New HIV Infections by mode of transmission in West Africa: A Multi-Country Analysis

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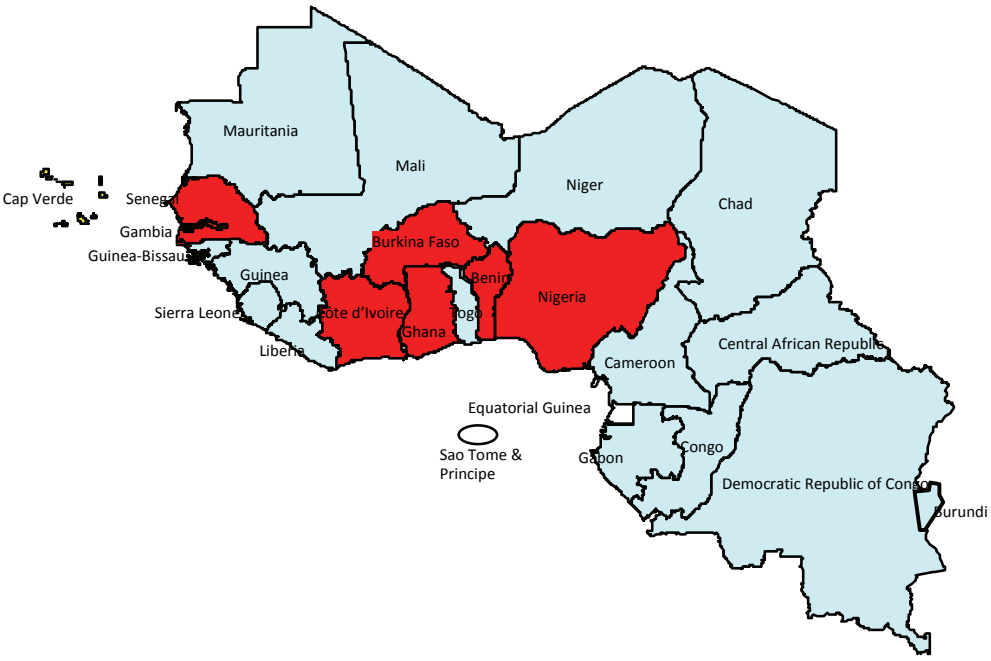

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Summary

Information on the distribution of new HIV infections by mode of transmission is important in planning prevention programs to effectively reduce the number of new infections. The Incidence by Mode of Transmission Model was developed to help countries estimate the proportion of new infections occurring among adults through key modes of transmission, such as sex work, multiple partnerships, stable partnerships, men who have sex with men (MSM), injecting drug use (IDU), unsafe medical injections and contaminated blood transfusions.

Six countries in West Africa (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria and Senegal) applied this model using data from serosurveys, behavioral surveys, STI surveillance and expert opinion. The activity was implemented by a technical team and the results were validated in national workshops. This report summarizes the finding from the six countries.

The contribution of each risk group to the number of new infections varies by country. Overall about one-fifth of new infections occur among people with multiple sexual partners and another one-third occurs in stable couples who do not currently report outside partners. About 10% of new infections are the result of sex work. There would be about one and a half times more new infections due to sex work if it were not for the high levels of condom use reported in sex worker contacts. New infections due to injecting drug use and sex between men seem to account for about 10-15% of all new infections but, except for Nigeria and Senegal, few data are available to inform these estimates. New infections due to unsafe medical injections or contaminated blood transfusions account for 1% or less of all new infections. About 30% of all new infections occur in people who have low risk behavior themselves but have partners with high risk behavior.

These results suggest that prevention programs need to focus on maintaining high levels of condom use in sex work, reducing the risk of multiple partnerships and expanding testing programs to identify discordant stable couples. While there is a need for better data on IDU and MSM behaviors in order to improve the understanding of the contribution of these groups, it is clear that specific programmes are needed for MSM and, in countries with significant numbers of IDU, for IDU.

Introduction

The number of people infected with HIV in the world has climbed to 33.4 [31.1-35.8] million by 2008. The number of new infections occurring each year has been decreasing slowly since the end of the 1990s but, in spite of increases in funding and coverage for some interventions, it appears that prevention efforts have not yet had a significant impact on reducing new infections globally. UNAIDS estimates that there 2.7 [2.4-3.0] million new infections occurred worldwide in 2008 including 1.9 [1.6-2.2] million in sub-Saharan Africa.[1]

In order for prevention efforts to be successful they need to be focused on the major sources of new infections. In some countries the largest number of new infections may be due to sex work or needle sharing among injecting drug users while in other countries most new infections may occur primarily among stable couples. Since each epidemic is unique, estimates of the sources of new infections must be made in each country and used to guide prevention efforts.

In 2003 Pisani and colleagues described an approach that uses available data to estimate the number of new infections occurring in key population subgroups[2]. They recommended calculating the number of new infections occurring annually in sub-populations from data on population size, HIV prevalence, number of partners, number of acts and use of condoms or clean needles. The article demonstrated the approach using data from Cambodia, Honduras, Indonesia, Kenya and Russia. This approach has been updated and implemented in a model, called the "Incidence by Modes of Transmission" model, which is available on the UNAIDS website[3].

In 2007 UNAIDS in collaboration with the World Bank organized an effort called Know Your Epidemic/Know Your Response in six countries in East and Southern Africa (Kenya[4], Lesotho[5], Mozambique, Swaziland[6], Uganda[7] and Zambia) to apply the Incidence by Modes of Transmission Model, as part of a wider synthesis, and compare the results to current prevention efforts. Those studies served to highlight for each country areas where current prevention efforts were missing some key population groups that were the source of many new infections.

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[1] UNAIDS, WHO. 2009 AIDS epidemic update. Joint United Nations Programme on HIV/AIDS. 2009.
[2] Pisani E, Garnett GP, Brown T, Stover J, Grassly NC, Hankins C, Walker N, Ghys PD. Back to basics in HIV prevention: focus on exposure *BMJ* 326:1384-1387, 21 June 2003.
[3] Gouws E, White PJ, Stover J, Brown T. Short term estimates of adult HIV incidence by mode of transmission: Kenya and Thailand as examples *Sex. Trans. Infect.* 2006;82;51-55 doi:10.1136/sti.2006.020164.
[4] Gelmon L, Kenya P, Oguya F, Cheluget B, Haile G. Kenya: HIV Prevention Response and Modes of Transmission Analysis. Kenya National AIDS Control Council, UNAIDS, World Bank Global HIV/AIDS Program/Global AIDS M&E Team, March 2009.
[5] Khobotlo M, Teshelo R, Nkonyana J, Ramoseme M, Khobotle M, Chitoshia A, Hildebrand M, Fraser N. Lesotho: Analysis of Prevention Response and Modes of Transmission Study, Kingdom of Lesotho, UNAIDS, World Bank Global HIV/AIDS Program/Global AIDS M&E Team, January 2009.
[6] Swaziland Study Team (S. Mngadi, N. Fraser, H Mkhatshwa, T Lapidos, T Khumalo, S Tsela, N Nhlabatsi, H Odido). Swaziland HIV prevention response and modes of transmission analysis. Final Report. March 2009
[7] Wabwire-Mangen F, Odiit M, Kirungi W, Kawaeesa Kisitu D, Okara Wanyama J. Uganda: HIV Modes of Transmission and Prevention Response Analysis, Uganda AIDS Commission, UNAIDS. March 2009.

Starting in 2008 UNAIDS organized a similar effort in six countries in West Africa: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria and Senegal. The effort in West Africa was smaller in scale focusing mainly on the modeling of new infections. This work built on a regional epidemic review prepared by the World Bank[8]. Teams working in each country have produced the country reports listed below.

- Guedeme A, Ekanmian GK, Toussou JY, Kiki Medegan V, Baruani YK. Rapport de l'Etude sur les Modes de Transmission du VIH au Benin, CNLS, UNAIDS, March 2009.
- Kintin Dénagnon F, André K, Gatali JB. Modes de transmission du VIH en Afrique de l'Ouest: Analyse de la distribution des nouvelles infections par VIH au Burkina Faso et recommandations pour la prévention. CNLS, UNAIDS, March 2009.
- Seck K, Eba K, Eby P. Modes de transmission du VIH en Afrique d'Ouest: Analyse de la distribution des nouvelles infections par le VIH en Côte d'Ivoire: Recommandations pour la prévention Ministère de la Lutte contre le SIDA, UNAIDS, May 2009.
- Bosu WK, Yeboah K, Gurumurthy R, Atuahene K. Modes of Transmission in West Africa: Analysis of the distribution of new HIV infections in Ghana and recommendations for prevention. Ghana AIDS Commission, UNAIDS. July 2009.
- Seck K. Modes de transmission du VIH en Afrique de l'Ouest: Analyse de la distribution des nouvelles infections par le VIH en Sénégal : Recommandations pour la prévention. UNAIDS, November 2008.
- Nnorom J, Oluwole F, Victor-Achuchoga J, Ogungbemi K, Sagbohan J. Modes of HIV Transmission in Nigeria: Analysis of the distribution of new HIV infections in Nigeria and recommendations for prevention. UNAIDS, December 2009.

Purpose

The purpose of this report is to summarize the inputs and results from the six country studies in West Africa and present conclusions and recommendations for programs in the region.

Approach

In each of the six countries national teams were selected to implement the study. These teams generally consisted of members from the national AIDS control program, one or two national consultants selected by the team and the local UNAIDS M&E officer. The teams were assisted by three international consultants (Kathy Lowndes of the Health Protection Agency and Centre hospitalier *affilier* universitaire de Quebec, Annick Borquez of Imperial College London and John Stover of Futures Institute) and experts from UNAIDS including Peter Ghys and Eleanor Gouws from the Epidemiology and Analysis Division.

At the start of the project the World Bank Global HIV/AIDS Program/Global M&E Team commissioned a synthesis of data about the epidemic and behavior in the region[8] that helped the country teams in their review of data. Representatives from the six countries met with UNAIDS, the World Bank and WHO in Dakar on 7-8 April 2008 to initiate the project. The country teams met in Cotonou, Benin on June 3-5 2008 to receive training in the process and the implementation of the model. The national consultants then worked with the country teams and international consultants to complete data collection, implement the model and prepare a draft report. In each country the draft report was reviewed at a national validation workshop. A final report was then prepared that incorporated the results of that review.

Partial preliminary results of this activity were presented at the International Conference on AIDS and STIs in Africa in Dakar, Senegal in December 2008.

Methods

The Incidence by Modes of Transmission Model calculates the annual number of new adult HIV infections expected by population group. New child infections are not included. The standard population groups in the model are:

- Injecting drug users (IDU)
- Regular sexual partners of IDU
- Men who have sex with men (MSM)
- Regular female sexual partners of MSM
- Female sex workers (SW)
- Male clients of female SW
- Regular male partners of female SW
- Men and women with multiple partners (more than one non-marital, non-cohabiting partner in the last year)
- Regular partners of those with multiple partners
- Stable couples (men and women with a single sexual partner in the past year)
- Adults receiving at least one medical injection in the past year
- Adults receiving at least one blood transfusion in the past year

Country teams can modify this list by adding additional special populations if they are important to the epidemic.

[8] Lowndes CM, Alary M, Belleau M, et al. West Africa HIV/AIDS Epidemiology and Response Synthesis. Characterisation of the HIV epidemic and response in West Africa: Implications for prevention. Washington: World Bank, Global AIDS Monitoring and Evaluation Team (GAMET): ACT Africa, November 2008. Available at www.worldbank.org/aids >publications.

The model calculates the number of new infections expected in a particular population group as a function of the number of people in the group and the annual risk of infection. The annual risk of infection is determined from the HIV prevalence in the partner population, the number of different partners in a year, the number of contacts per partner per year, the prevalence of other sexually transmitted infections (STIs) in either partner (for sexual transmission only), and the proportion of contacts that are protected. Sexual contacts can be protected by condom use, IDU transmission can be avoided by the use of clean needles, blood transfusion can be protected by screening of donated blood and unsafe medical infections can be protected by using sterile needles.

The formula for new infections resulting from sexual transmission is shown below:

$$I = U\left(1 - \{pS[1-\beta']^{\alpha(1-v)} + p(1-S)[1-\beta]^{\alpha(1-v)} + (1-p)\}^{n}\right)$$

Where:

I = incidence, the annual number of new infections in the population group

U = the number of uninfected individuals in the population group

p = HIV prevalence in the partner population

S = prevalence of other STIs in the target or partner population

β = the probability of transmission in a single contact in the absence of other STIs

β' = the probability of transmission in a single contract in the presence of other STIs

α = number of contacts per partner

v = the proportion of acts that are protected

n = number of partners

The probability of transmission in a single contact in the absence of other STIs (β) is normally set to 0.0011 for male to female transmission based on a study in Rakai, Uganda[9]. The probability of female to male transmission is somewhat lower at 0.0007 and is modified by male circumcision. Specifically the probability of transmission is reduced by 60% (based on the randomized control trials in South Africa[10], Uganda[11] and Kenya[12]) multiplied by the proportion

[9] Gray RG, Wawer MJ, Brookmeyer R, *et al.* Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1 discordant couples in Rakai, Uganda. *Lancet* 2001; 357: 1149-53.
[10] Auvert B, Taljaard D, Lagarde E, Sobngwi-Tambekou J, Sitta R, et al. (2005) Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: the ANRS 1265 Trial. PLoS Med 2: e298.

of men that are circumcised. The STI co-factor is set to increase transmission by a factor of 4 in the presence of STIs[13]. We assume a probability of transmission of 0.01 for male to male transmission in the absence of other STIs; for transmission through contaminated needles by injecting drug users the transmission per contact is assumed to be 0.01[14].

The uncertainty around the estimates of the proportion of new infections occurring in each risk group can be calculated by specifying ranges for each of the inputs. The model performs 1000 Monte Carlo calculations selecting a value for each input from within the specified range using evenly distributed random numbers.

There is little information available on the true uncertainty ranges. There is evidence that reports of behavior collected through national surveys under-estimate the extent of risky behaviors, particularly the proportion of men that visit sex workers and the proportion of men and women that have sex with multiple partners.

For this report we have used ranges of plus or minus 10-20% for the proportion of the population in each risk group, 10-20% for HIV prevalence by risk group, 10% for the number of partner and number of acts per partner, and 5-20% for the percentage of acts protected. National estimates of prevalence do include plausibility ranges for the total annual number of new infections. These country-specific ranges are used to exclude any combination of inputs that results in a number of new infections falling outside the range.

There are several limitations to this model. It does not include the effects of ART on transmission. It does not consider heterogeneity of behaviors within risk groups and it does not account for the additional risk that may occur when people are in two or more risk groups. The model does not explicitly include the changing probability of transmission during the course of HIV infection and, therefore, may not adequately capture the effects of multiple concurrent partnerships. Finally the model considers transmission only for a single year so cannot capture the dynamics of transmission that occur over time.

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[11] Gray RH, Kigozi G, Serwadda D, Makumbi F, Watya S, et al. (2007) Male circumcision for HIV prevention in men in Rakai, Uganda: a randomised trial. Lancet 369: 657-666.

[12] Bailey RC, Moses S, Parker CB, Agot K, Maclean I, et al. (2007) Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomised controlled trial. Lancet 369: 643-656.

[13] Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sex Trans Infec*1999; 75: 3-17.

[14] Gouws E, White PJ, Stover J, Brown T. Short term estimates of adult HIV incidence by mode of transmission: Kenya and Thailand as examples *Sex. Trans. Infect.* 2006;82;51-55 doi:10.1136/sti.2006.020164.

Data

Implementing the Incidence by Modes of Transmission Model requires country specific data on the distribution of the adult population by risk group and, for each risk group, HIV and STI prevalence, the number of partners, number of acts per partner and the proportion of acts protected.

Information on the distribution of the population by risk group was derived from a variety of sources in the six countries. All countries have had national Demographic and Health Surveys (DHS) or similar national household surveys that provide information on reported sexual behaviors of adults. These surveys are generally used to determine the proportion of adult male and female population in the following categories:

- No risk, those reporting no sexual activity or injection of drugs in the past year
- Stable couples, those reporting a single sexual partner in the last year
- Multiple partners, those reporting more than one sexual partner in the past year

Most national surveys also include questions for men on whether they have paid for sex in the past year. The proportion of men responding 'Yes' to this question is generally much lower than the results when special surveys using anonymous polling techniques or other methods of estimating the size of this population are used[7]. Thus it appears that men under-report visits to sex workers when responding to standard national surveys. As a result country teams used data from special surveys or regional averages rather than national survey data to estimate the size of this group.

Data on the proportion of the population engaging in injecting drug use or sex between men are not available in most countries except Nigeria. Nigeria has conducted two behavioral surveys that did collect information on these behaviors[15],[16]. Most other countries based their estimates on the Nigeria data or regional averages from two reviews of global data on IDU[17,18] and MSM[19] behavior. A global review of estimates of clients of sex workers was useful when country-specific information was not available[20].

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[15] Federal Ministry of Health. National HIV/AIDS & Reproductive Health Survey (NARHS). Abuja, Nigeria; 2005.
[16] Federal Ministry of Health. HIV/STI Integrated Biological and Behavioural Surveillance Survey (IBBSS) 2007; 2007.
[17] Aceijas A, Friedman SR, Cooper HLF, Wiessing L, Stimson GV, Hickman M. Estimates of injecting drug users at the national and local level in developing and transitional countries, and gender and age distribution *Sex Transm Inf* 2006;82; 10-17.
[18] Mathers BM, Dagenhardt L, Phillips B, Wiessing L, Hickman M, Srathdee SA, *et al.* Global epidemiology of injecting drug use and HIV among people who inject drugs: a systematic review *The Lancet* 372:9651, 1733-1745, 15 November 2008, DOI:10.1016/S0140-6736(08)61311-2.
[19] Caceres C, Konda K, Pecheny M, Chatterjee A, Lyerla R. Estimating the number of men who have sex with men in low and middle income countries. *Sex Transm Inf* 2006;82; 3-9.
[20] Caraël M, Slaymaker E, Lyerla R, Sarkar S. Clients of sex workers in different regions of the world: hard to count. Sex Transm Infect. 2006;82 (Suppl III):iii26- 33.

Benin, Nigeria and Ghana have conducted detailed sex worker surveys that provided information to estimate the number of sex workers[7]. The other countries relied on expert opinion and regional averages from a review of global data[21].

The number of partners of IDU, MSM, and clients of sex workers was generally estimated from the general marriage rate or from specific surveys of these high / at-risk populations. Nigeria had survey information to determine the number of partners of IDU.

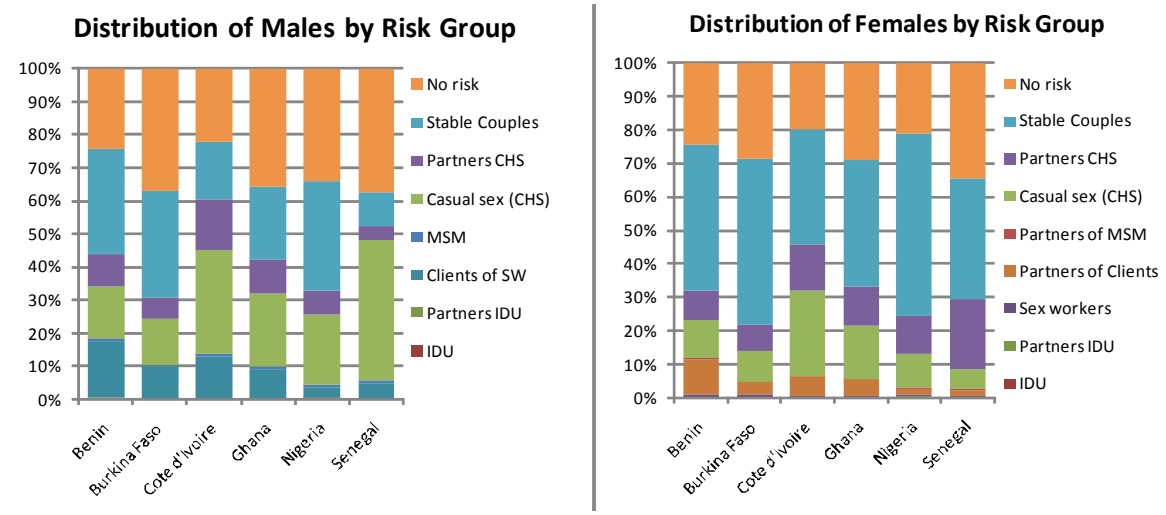
In cases of multiple risk factors people were classified in the category of highest risk. Thus, the proportion of men in the multiple partner category was usually set equal to the proportion who reported more than one sexual partner in the last year in the national survey minus the proportion who were classified as clients of sex workers. The proportion of the population in stable couples was usually estimated as the residual of those reporting a single partner in the last year in the national survey minus those classified as partners of IDU, MSM and clients of sex workers.

The final distribution of the population by risk groups is shown in Figure 1. The IDU population is quite small ranging from 0.1% to 0.5% of the male population and 0% to 0.4% of the female population. The MSM population is also assumed to be small ranging from 0.1% to 0.8% although these estimates are generally not based on local data. For men the largest populations at risk are clients of sex workers (ranging from 2.9% to 17% of the population) and those with multiple sexual partners (ranging from 14% to 43%). Between 0.6% and 1.0% of the female population is classified as sex workers. The majority of the female population is classified as stable couples (27-54%) or no risk (20-35%). About 8-12% of women were estimated to be partners of men with outside partners and another 4-11% were estimated to be partners of men who visit sex workers.

People in any of these risk groups may also be exposed to the risk of infection through unsafe medical injections or blood transfusions. The number of people receiving blood transfusion each year was usually determined from reports from the national blood transfusion service. The average number of medical injections per person per year was based on national surveys (Benin and Côte d'Ivoire) or a regional review by WHO[22].

[21] Vandepitte J, Lyerla R, Dallabetta G, Crabbe F, Alary M, Buve A. Estimates of the number of female sex workers in different regions of the world. *Sex Transm Infec* 2006;82;18-25.
[22] Hauri AM, Armstrong GL, Hutin YJF. The global burden of disease attributable to contaminated injections given in health care settings *International Journal of STD & AIDS* 2004; 15; 7-16.

Figure 1. Distribution of adult males and females by risk group and country

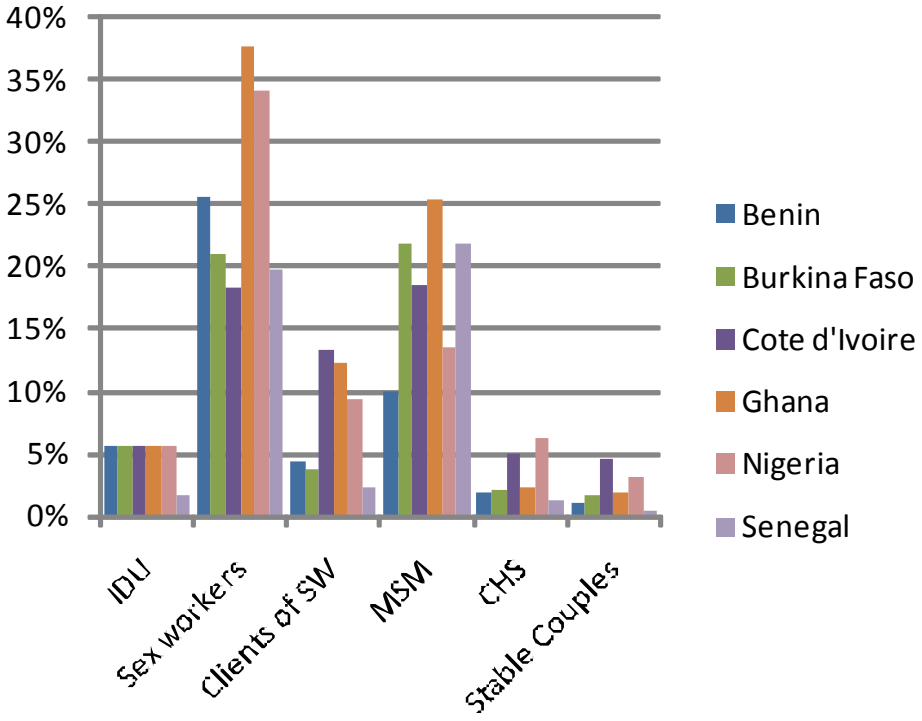


Estimates of HIV prevalence by risk group were available from national surveys for the larger population groups, including No Risk, Stable couples and Multiple Partners. For the highest risk groups (IDU, MSM, sex workers and clients of sex workers) country teams relied on cross-sectional bio-behavioural surveys carried out in Nigeria, in the context of project SIDA 1/2/3 in Benin, Burkina, Ghana, Senegal; and in the context of Project RETRO-CI in Côte d'Ivoire[7].

These estimates are shown in Figure 2. The highest levels of prevalence occur in sex workers and men who have sex with men. Male clients of sex workers have the third highest prevalence. Prevalence among IDU is the same in all countries other than Senegal because the other countries all used data from Nigeria to represent IDU prevalence in their countries.

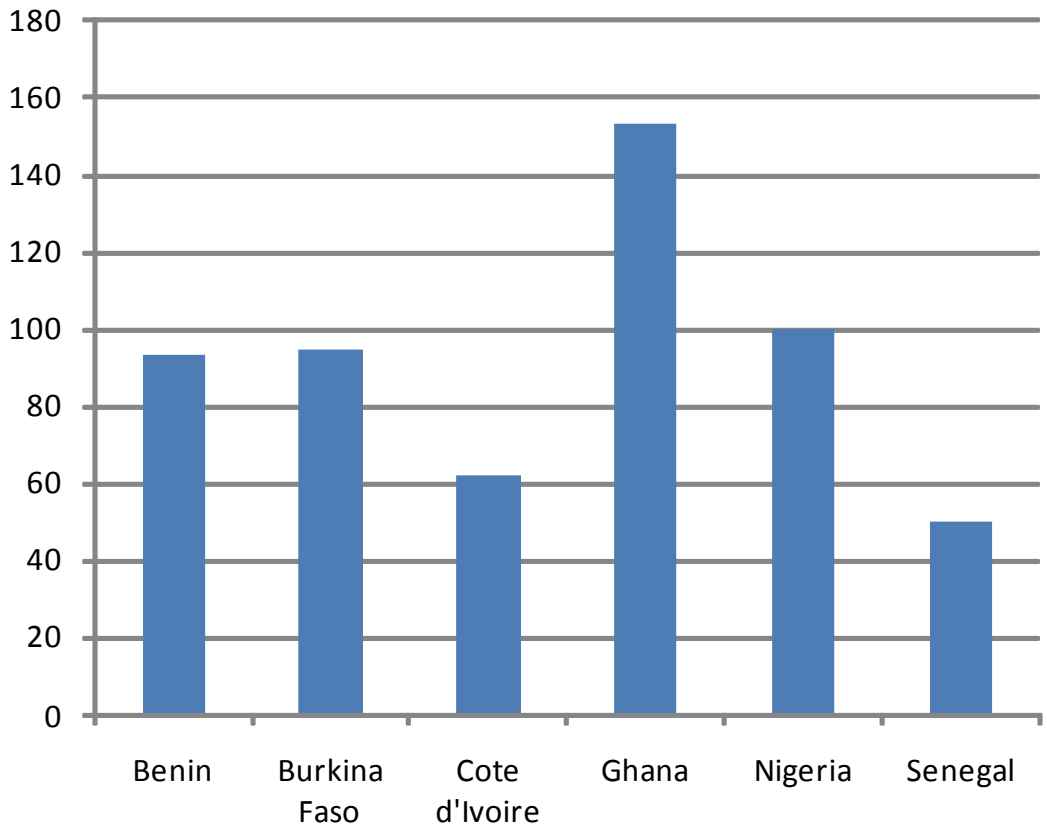
Once the prevalence estimates for all risk groups are entered, the model can be used to calculate the prevalence of the entire adult population. This figure should fall within the range of the national estimate of adult prevalence. If it does not, the inputs are reviewed and revisions are usually made to the less certain inputs until agreement is reached.

Figure 2. Estimated HIV prevalence by risk group and country



Information on the number of partners for each risk group generally comes from behavioral surveillance surveys when it is available for sex workers, MSM and IDU. Figure 3 shows the estimated number of partners per year for sex workers by country. Most countries had some information on the number of sex workers partners. Only Nigeria had behavioral surveys for IDU and only Nigeria, Senegal and Ghana have data on MSM. Data from national surveys is used to estimate the average number of partners per year among men and women with multiple partners. By definition stable couples have one regular partner.

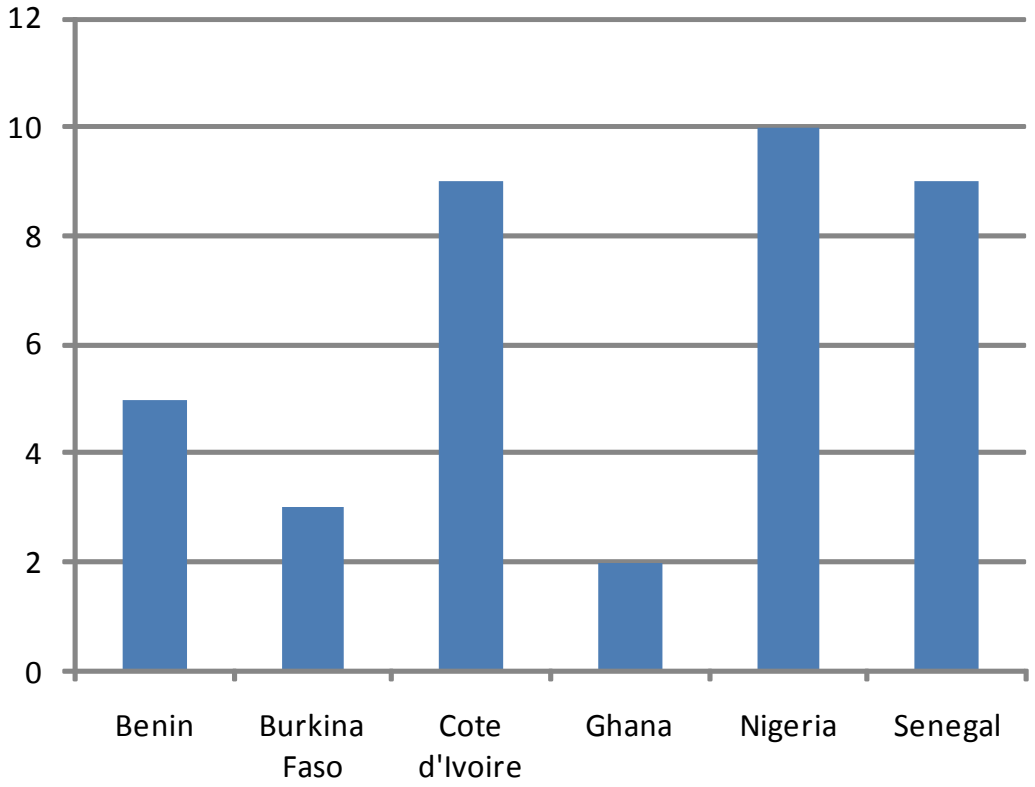
Figure 3. Average number of partners of sex workers by country per year



The number of acts per partner is not known precisely for most risk groups. Behavioral surveillance surveys often report on the number of acts for sex workers. Estimates vary from 2 to 10 acts per partner as shown in Figure 4. For stable couples and partners of high risk populations most country teams used the annual coital frequency among married couples which was estimated to range from 70 to 108[23]. For those with multiple partners the number of acts per partner is less than this and is usually estimated as the coital frequency among married couples divided by the average number of casual partners.

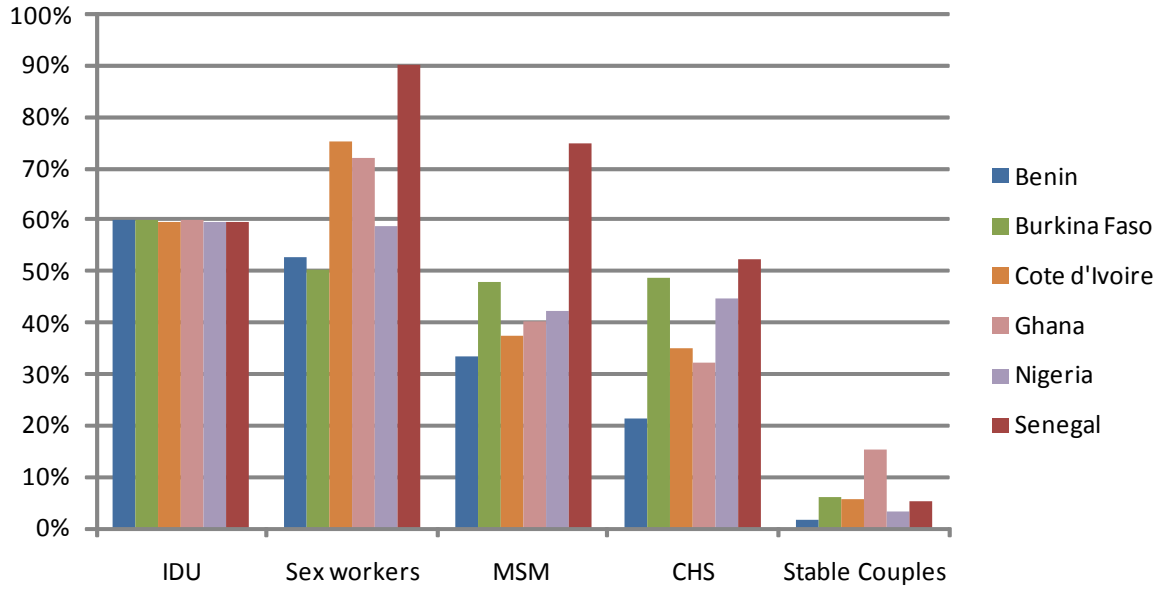
[23] Stover J, Bertrand J, Shelton J. Empirically-Based Conversion Factors for Calculating Couple-Years of Protection *EVALUATION Review* 24:1;3-36, February 2000.

Figure 4. Number of sex acts per partner per year for sex workers by country



Information on the percentage of sex acts that were protected with condom use comes from national surveys or behavioral surveillance surveys. Among married couples condom use is low (2-15%), but it is considerably higher among those with multiple partners (21-52%) and sex between sex workers and clients (50-88%) as shown in Figure 5.

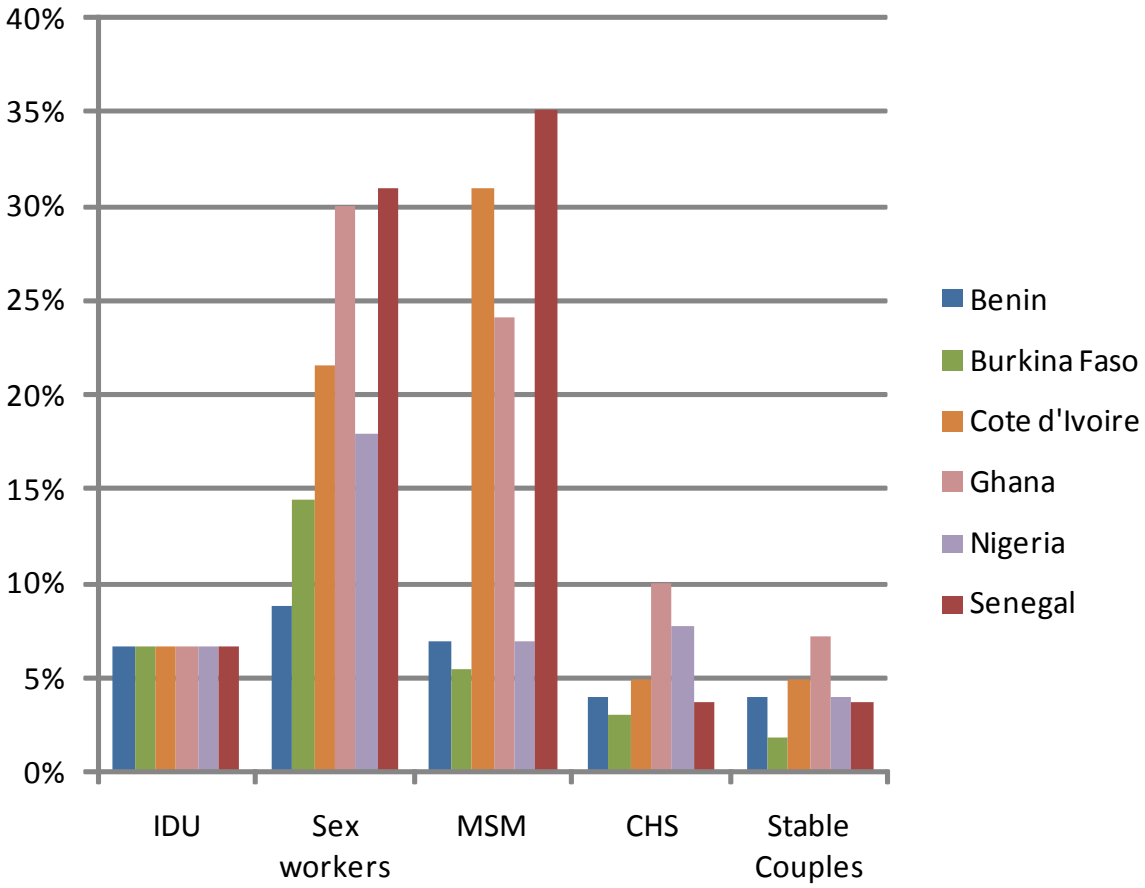
Figure 5. Percentage of contacts protected by risk group



Data on the prevalence of other sexually transmitted infections were generally available only from special studies and only Nigeria had data for IDUs[24]. Estimated prevalence ranged as high as 30-35% for sex workers and MSM but was generally 5% or less for other population groups, as shown in Figure 6.

[24] Federal Ministry of Health. HIV/STI Integrated Biological and Behavioural Surveillance Survey (IBBSS) 2007; 2007.

Figure 6. Prevalence of other sexually transmitted infections by risk group



Results

The data described above are used in the Incidence by Modes of Transmission Model to estimate the number of new infections occurring in each population group. The total number of new HIV infections across all risk groups is compared with the national estimate. If the model estimate falls outside the range of the national estimate the inputs are reviewed and changes made to the less certain inputs until agreement is reached.

The distribution of new infections by risk group is shown in Figure 7. The proportion of new infections occurring in stable couples varies from 20% in Senegal to nearly 50% in Burkina Faso. This is consistent with the fact that Senegal has the lowest proportion of the population categorized as stable couples. Burkina Faso and Nigeria have the highest proportion of their populations classified as stable couples. Côte d'Ivoire has the largest proportion of new infections in the multiple partners category which is consistent with the inputs that show about 30% of the population in this category compared to about 20% in the other countries. New infections among men who have sex with men are estimated at 11-13% in Côte d'Ivoire, Ghana and Nigeria and 2-5% in the other countries. This also reflects the different assumptions of the proportion of the population in this risk group.

Figure 7. Distribution of new infections by risk group and country

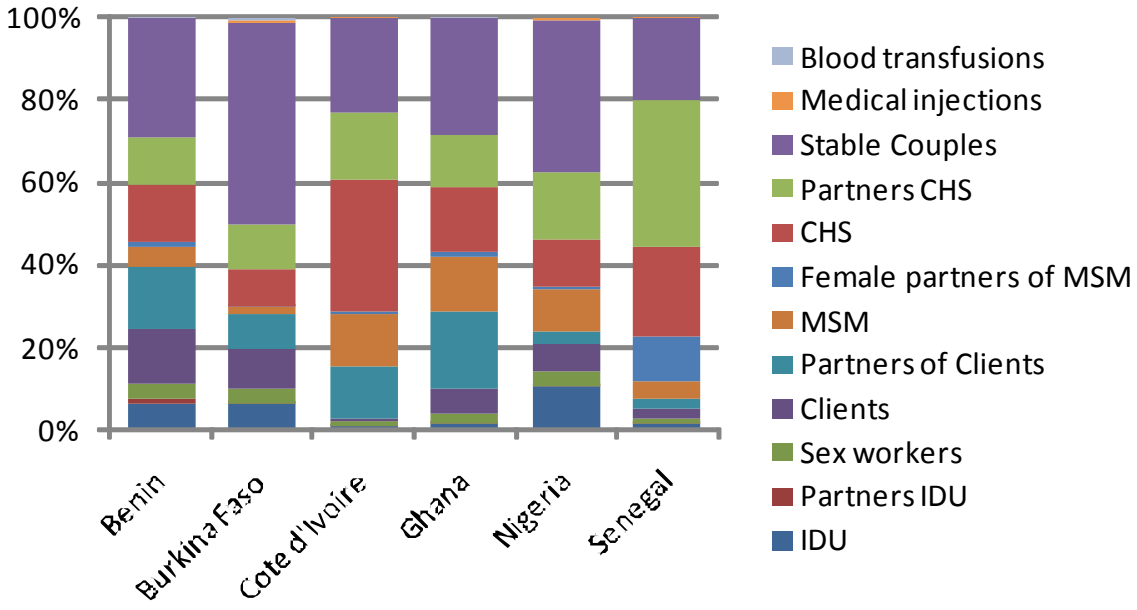


Table 1 shows the ranges around the estimates of new infections by source for each country. The ranges are quite large for some of the risk groups, particularly for stable couples. Since the total number of new infections is constrained to lie with ranges indicated by the epidemiological data the variations shown in Table 1 are correlated across risk groups. When the percentage of new infections occurring among stable couples is high, it is likely that the percentage occurring among those with multiple partners is low. There is a positive correlation between the percentage of new infections due to certain risk groups (sex workers, IDU, MSM, people with multiple partners) and the partners of those groups.

These ranges should be interpreted with caution since the ranges on the input values are based on solely on judgment with little hard data to inform these decisions.

Table 1. Plausibility ranges for the percentage of new infections occurring in each population group

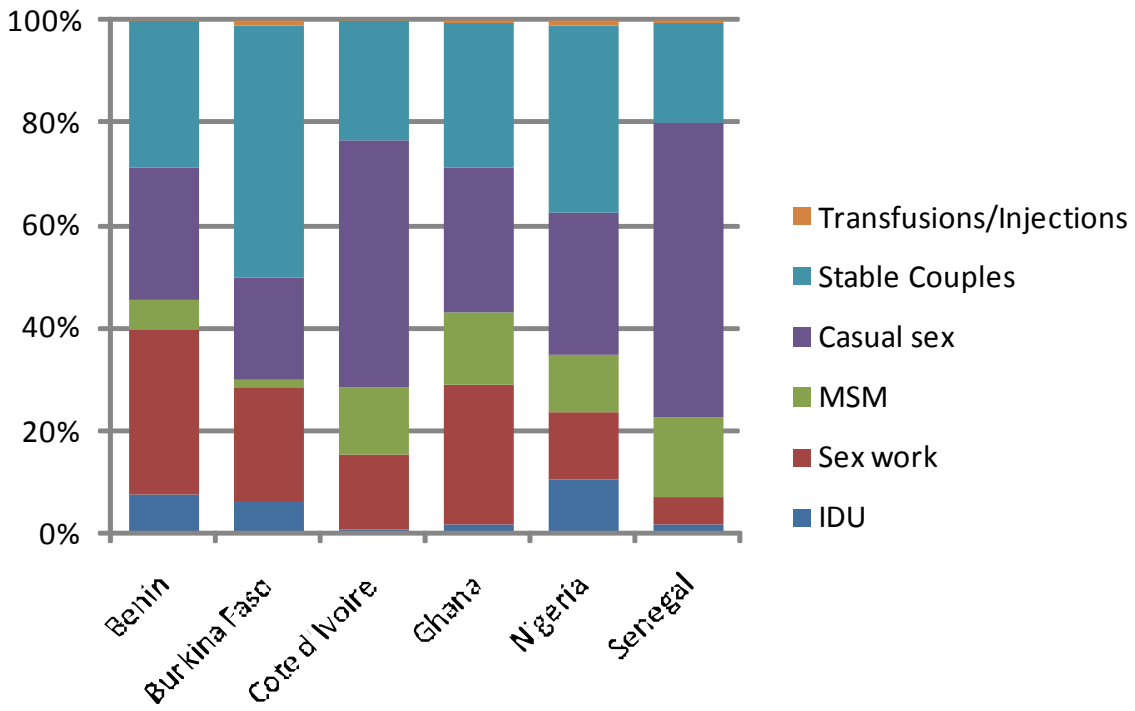
	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Nigeria	Senegal
IDU	1.9 – 13	1.1 – 7.7	0.2 - 1.6	0.3 - 4.0	1.5 – 13	0.4 – 3.7
IDU Partners	0.2 - 0.4	0.1 - 0.2	0 - 0.1	0 - 0.1	0.1 - 0.4	0 - 0.1
SW	3.2 – 6.1	2.1 - 4.9	0.8 – 2.0	1.4 - 3.2	2.6 – 5.2	0.1 - 1.4
Clients	11 – 22	6.5 – 15	0.6 - 2.1	3.1 - 9.6	6.4 – 14	1.1 – 10
Client Partners	12 – 18	7.7 – 14	8.9 – 14	14 – 21	2.1 - 3.1	5.6 - 8.5
MSM	4.3 - 8.4	1 - 2.1	6.5 – 19	8.0 – 18	7.5 - 14	1.3 - 8.0
MSM partners	1.8 - 2.8	0.4 - 0.6	0.8 - 1.9	1.2 - 2.5	0.8 - 1.2	4.1 – 11
Casual HS	12 – 22	6.3 – 12	28 – 48	11 – 20	9.9 - 18	21 – 38
Partners CHS	8.4 – 15	6.7 – 12	11 – 19	8.0 – 14	11 - 21	19 – 35
Stable Couples	12 – 30	42 – 59	7.6 – 31	24 – 40	26 - 46	4.8 - 34
Medical injection	0 – 0.1	0.1 - 0.3	0.1 - 0.2	0.0 - 0.4	0.0 – 0.5	0.1 - 0.2
Blood transfusions	0 – 0.1	0.2 – 1.0	0 – 1.0	0.1 - 0.5	0.0 - 0.9	0 -1.1

Another way to look at the results is shown in Figure 8 which combines new infections occurring in the highest risk groups (IDU, MSM, sex workers) with the new infections among their partners. This view shows the important of each source of new infection in the overall epidemic. It suggests that the importance of the different modes of exposure is as follows:

- IDU: 1-11%
- Sex work: 6-32%
- MSM: 2-15%
- Multiple partners: 20-58%
- Stable couples: 20-50%
- Blood transfusion: 0-1%
- Unsafe medical injections: 0-1%

A significant number of new infections occur among stable couples. These are people who currently have a single faithful partner so new transmissions occur only because some couples are discordant, that is, one partner is infected and the other is not. The infected partner would have acquired the infection before the partnership was formed or in a previous year from high risk behavior that has since ceased. Prevalence is low in this group so the rate of new infections will also be low, but since the largest share of the population is stable couples in most countries the number of new infections can be larger than other groups which have a higher risk of transmission but smaller numbers of people.

Figure 8. Distribution of new infections by source of risk

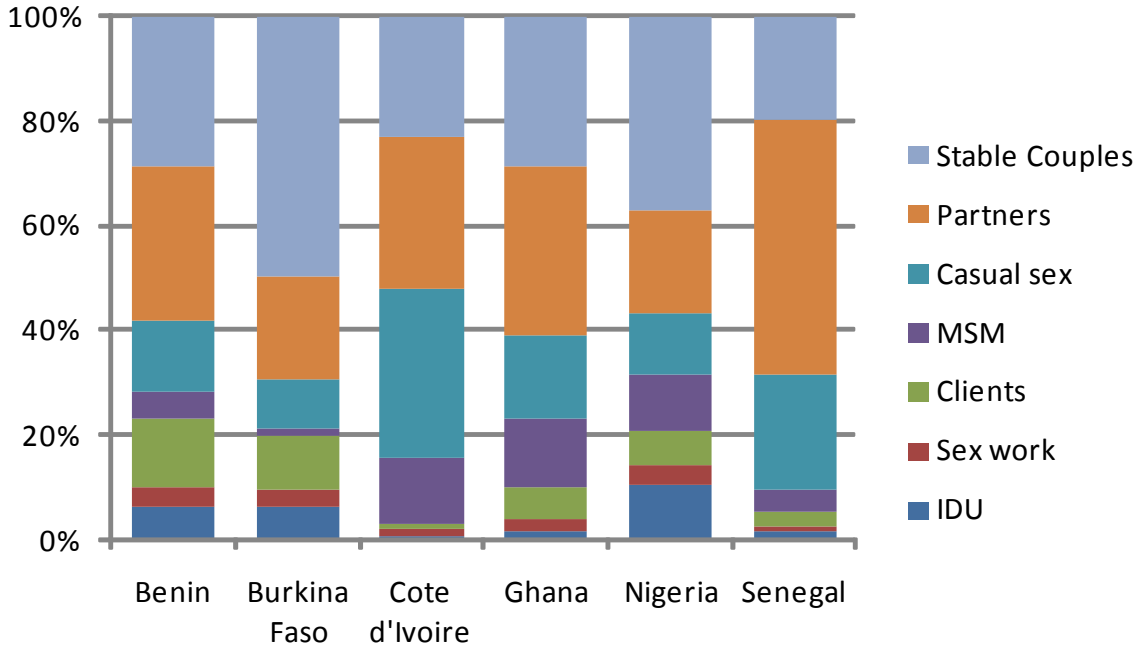


Another way to look at the results is to consider partners of high risk people as a separate category. This is shown in Figure 9. This chart shows clearly that a considerable number of new infections occur among people who themselves only have a single partner, but are at risk because of the high risk behavior of their partners. The proportion of new infections occurring in this group ranges from 20% in Burkina Faso and Nigeria to around 30% in Benin, Côte d'Ivoire, and Ghana and possibly as high as 49% in Senegal.

All the models found that the percentage of new infections due to unsafe medical injections is less than one percent (0.4%, range 0.1%-0.9%) and that the percentage due to contaminated

blood transfusions is even lower (0.1%, range 0.0%-0.5%). The percentage due to unsafe medical injections is somewhat lower than the 1-3% found by other studies[25].

Figure 9. Distribution of new infections by behavior



Conclusions

The results of these county analyses show that there is great diversity in the sources of new HIV infections across countries but that several important conclusions can be drawn.

1. There is no single population group or transmission mechanism that is responsible for a majority of new infections. On average across all six countries about one-third of new infections are due to multiple partners, one-third occur among stable couples, and one-fifth to one-quarter are due to sex work. MSM and IDU transmission contribute some amount as well but the proportion is not well understood because of a lack of good data.
2. Twenty to 30% of new infections occur in people who are in stable partnerships but have partners with high risk behavior. Since they are married or in long-term relationships with their partners it may be difficult to negotiate condom use. Taken together with the first point above this indicates that the majority of new infections may occur to people

[25] White RG, Ben SC, Kedhar A, Orroth KK, Biraro S, Baggaley RF *et al*, Quantifying HIV-1 transmission due to contaminated injections. *PNAS* 104:23;9794-9799, June 23, 2007.

who are in stable partnerships. The expansion of testing programs to identify discordant couples may be one option to provide these people with the information required to protect themselves.

3. New infections among sex workers and their clients account for about 15-25% of new infections. Since HIV prevalence is typically very high among sex workers and they have many different partners the risk of transmission is very high. However, some 50%-90% of sex acts are reportedly protected through condom use (at least in populations reached by interventions where it is more likely that surveys are conducted). This greatly reduces the number of new infections occurring through this mechanism. The number of new infections due to sex work would be more than twice as high without this level of condom use. In addition, infections occurring among sex workers have the potential to lead to a large number of secondary infections. Thus there is a need for prevention programs to address this mode of transmission.
4. Data on IDU and MSM are currently scarce in West Africa. In countries with data on these populations, the results indicate that they do contribute a significant proportion of new infections. However, the lack of good data in most countries makes it hard to estimate the importance of these mechanisms with precision.

This analysis is intended to support better planning for HIV prevention. Thus, it is useful to compare these findings to the current response to the HIV epidemic. For example, does the current expenditure and effort on prevention activities match the sources of new infections or is it very different?

One measure of the allocation of current effort is expenditures on prevention interventions. All six countries conducted a National AIDS Spending Assessment (NASA) for 2006 or 2007. Data on expenditures by prevention category are available for three countries: Burkina Faso, Côte d'Ivoire and Ghana[26]. The proportion of prevention expenditures devoted to programs for sex workers, clients, MSM and IDU is only 1.7% in Burkina Faso, 0.4% in Côte d'Ivoire, and 0.24% in Ghana whereas the percentage of new infections due to these population groups is 30%, 28% and 43% respectively. The spending assessment may under-estimate the true proportion of expenditures benefitting these groups since some activities (condom promotion, VCT, communications) will support them as well, but it seems clear that the resources devoted to this source of new infection are far less than the contribution to the continuing epidemic. By comparison the average percentage of prevention resources devoted to other activities is 20% for PMTCT, 9% for VCT, 18% for behavior change communications, and 23% for condom promotion and distribution.

A separate analysis of the response to HIV in West Africa conducted by the Centre hospitalier *affilier* universitaire de Quebec commissioned by the World Bank[27]also concluded that the

[26] UNAIDS Report on the global AIDS epidemic: 2008, Geneva, 2008.
[27] Lowndes CM, Alary M, Belleau M, et al. West Africa HIV/AIDS Epidemiology and Response Synthesis. Characterisation of the HIV epidemic and response in West Africa: Implications for prevention. Washington: World

allocation of prevention resources to address new infections among sex workers, clients, MSM and IDU falls far short of the importance of these sources.

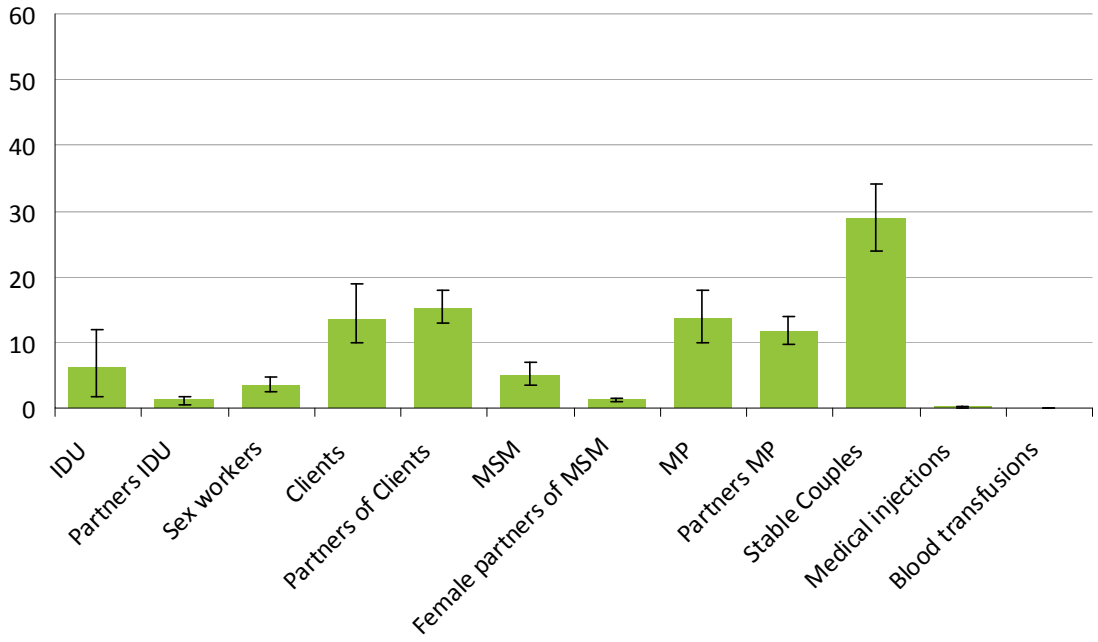
In spite of the low level of effort apparently allocated to these high risk populations, condom use is reported to be between 50% and 90% among sex workers and clients and Benin and Burkina Faso report reaching 60% of sex workers with prevention programs[28].

This activity demonstrates that it is possible for planners to develop rough estimates of the sources of new infection in their countries. Better data would certainly provide more precise estimates. More and better data may allow future analyses to examine the sources of new infections over time and to examine the role of multiple concurrent partnerships in HIV transmission. However, the current information is a start and should be used to inform the planning of prevention programs. It is clear that programs targeting multiple population groups and risk behaviors will be required to address all significant sources of new HIV infections.

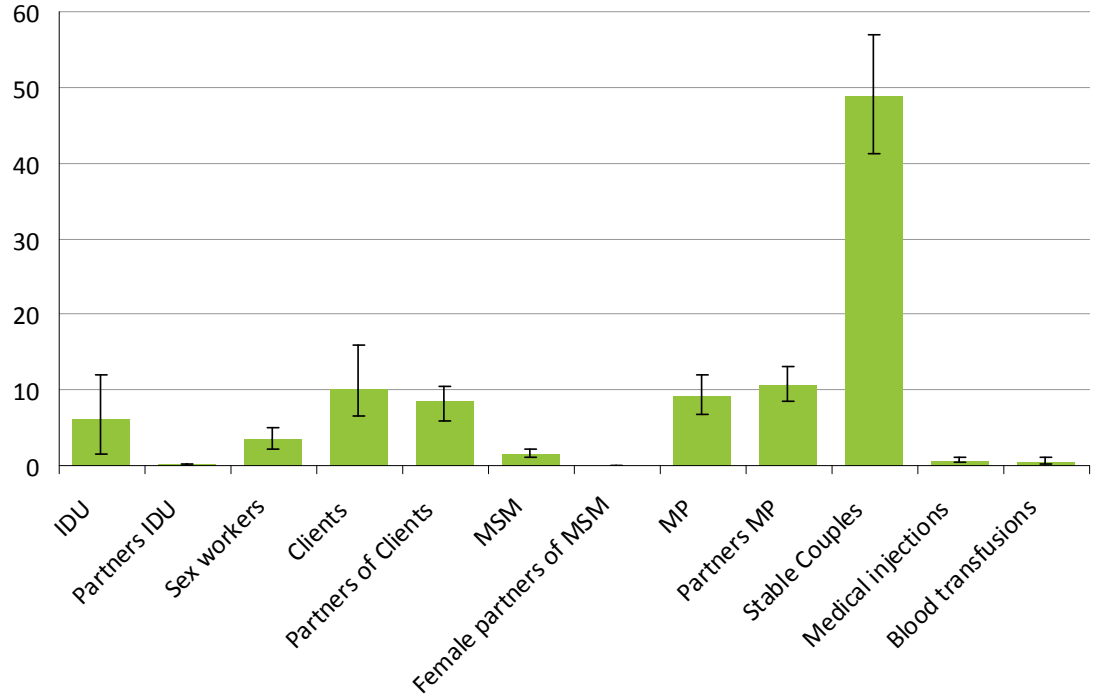
Bank, Global AIDS Monitoring and Evaluation Team (GAMET): ACT Africa, November 2008. Available at www.worldbank.org/aids >publications.

[28] UNGASS Indicator 9. Percentage of most-at-risk populations reached with prevention programmes.

Percentage of new HIV infections by risk group
Benin

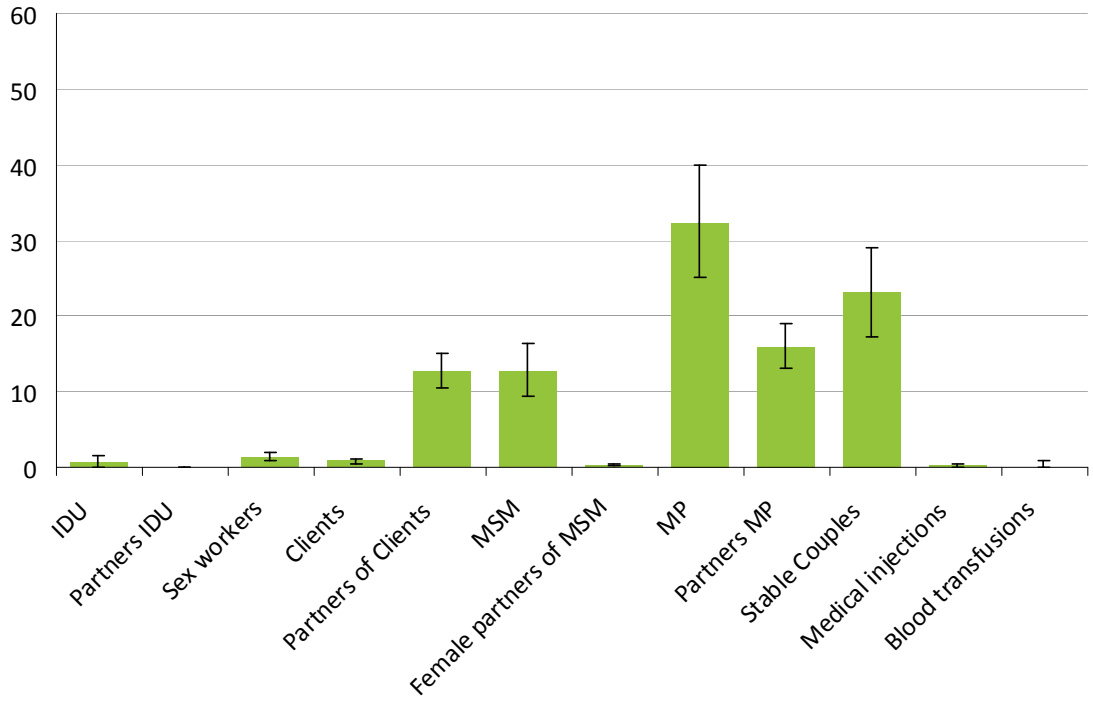


Percentage of new HIV infections by risk group
Burkina Faso



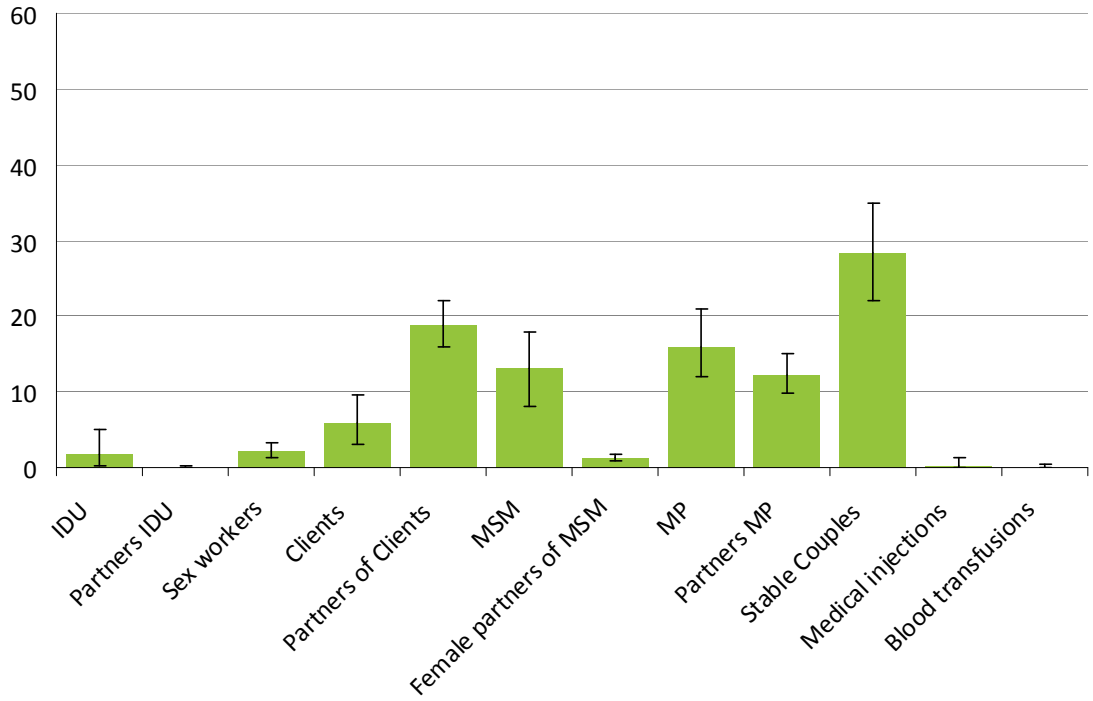
Percentage of new HIV infections by risk group

Côte d'Ivoire

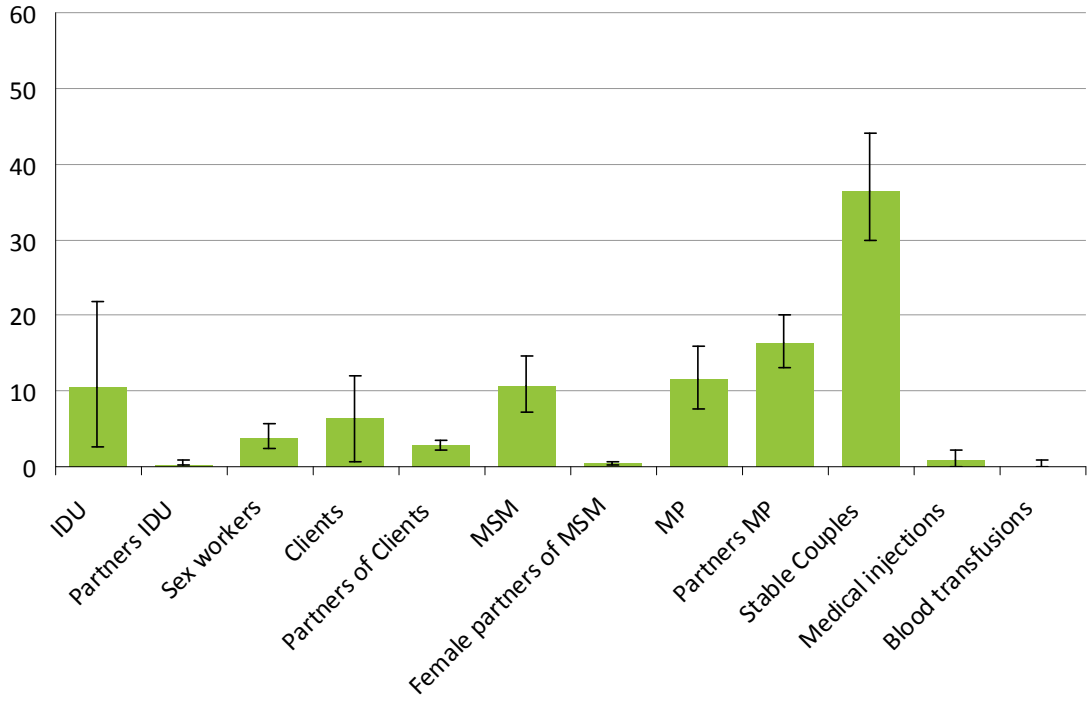


Percentage of new HIV infections by risk group

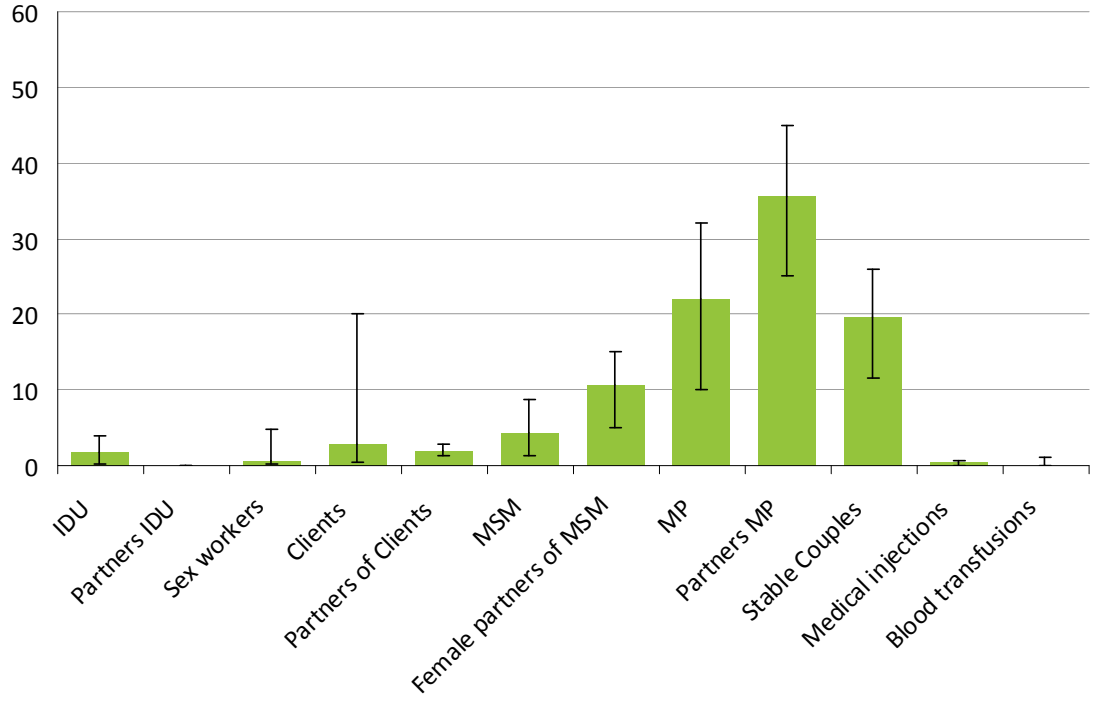
Ghana



Percentage of new HIV infections by risk group
Nigeria



Percentage of new HIV infections by risk group
Senegal



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