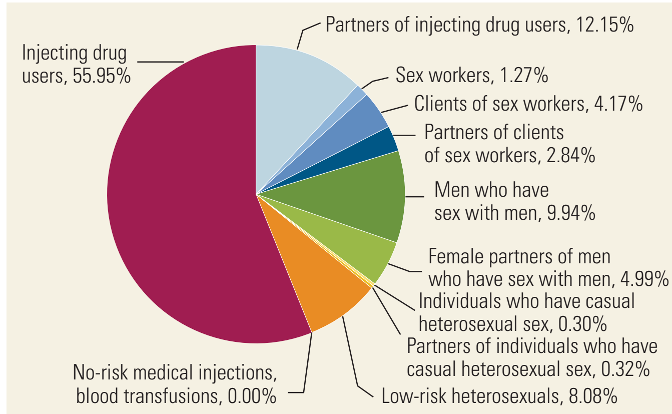
Generalized epidemics were previously defined as epidemics in which more than 1 percent of the general population was infected. Recent definitions focus on transmission dynamics, and generalized epidemics are now defined as epidemics that are sustained by heterosexual transmission in the general population.

The distinction between concentrated and generalized epidemics is important: interventions in a concentrated epidemic should address specific key populations (Wilson and Halperin 2008), whereas interventions in a generalized epidemic should address the broader, general population, while also focusing on high risk subgroups within it. As heterogeneous as community norms and sexual values and practices can be in the general population, so, too, are the sources of infection. For example, in KwaZulu-Natal, South Africa's most HIV/AIDS-afflicted region, most infections are transmitted through heterosexual sex (figure 8.5). However, key populations and their sexual partners also play a large role.

Casual sex is highly prevalent in countries experiencing severe generalized epidemics. In Lesotho and Swaziland, where HIV prevalence was 23 percent and 27 percent, respectively, in 2013 (UNAIDS 2014b), casual sex, as opposed to commercial sex, is highly prevalent among men who work as soldiers, police, miners, drivers, guards, and seasonal workers (Family Health International and others 2002; Swaziland Ministry of Health and Social Welfare 2002).

HIV prevalence also varies across gender and age groups. In Swaziland, more than half of females ages 30–34 and nearly half of men ages 35–39 are living with HIV/AIDS. For people ages 18–29, prevalence is at least twice as high in women as in men (Swaziland Ministry of Health 2012).

Figure 8.4 Sources of New HIV Infections in the Islamic Republic of Iran



Source: Nasirian 2011.
Note: HIV = human immunodeficiency virus.

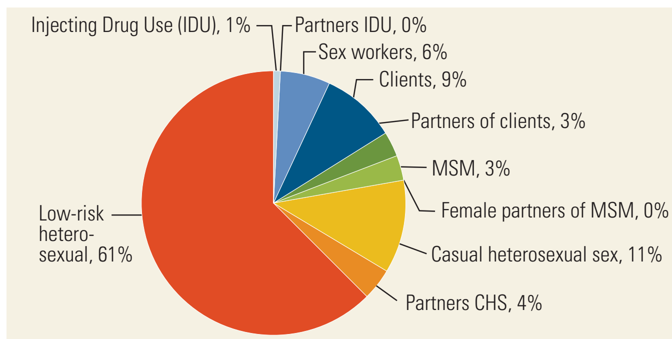
Mixed Epidemics

Mixed epidemics are characterized by both concentrated and generalized transmission, often in the same area, as in much of West Africa. Transmission can also change, moving from concentrated to generalized. In mixed epidemics that are changing from concentrated to generalized transmission, bridge populations, such as paying and nonpaying partners of sex workers and bisexual MSM, transmit HIV to the general population.

Epidemics of mixed transmission can also be geographically mixed, with concentrated epidemics occurring in some areas and generalized epidemics occurring in others. In most provinces in Indonesia, the epidemic is concentrated and sustained in key populations of IDUs and MSM, especially transgender (*waria*) and male sex workers. However, in the Indonesian provinces of Papua and West Papua, the epidemic is driven largely by heterosexual transmission, both by sex workers and by the general population, and HIV prevalence is much higher than in the rest of the country, at 2.40 percent in Papua and 0.27 percent in West Papua (Indonesian National AIDS Commission 2012).

According to projections for 2000–20, the epidemic in Jakarta began with male IDUs but quickly spread to MSMs, who soon became the largest source of transmission. The epidemic in Papua spread steadily through females in the general population (figure 8.6).

Figure 8.5 Sources of New HIV Infections in KwaZulu-Natal, South Africa



Source: SACEMA 2009.
Note: CHS = individuals who have casual heterosexual sex; HIV = human immunodeficiency virus; MSM = men who have sex with men.

TAILOR THE HIV/AIDS RESPONSE

Tailoring the local response to a local epidemic requires more than just knowledge of transmission dynamics. It also requires the use of proven interventions that target the right people and that are applied effectively in the right places.

Invest in the Right Interventions

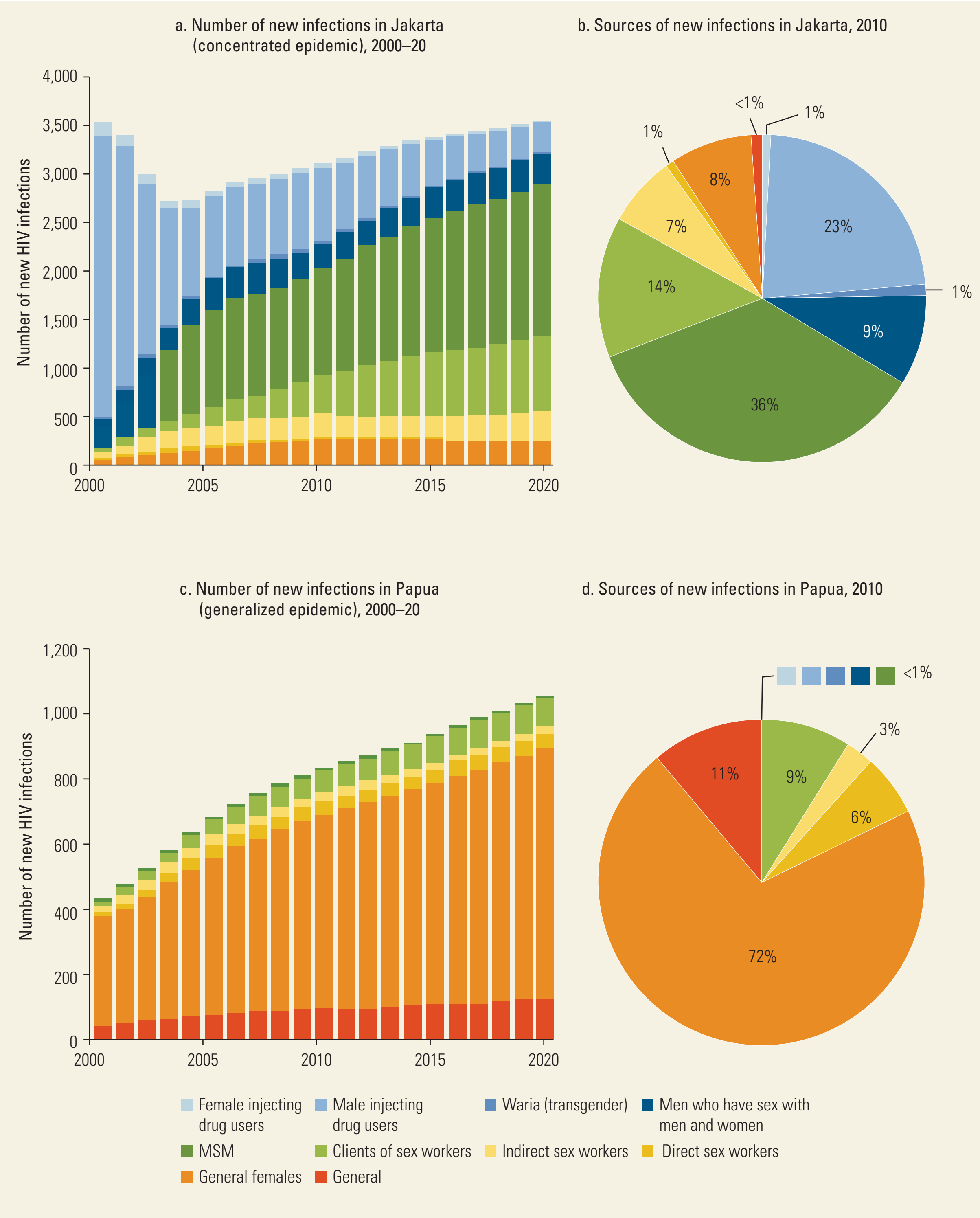
Several biomedical and sociobehavioral interventions have been effective at preventing infection and transmission at the individual and population levels. All are important in any comprehensive response, but specific interventions have been proven to be most effective in certain epidemic contexts. Prioritizing the right interventions based on epidemic context is essential.

Interventions for Concentrated Epidemics

Effective targeted interventions for concentrated epidemics have six core components:

- Behavior-change communication
- Condom programs and needle and syringe programs (NSPs)
- Sexual health and harm-reduction services, including opioid substitution therapy (OST)

Figure 8.6 Projected Transmission Dynamics of the Mixed HIV Epidemic in Jakarta and Papua, Indonesia, 2000–20



Source: Modeling by Kirby Institute, University of South Wales.
Note: HIV = human immunodeficiency virus; MSM = men who have sex with men.

- HIV testing, counseling, and treatment (ART)
- Solidarity and community empowerment
- Supportive local and national legal and policy environments.

The World Health Organization (WHO), the United Nations Joint Programme on HIV/AIDS (UNAIDS), and the United Nations Office on Drugs and Crime promote a comprehensive package of HIV interventions for IDUs, including three priority interventions: NSPs, OST, and ART. In a study of 99 cities, those with NSPs saw a 19 percent reduction in prevalence per year, while those without NSPs experienced an 8 percent increase over approximately one decade (MacDonald and others 2003). Among other effects, OST programs have been shown to reduce HIV incidence among IDUs (MacArthur and others 2012; van den Berg and others 2007). ART has reduced transmission by reducing infectiousness (Cohen and others 2011; Quinn and others 2000; Wood and others 2009).

Community empowerment, often leading to community mobilization, has been effective in programs targeting sex workers. Community empowerment and mobilization has led to increased condom use, lower risk for STIs, and increased HIV testing in India (Beattie and others 2014; Blanchard and others 2013; Fonner and others 2014) and Africa (Chersich and others 2013). In Asia, social programs marketing condoms have increased condom use (Lipovsek and others 2010; Ngoc and others 2011; USAID 2011). Along with promoting the use of condoms, other interventions to address sexual health, including reducing the incidence of and treating STIs, have also been associated with a reduction in HIV prevalence in sex-worker populations (Ghys and others 2001; Ghys and others 2002; Laga and others 1994; Rojanapithayakorn and Hanenberg 1996). One of the most successful interventions has been India's Avahan Program, which is supported by the Bill & Melinda Gates Foundation. A large-scale, cost-effective program promoting all of the core components of interventions for concentrated epidemics, the Avahan Program averted an estimated 42 percent of HIV infections in 4 years and an estimated 57 percent in 10 years (Pickles and others 2013; Vassall and others 2014).

Condom promotion; HIV testing, counseling, and treatment; and behavior change to reduce risky sexual practices are important interventions for MSM. In the 1980s, behavior change on a large scale, including a decrease in the number of sexual partners and an increase in the use of condoms, helped to curb the epidemic in MSM in Australia and the United States (Kippax and Race 2003; Winkelstein and others 1987). However, in randomized clinical trials, behavioral interventions had a minimal effect on reducing incidence of HIV among MSM.

Solid evidence exists for the use of specific interventions in concentrated epidemics, but coverage and implementation are lacking in many programs. UNAIDS (2012) reports that 86 percent of countries have low or no coverage of NSPs, and more than 85 percent of people who inject drugs lack access to NSP, OST, or ART services (Stoicescu 2012). MSM and sex workers are poorly represented in prevention programs, with 70 percent and 75 percent of countries reporting very low or no coverage for these populations, respectively (UNAIDS 2012). The inadequate coverage of sex workers is especially disconcerting, since the bulk of new infections come from this group in many concentrated epidemics.

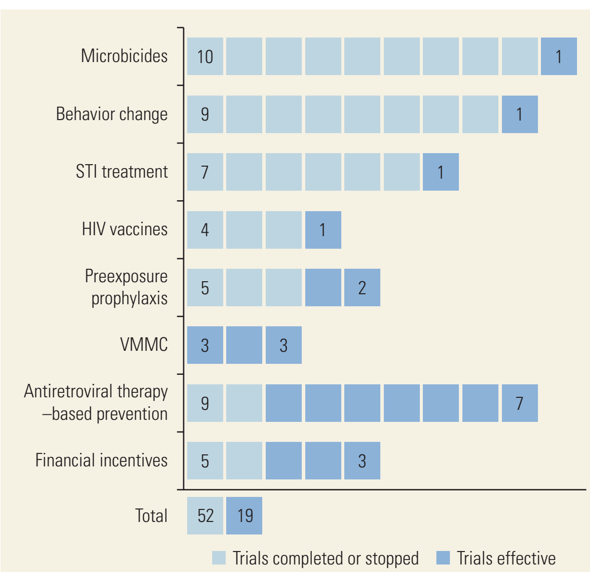
Finally, preexposure prophylaxis (PrEP) is a promising new biomedical tool for use in key populations and is recommended by the WHO for individuals at "substantial risk" of HIV (WHO 2015). The WHO made the recommendation based on evaluations of PrEP effectiveness in a number of studies among serodiscordant couples, heterosexual men, women, MSM, IDU, and transgender women, especially when adherence was high. For example, PrEP reduced HIV incidence by 44 percent among MSM and by 90 percent among fully adherent MSM in a multicountry study (Grant and others 2010). PrEP has been shown to prevent infection in IDUs, resulting in a 49 percent reduction of HIV incidence in PrEP groups compared with placebo groups (Choopanya and others 2013). Overall, across studies in different at-risk populations, a meta-analysis of 10 randomized controlled trials found a 51 percent reduction in infection risk among PrEP users versus those who took a placebo (Fonner and others 2016). Many studies show PrEP efficacy, but success outside the context of clinical trials will not be easy. Adherence may be lower in real-life implementation scenarios, challenging the effectiveness of PrEP. In these settings, implementation of adherence-support programs will be very important in combination with PrEP. Also, achieving success in developing countries will be much more difficult because fewer programs in low- and middle-income countries reach key populations such as MSM and IDUs.

Interventions for Generalized Epidemics

Various interventions have been tested for generalized epidemics, including those that have been effective in concentrated epidemics. However, randomized controlled trials using HIV incidence endpoints have found only VMMC, ART-based prevention, and financial incentives to be consistently effective (figure 8.7). Of the cash transfer trials, one used STIs, not HIV specifically, as an endpoint, and another used prevalence as a proxy for incidence.

ART-based prevention, such as TasP, has been proven to reduce transmission. In clinical trials, TasP can reduce risk by more than 96 percent (Cohen and others 2011). Outside of clinical trials, it is still effective but less so. In KwaZulu-Natal, South Africa, infection was 34 percent lower in areas with 30 percent to 40 percent ART coverage than in areas with less than 10 percent coverage (Tanser and others 2013). In China, infection was 26 percent lower in serodiscordant couples in which the infected partner received ART than in couples in which the infected partner did not (Jia and others 2013). In Swaziland, where about 85 percent of persons with CD4 cell counts of less than 350 are on ART, measured annual HIV/AIDS incidence was 2.4 percent on top of 26 percent adult prevalence (Swaziland Ministry of Health and Social Welfare 2002). Because of TasP's proven prevention benefits, the WHO now recommends a universal TasP strategy. Under the test-and-treat strategy, all individuals living with HIV/AIDS are eligible for ART, regardless of CD4 count, and catching and treating HIV infection earlier may prevent new infections within the community. As more programs adopt and implement this strategy, more information will be available on the effectiveness of TasP at the population level. In addition, randomized clinical trials are under way in several African field sites (Botswana, Kenya, South Africa, Uganda, and Zambia) to evaluate changes in incidence as a result of TasP and other interventions.

Figure 8.7 Effectiveness of Interventions for Preventing Infections in Generalized HIV/AIDS Epidemics



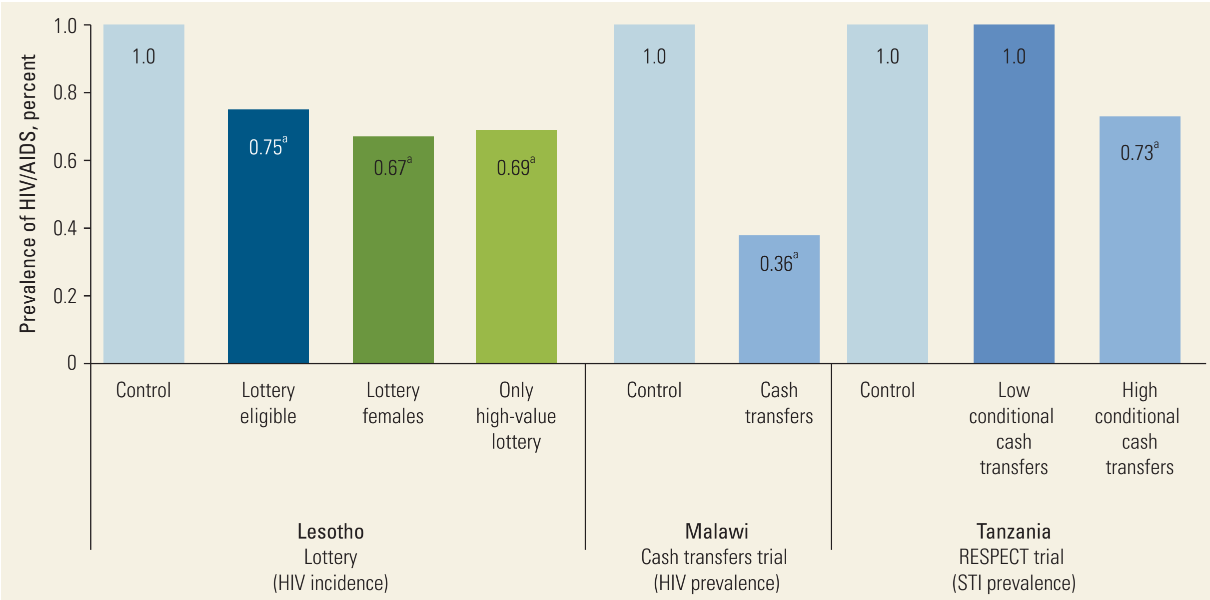
Sources: Baeten and others 2012; Marrazzo and others 2015; Padian and others 2010; Peterson and others 2007; Thigpen and others 2012; Van Damme and others 2012; Weiss and others 2008.
Note: HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome; STI = sexually transmitted infection; VMMC = voluntary medical male circumcision.

VMMC is extraordinarily effective at reducing HIV incidence in generalized epidemics. In clinical trials, the protective effect of VMMC was 60 percent (Auvert and others 2005; Bailey and others 2007; Gray and others 2007); the long-term effect may be even higher. Longer-term follow-up suggested that incidence in persons who were circumcised, compared with those who were not, was 67 percent lower over 4.5 years in Kenya, 73 percent lower over 2.8 years in Uganda, and 76 percent lower over 3.0 years in South Africa (Auvert and others 2013; Bailey and others 2010; Gray and others 2012). In 13 countries, projections suggest that 80 percent implementation of VMMC (20 million circumcisions) and sustaining this level of coverage could avert 3.4 million new infections through 2025 (Njeuhmeli and others 2011). This target has not yet been met; at the end of 2015, only 11.6 million circumcisions had been performed (UNAIDS 2016).

Randomized controlled trials with STI and HIV endpoints conducted by the World Bank and others show that financial incentives, including conditional cash transfers, can reduce HIV and other STIs (figure 8.8). The premise behind financial incentives is that the income effect on sexual behavior may mitigate sexually risky behavior, such as when impoverished young girls seek out older males (who are more likely to be infected) for gifts and financial assistance or engage in transactional sex. In Tanzania, individuals who received up to US$60 annually to stay STI-free had 25 percent lower STI prevalence (de Walque and others 2012). In Malawi, girls whose families received up to US$15 a month to stay in school had 70 percent lower prevalence, compared with the control group, members of which received no payment (Baird and others 2012). Adolescents in Lesotho who received a lottery ticket to win up to US$50 or US$100 every four months if they stayed STI- and HIV-free had 25 percent lower HIV incidence, with even greater reductions among girls (33 percent) and in the group receiving US$100 (31 percent).

Although promising, these initial studies represent only early efforts to determine whether financial incentives can and should be included in HIV prevention programs. The Tanzania study assessed the impact on STIs other than HIV, although reducing STI risk may also reduce HIV risk; the Lesotho study found only a small statistically significant effect. The Malawi study used cumulative HIV prevalence among young women as a

Figure 8.8 Effect of Financial Incentives on Reducing HIV and STIs in Lesotho, Malawi, and Tanzania



Sources: Baird and others 2012; de Walque and others 2012; Nyqvist and others 2015.
Note: HIV = human immunodeficiency virus; RESPECT = Rewarding STI Prevention and Control in Tanzania; STIs = sexually transmitted infections.
a. Statistically significant effect.

proxy for incidence, and there was no baseline or randomization. Furthermore, to the disappointment of the HIV-prevention field, the most recent evaluations of cash transfer interventions in South Africa's generalized epidemic have not shown the same success as the studies in Lesotho, Malawi, and Tanzania, and were challenged by study design and context issues (HPTN 2015; Karim and others 2015). Further studies are needed to evaluate the effectiveness of financial incentives for prevention, whether they are scalable and affordable, and whether their outcomes are durable.

For the general population and in generalized epidemics, limited data exist on the effectiveness of promoting condom use and of behavior-change programs, and a Cochrane review found no clear evidence that community interventions promoting condom use reduce HIV or STI transmission (Moreno and others 2014). However, these interventions need to be supported as part of the overall HIV/AIDS response, as they absorb a small share of the budget.

Tailor the Response for the Right People in the Right Places

It is important not only to invest in context-appropriate interventions, but also to reach the right people with these interventions and to apply them in the right places. While an epidemic may be classified as generalized, concentrated, or mixed at the national level, there may be much heterogeneity at the subnational level. For example, Vietnam's concentrated epidemic is sustained by high prevalence in MSM, male IDUs, and female sex workers, but considerable regional variation is evident in the number of infections and persons infected (map 8.2).

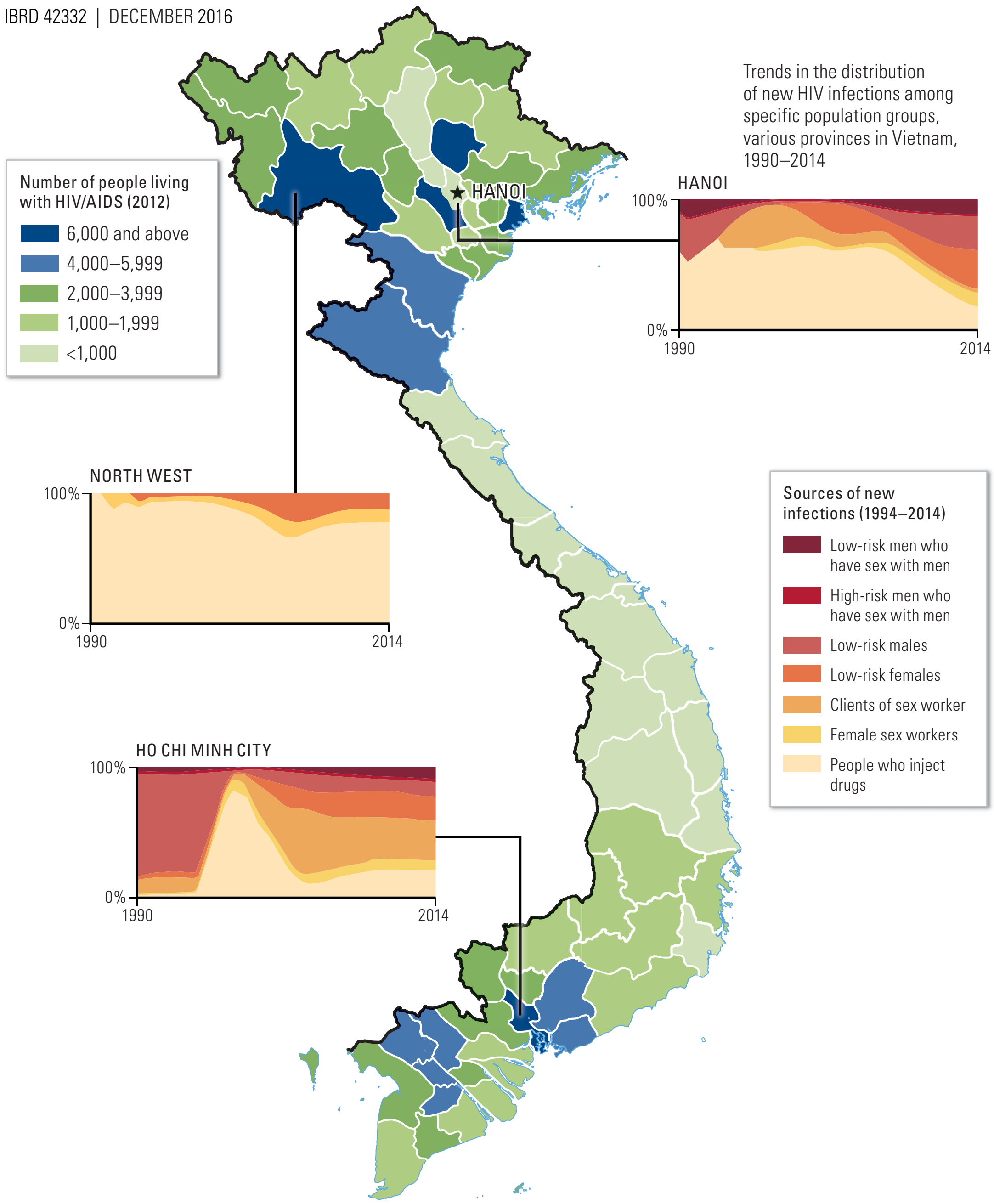
Two approaches are useful for identifying and reaching the right people in the right places: (1) program science, and (2) geographic targeting and hotspot mapping.

Right People: Program Science Approach

Program science is the "systematic application of theoretical and empirical scientific knowledge to improve the design, implementation, and evaluation of public health programmes" (Blanchard and Aral 2011, 1). Program science is useful for tailoring the response to local epidemics and has three core components:

- *Program intelligence*: Data collection and information gathering on modes of transmission, optimal resource allocation, local epidemic appraisal, and ethnographic-linked interventions
- *Program implementation*: Design, development, and delivery of standard intervention packages,

Map 8.2 HIV/AIDS Burden and Sources of New Infections in Vietnam, by Region, 1990 and 2014



Source: UNAIDS 2014a.
Note: HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome.

implementation manuals, quality assurance guidelines, support and training for coordinated program implementation, and knowledge exchange

- *Program evaluation*: Real-time program management data and impact evaluation.

Program science has been used to assess and design the response to the epidemic in Nigeria, which is the world's most diverse and second-largest epidemic by numbers infected. The transmission dynamics are mixed: 42 percent of new infections occur in low-risk heterosexual individuals within the general population, although key populations—only 1 percent of the total population—account for 23 percent of new infections (Blanchard and Aral 2011; NACA 2014). In Cross River State, more than 50 percent of transmission is from key populations and their partners (Prudden and others 2013) (figure 8.9). Prevalence is equally varied, with the highest prevalence concentrated in four states and the lowest (well under the 3 percent of the national average) in nine states (map 8.3).

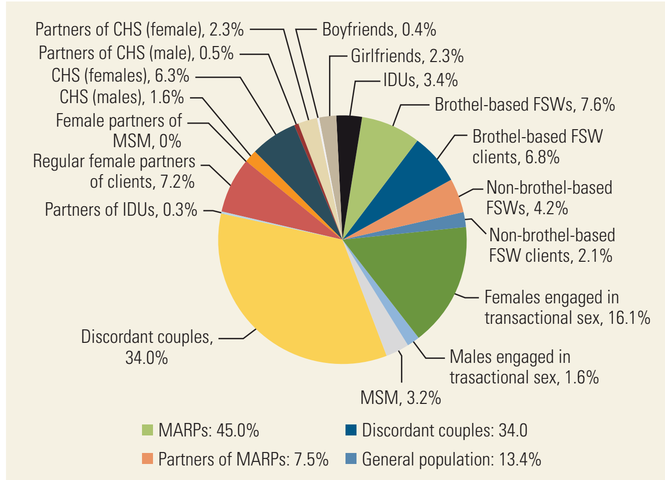
Program intelligence, gathered through biological and behavioral surveillance and through local epidemic appraisals conducted initially in eight states, provided additional information on populations at risk in Nigeria. HIV/AIDS prevalence is high in key populations, specifically IDUs (42 percent), MSM (17 percent), sex workers not in brothels (22 percent), and sex workers in brothels (27 percent) (NACA 2014). Local epidemic appraisals mapped out key population hotspots and estimated their size. Female sex workers were the largest key population: there were 10,581 female sex workers, compared with 447 IDUs and 495 MSM (NACA 2013). Sex workers by state were enumerated and, in some cases, geospatially mapped out (map 8.4). An assessment of the venues most frequented by individuals seeking new sexual partners revealed that bars, clubs, and restaurants were the primary locations in which both sexes sought out sexual partners (figure 8.10).

The information gathered through program intelligence provided the basis for the design of a strategy that targeted key populations and that ranged from national- to local-level planning. This strategy entailed the following steps (NACA 2013):

- Specify the target population, for example, female sex workers, and develop the rationale for selection.
- Define the intervention package, segmented by population group.
- Set coverage targets at the macro level; for example, cover 60 percent of estimated female sex workers.
- Set specific objectives for project reach at the micro level; for example, reach 80 percent of female sex workers using peer education.
- Set outcome objectives; for example, obtain consistent condom use of 80 percent.
- Plan and implement a scaled program, including a scaling-up strategy.

The final component of program science is evaluation. The Nigerian government has indicated that it plans to conduct an evaluation using a combination of dose-response behavioral and biological data and mathematical modeling.

Figure 8.9 Example of Heterogeneity of Sources of New HIV Infections in Cross River State, Nigeria



Source: Prudden and others 2013.
Note: CHS = individuals who have casual heterosexual sex; FSW = female sex worker; HIV = human immunodeficiency virus; IDU = injecting drug user; MARP = most-at-risk population; MSM = men who have sex with men.

Right Places: Geographic Targeting and Hotspot Mapping

Hotspot mapping can help locate key populations in a concentrated epidemic and help determine the optimal allocation of national resources, based on the size of the epidemic across regions.

Geographic targeting can reveal locations where epidemics are concentrated. For example, more than 70 percent of India's HIV/AIDS burden began in four southern states (Andhra Pradesh, Karnataka, Maharashtra, and Tamil Nadu) and four northeastern states (Bihar, Gujarat, Uttar Pradesh, and West Bengal) and spread from there (NACO 2013; World Bank 2012).

Hotspot targeting can also help locate key populations. Pakistan has a severe epidemic in its IDU population, 69 percent of whom live in four cities (Faisalabad, Hyderabad, Karachi, and Lahore) that account for 19 percent of the total population.[2] HIV is also growing among female and transgender sex workers: 72 percent of female sex workers are in five cities (Faisalabad, Hyderabad, Karachi, Lahore, and Multan), and 64 percent of transgender sex workers are in three cities (Karachi, Lahore, and Multan) (Blanchard 2012; Reza and others 2013) (map 8.5).[3]

Average national HIV prevalence masks subnational variations. An analysis of 20 Sub-Saharan African countries revealed spatial clustering of infections, in which 14 percent of the population lives in high-prevalence clusters and 16 percent lives in low-prevalence clusters,

Map 8.3 Prevalence of HIV/AIDS in Nigeria, by Region

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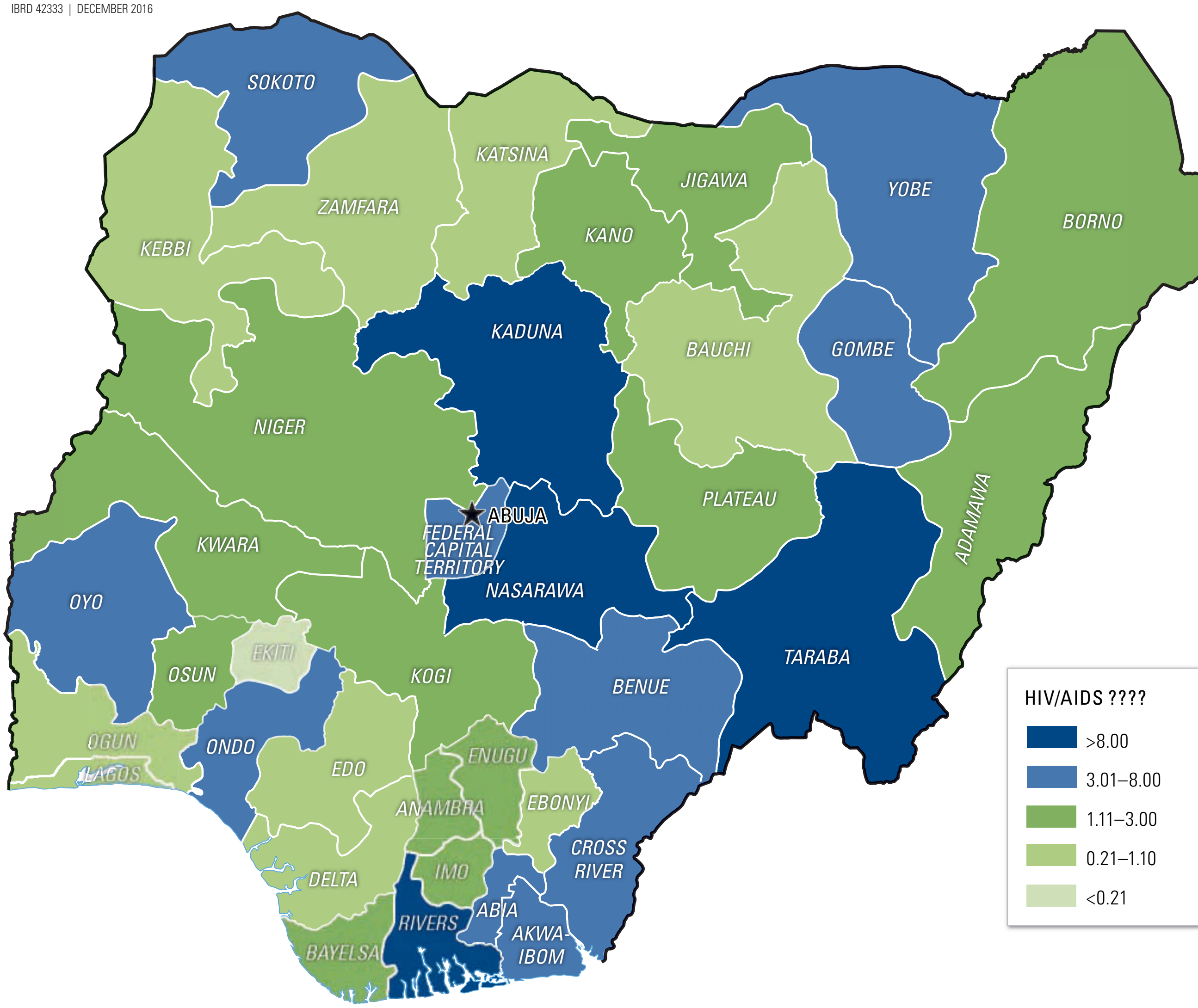


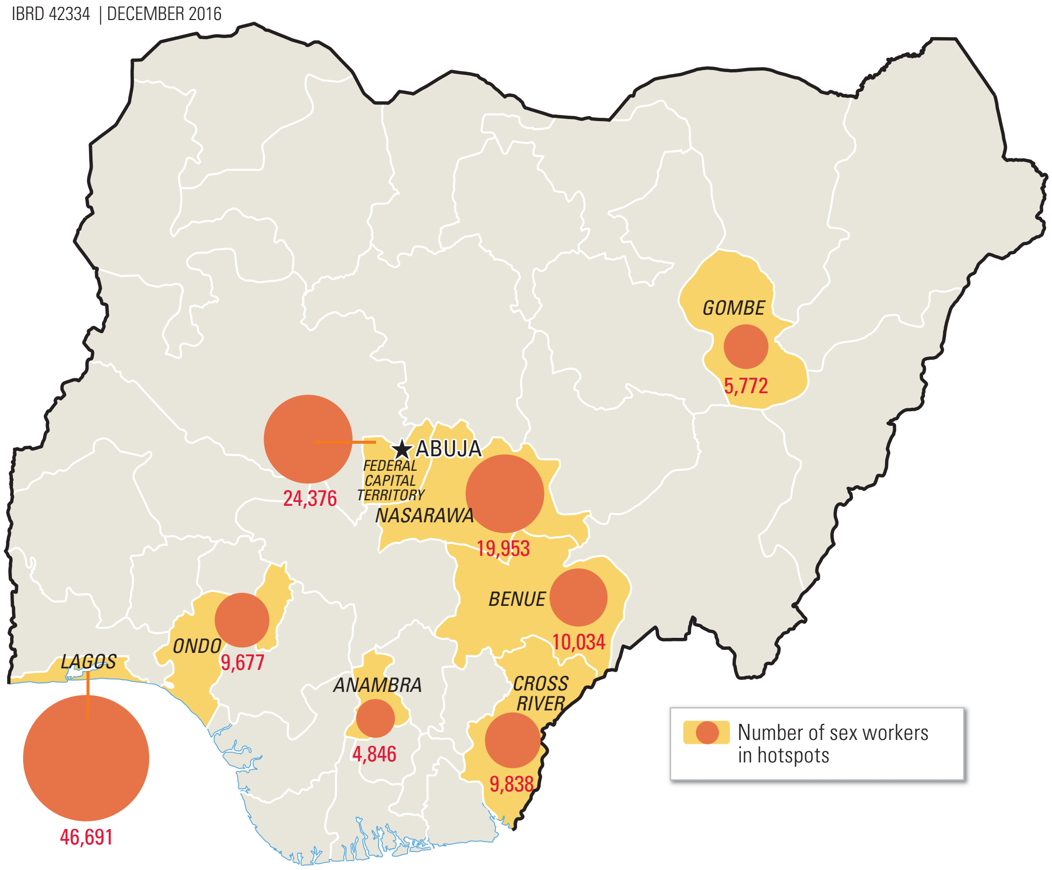
Source: NACA 2014. "Global AIDS Response Country Progress Report: Nigeria GARPR 2014." NACA, Abuja.
Note: HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome.

the difference potentially due to behavioral or biological factors (Cuadros, Awad, and Abu-Raddad 2013). Islands of high or low prevalence, due to intense clustering, can serve as prime targets for a focused response.

Hotspot mapping can also guide targeted prevention efforts. In Thailand, 70 percent of new infections occur in 33 of the country's 76 provinces (National AIDS Management Center 2013); in Kenya, nine counties with the highest burden account for 54 percent of new infections but account for only 24 percent of the Kenyan population (Government of Kenya 2013).[4] It makes sense to allocate the majority of prevention resources to these high-burden regions while scaling back resources for the eight lowest-burden counties, which account for less than 2 percent of new infections (Government of Kenya 2013).

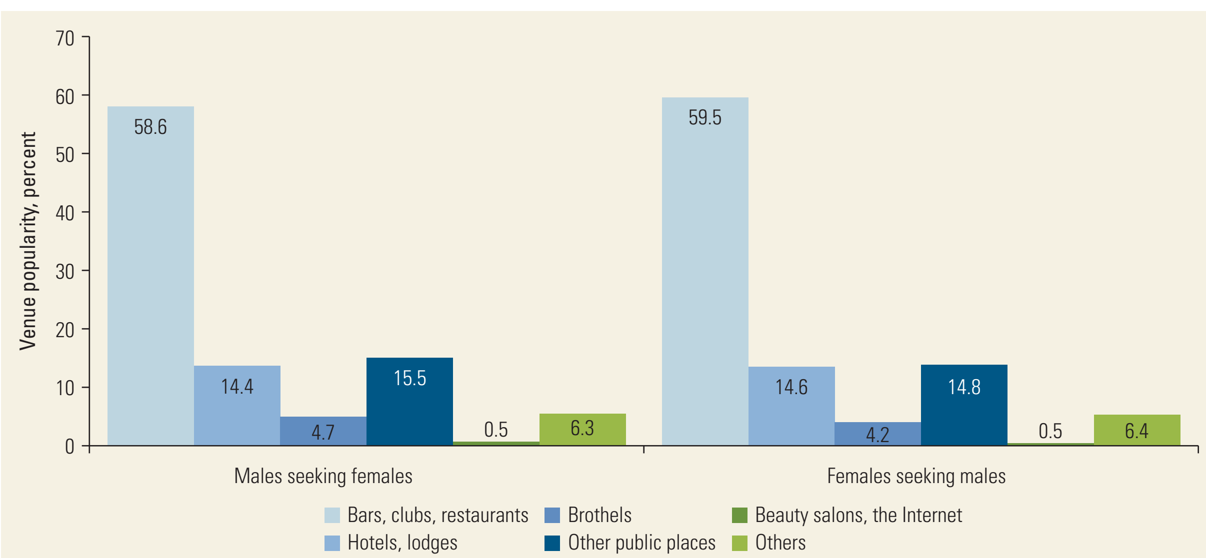
Geographic targeting and hotspot mapping are relatively new and need to be tested rigorously for feasibility and utility. Ideally, this time- and resource-intensive approach would reveal epidemic dynamics adhering to the 80:20 rule, where 80 percent of a parameter (prevalence, new infections, risk, transmission dynamics) can be attributed to 20 percent of a larger group (population, region). This outcome may be obtained

Map 8.4 Number of Sex Workers in Nigerian Hotspots



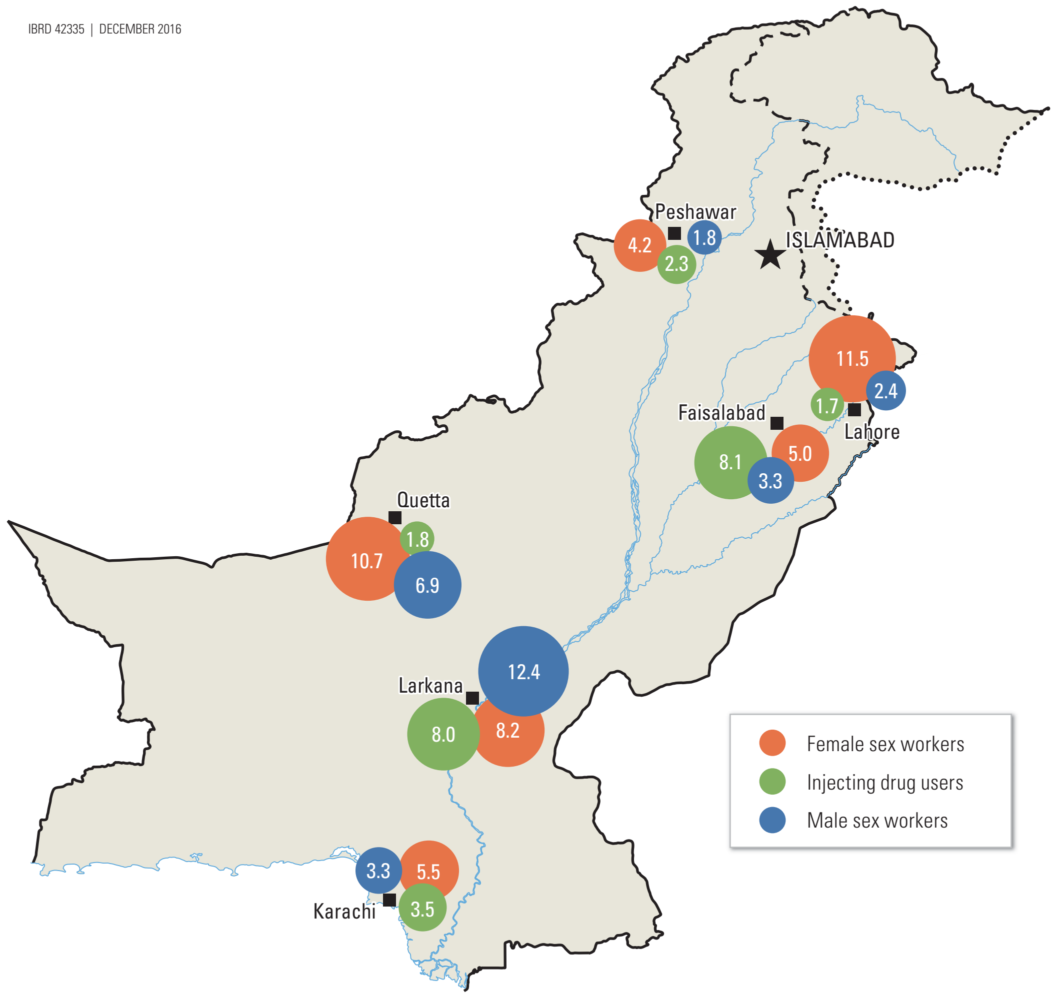
Source: NACA (National Agency for the Control of AIDS). 2013. "HIV Epidemic Appraisals in Nigeria: Evidence for Prevention Programme Planning and Implementation: Data from the First Eight States." NACA, Abuja.

Figure 8.10 Popularity of Venues Where Individuals Seek New Sexual Partners in Nigeria



Source: NACA 2013.

Map 8.5 Population Density (per 1,000 Adult Males) of Key HIV/AIDS Populations in City Hotspots in Pakistan



Source: Reza and others 2013.

more typically in concentrated epidemics, but even generalized epidemics exhibit varying degrees of geographic and population-level concentration of infections.

OPTIMIZE ALLOCATIVE EFFICIENCY FOR COST-EFFECTIVE PROGRAMMING: THE RIGHT MIX

In all epidemics, the response is more effective and more cost-effective if it is tailored to the local transmission dynamics. To achieve maximum impact per expenditure, prioritizing and optimizing the allocation of resources are crucial; that is, the right mix of interventions must be applied.

The use of Optima—an epidemic- and cost-modeling software—can facilitate the effort to apply the right mix of interventions. Developed by the Kirby Institute at the University of New South Wales with input from the World Bank, Optima is a mathematical model of transmission dynamics and disease progression integrated with an economic and financial analysis framework. Its highly flexible structure can accommodate country-specific inputs. It can divide the population into subgroups and characterize them by demographics, HIV risk, disease, and clinical and treatment status, including changes in health states and population groups. The model uses a range of inputs (demographic, epidemiological, behavioral, clinical, and financial) to generate the most appropriate ratio of interventions at different spending levels. Although not all parameters have to be entered, the more data points in the model, the more reliable the analysis.

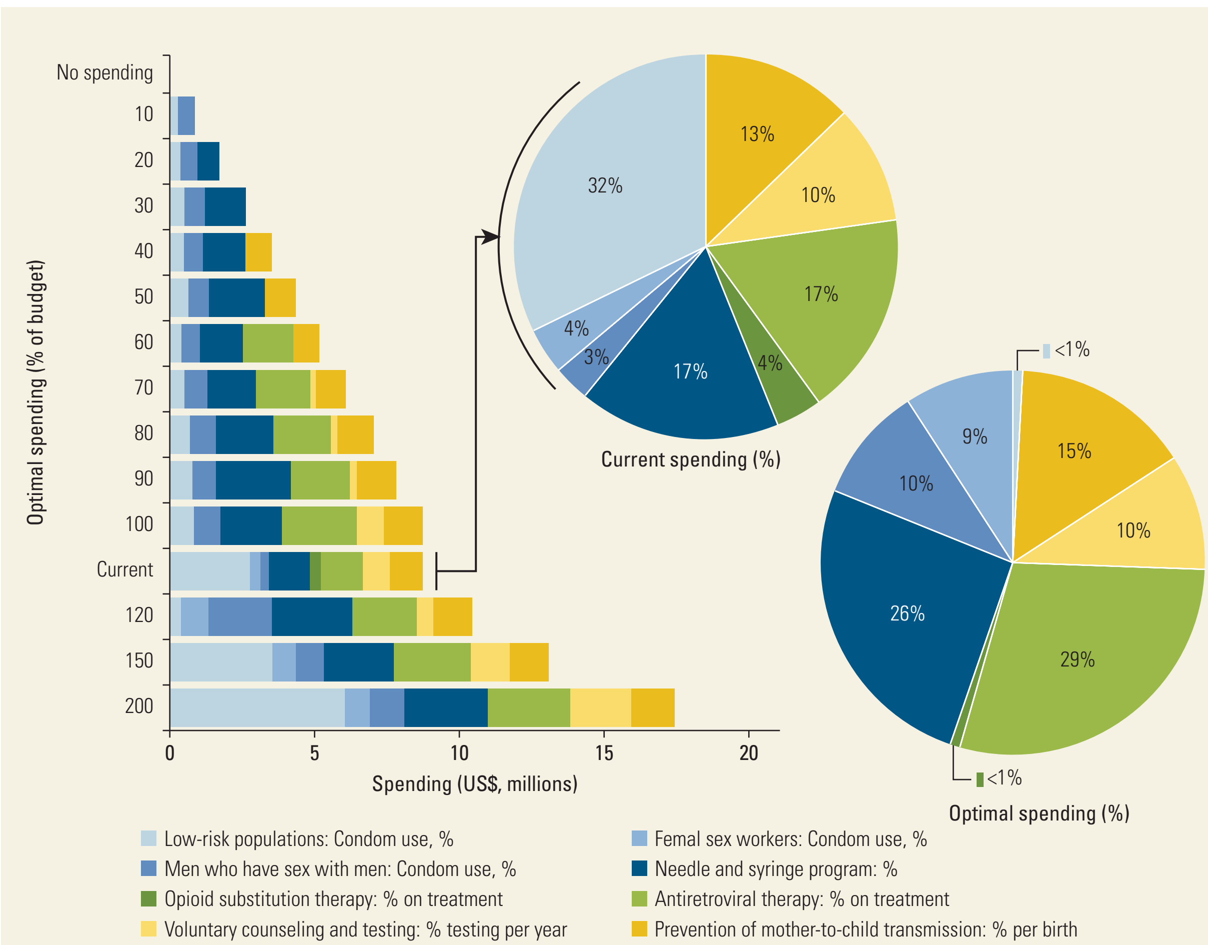
The result is a set of analyses showing outcomes based on a range of programmatic allocations and financial investments in comparison with current allocations and investments. For example, an Optima analysis for Belarus suggests that current allocations would have to be restructured if the number of new HIV infections is to be reduced by 2020. The optimal programmatic structure would shift funds from the general population to key populations, specifically increasing NSP spending until saturation is reached, and tripling and doubling spending on condom programs targeting MSM and female sex workers, respectively. To minimize new infections, the results suggest that Belarus should substantially increase ART coverage (figure 8.11).

Optima can produce optimal allocations for a range of budget scenarios. In the tightest budget scenario, Belarus should focus on prevention in key populations and gradually add counseling, testing, and treatment services as the budget increases. Only when spending exceeds the current budget will investments in prevention be warranted for low-risk populations.

Optima can also indicate ways to maximize the impact of current spending. By spending the same amount of money differently, Belarus could reduce the number of new infections by 27 percent, and a 2014 analysis projected halving the number of new infections in Swaziland by 2016. This improvement in allocative and technical efficiency in Swaziland would cost only an additional US$8 million, as compared with 10 times that amount based on current allocations (figure 8.12). Table 8.1 lists the costs associated with scaling up specific interventions in Swaziland, including the incremental cost-effectiveness ratio for infections averted.

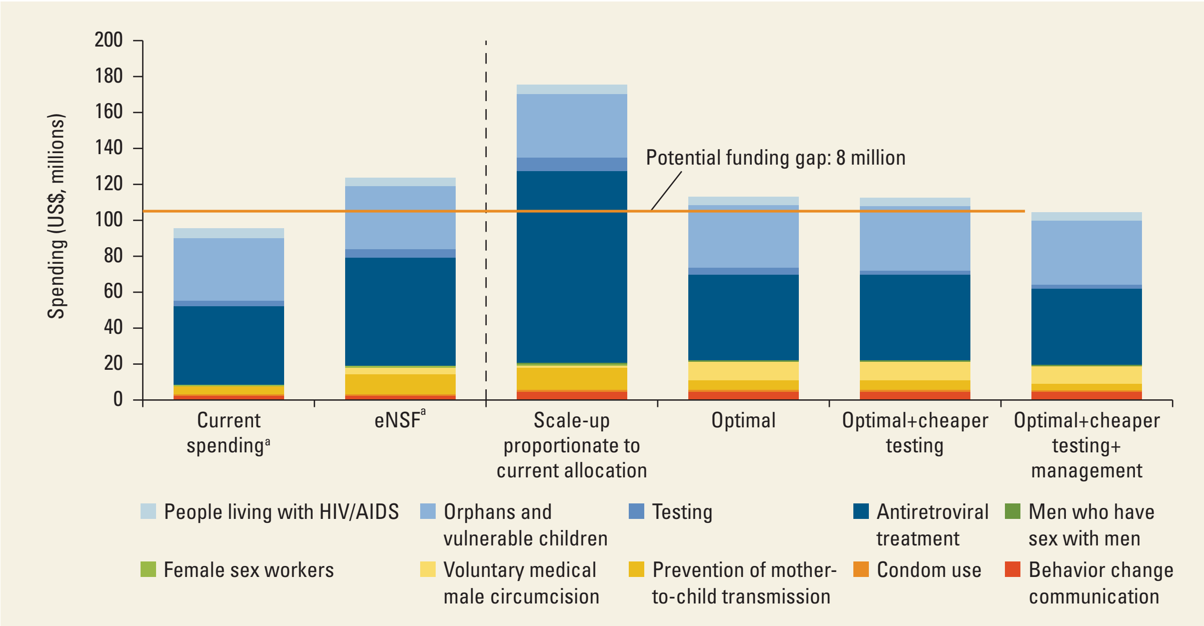
The use of Optima for Belarus is an excellent example of how shifting allocations can maximize the impacts of

Figure 8.11 Optima-Projected Results for Belarus: Current and Optimal Allocation of Resources for HIV/AIDS Programs



Source: Wilson and others 2013.
Note: HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome.

Figure 8.12 Allocative and Technical Efficiency Gains and Costs Associated with Halving the Number of New HIV Infections in Swaziland by 2016



Source: Unpublished data from Wilson and Kerr.
Note: eNSF= Extended National Strategic Framework; HIV = human immunodeficiency virus.
a. The Optima model projects that incidence will decline by 13 percent by 2018 under current spending, and by 35 percent under the eNSF.

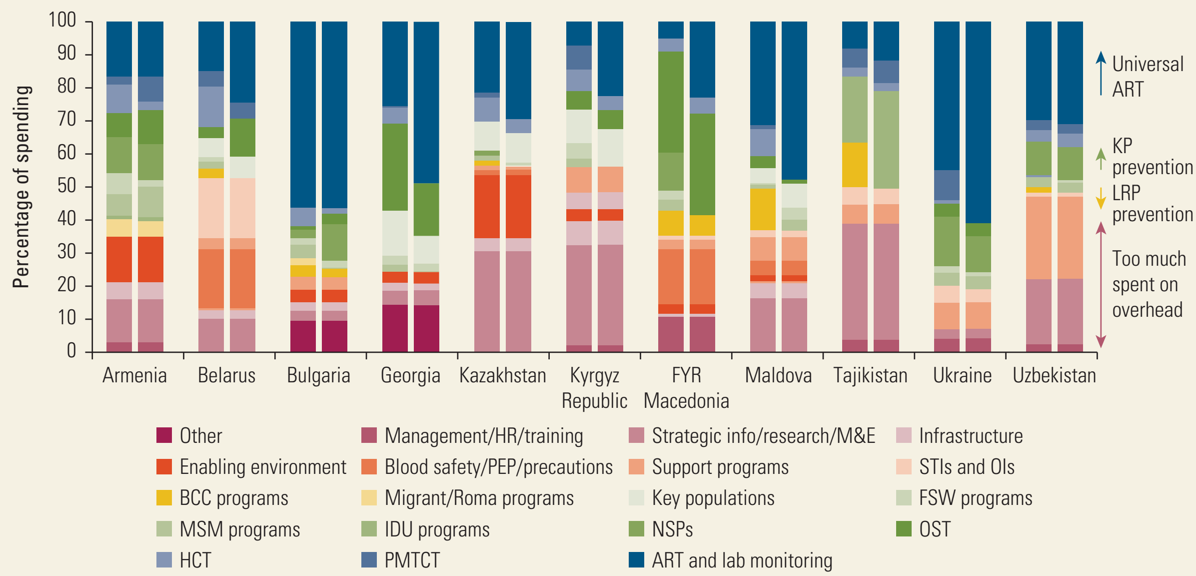
Table 8.1 Optima-Projected Program Costs of Moderate Scale-up of Interventions, Number of New Infections and Deaths Averted, and Resulting Incremental Cost-Effectiveness Ratios in Swaziland by 2030

US$ unless otherwise noted

			Infections averted		AIDS-related deaths averted	
Moderate scale-up of interventions	**Unit costs (US$ per person per year)**	**Discounted cost of program[a]***	**Number**	**Incremental cost-effectiveness ratio**	**Number**	**Incremental cost-effectiveness ratio**
All interventions	—	74,205,074	27,355	2,713	7,413	10,010
Antiretroviral therapy	131.70	13,654,653	7,452	1,832	4,254	3,210
Voluntary medical male circumcision	130.70 (per male age 10–49)	2,475,488	13,291	186	1,334	1,856
CCTs	76.56[a] (per female age 15–24)	45,031,793	9,895	4,551	1,033	43,608
Prevention of mother-to-child transmission of HIV	186.00 (per pregnant woman)	767,735	1,164	659	221	3,480
TB and HIV/AIDS co-treatment	247.00[b]	37,669,429	—	—	1,220	30,883

Source: Kelly and others 2014.
Note: * = Discounted cost is today's dollar equivalent of future costs. CCT = conditional cash transfer; TB = tuberculosis; — = not applicable.
a. It was assumed that only 29 percent of the costs for the CCT program would be allocated to the HIV program, as there are multiple benefits to this intervention (see Remme and others 2014, table 3); therefore, the HIV program would not be expected to fund the full cost of the CCT program, which is US$264 per girl or young woman age 15–24 per year.
b. It was assumed that the cost of the TB/HIV program would increase proportionately to the increased TB/HIV coverage over time to meet targets. As well, since it was reported that "the prevalence of HIV among TB patients is 79.6 percent, therefore 79.6 percent of total expenditure on TB was captured as TB/HIV treatment expenditure" (UNAIDS, n.d.), it follows that only 80 percent of the TB/HIV spending was allocated to the HIV program.

Figure 8.13 Optima Analysis Findings in Eastern Europe and Central Asia



Source: David Wilson, personal communication.

Note: ART = antiretroviral therapy; BCC = behavioral change communication; FSW = female sex worker; HCT = HIV counseling and testing; HR = human resources; KP = key population; LRP = low-risk population; M&E = monitoring and evaluation; MSM = men who have sex with men; NSP = needle and syringe program; OI = opportunistic infection; OST = opioid substitution therapy; PEP = postexposure prophylaxis; PMTCT = prevention of mother to child transmission; PWID = people who inject drugs; STI = sexually transmitted infection.

current and future spending in a concentrated epidemic. The opportunity to increase allocative efficiency is modest in generalized epidemics, such as in Swaziland, because transmission is not highly concentrated and resources are not grossly misallocated. It is difficult to determine what programs or interventions could be assigned a lower priority or given up. Nevertheless, Optima is an important first step in painstaking hands-on work that focuses on intracategory analyses and the interplay between allocative and implementation efficiency, keeping in mind the heterogeneity and uniqueness of each epidemic at national and subnational levels. However, some general conclusions can be made from looking at a range of Optima analyses performed in Eastern Europe and Central Asia. Across the board, optimal allocations include larger investments in ART for all populations and in HIV programs for key populations. Fewer resources could be spent on programs for low-risk populations, and the analyses reveal that far too much is spent on overhead and program administration (figure 8.13).

CONCLUSIONS

Financing of HIV/AIDS programs is subject to numerous competing priorities. To make better use of existing resources, a greater understanding of the heterogeneity, transmission dynamics, and geographic variation of epidemics is needed, together with the use of proven interventions. Greater targeting of the right interventions for the right people in the right places at the right times will improve the efficiency and effectiveness of the global response. The HIV/AIDS epidemic will not end without an effective vaccine or cure. In the meantime, greater understanding of transmission dynamics and more efficient implementation and delivery of prevention, detection, and treatment programs can prevent a substantial proportion of new infections.

NOTES

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  (a) lower-middle-income = US$1,046 to US$4,125
  (b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

1. For more a more detailed discussion on the use of models to inform decision making regarding resource allocation for HIV program planning, please refer to chapter 9 of this volume (Kahn and others 2017).

2. Calculations based on 2010 and 2011 data from City Mayors.com (http://citymayors.com/statistics/largest-cities-mayors-mr2.html) and Knoema.com (http://knoema.com/atlas/Pakistan/Population).
3. Calculations based on 2010 and 2011 data from City Mayors.com (http://citymayors.com/statistics/largest-cities-mayors-mr2.html) and Knoema.com (http://knoema.com/atlas/Pakistan/Population).
4. Calculations based on 2010 data from Kenya National Bureau of Statistics (http://www.knbs.or.ke/index.php?option=com_content&view=article&id=176&Itemid=645).

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