2012

Modes of HIV Transmission in Jamaica

Distribution of new HIV infections in Jamaica for 2012: Recommendations for efficient resource allocation and prevention strategies

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HIV MODES OF TRANSMISSION MODEL

Distribution of new HIV infections in Jamaica for 2012: Recommendations for efficient resource allocation and prevention strategies

This report was generated as a result of the study conducted from September 2011 – February 2012 by a working team as outlined below:

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Table of Contents

Figures

Tables

Acronyms

MOT working groups:

JMWG: The Jamaica MOT Working Group

JMEG: The Jamaica MOT Expert Group

Epidemiology:

AIDS: HIV disease state corresponding to a CD4 count below 200 cells/uL

ANC: Antenatal clinic

GUD: Genital ulcer disease

STI: Sexually transmitted infection

PITC: Provider initiated testing and counselling

PLHIV: People living with HIV

VCT: Voluntary testing and counselling

Behavioural risk groups (see Error! Reference source not found.**):**

MSM: men who have sex with men

FSW: female sex workers

IDU: injecting drug users

CHS: Casual heterosexual sex

LRH: Low risk heterosexual

Executive summary

Introduction: The HIV epidemic in Jamaica is currently being described as showing features of both a generalised and a concentrated epidemic. This characterisation is based on the most recent estimates of the number of current HIV infections in the general population as well as surveillance data from the antenatal clinics, demonstrating rates of 1.7% and 0.9% respectively. The decreasing prevalence in ANC settings has prompted a shift in characterising the epidemic as increasingly becoming concentrated. As a result, prevention interventions have been increasingly targeted to traditionally vulnerable populations. Recently conducted surveys including SW and MSM have provided important data on HIV prevalence and behavioural characteristics. In the current climate of significantly reduced funding for HIV in Jamaica, the requirement of resource allocation for interventions which target the groups at highest risk for acquiring HIV is of paramount importance to ensure the continued reduction in HIV infections in the country.

Objectives: Prevention efforts are most effective when interventions target populations at highest risk and address the behaviors that increase risk for HIV infection. The UNAIDS MOT model was applied to assess the HIV epidemic in Jamaica allowing policy makers to gain an understanding of the short-term risk of HIV infection in various risk groups and guide the national response to HIV.

Methodology: The MOT model generates estimates of the number of new or incident HIV infections in key identified populations over the coming year. It utilizes data for key risk groups including the proportion of adults in each group, the current HIV and STI prevalence, patterns of risk including number of partners and acts per partner and levels of condom use in each risk group. The risk groups identified for inclusion into this model include: men who have sex with men, female sex workers and their clients as well as subdivisions of the general population. Key documents included in the analysis include the 2011 National HIV/AIDS Programme Data and Statistics, 2008 National Knowledge and Behaviour Survey, The Worker survey (FSW, Clients of FSW) and the Men's Health Survey (MSM). The model also performs a sensitivity analysis to account for various sources of uncertainty.

Results: The model suggests that approximately 2,590 infections will occur in Jamaica in 2012. Approximately 32% of new infections occur in the MSM group, indicating this group is at highest risk for HIV infections. Female partners to MSM are also at significant risk with an estimated 7% of new infections occurring in this group. Persons identified as having low self-perceived risk, reporting one sexual partner in the previous 12 months (low-risk heterosexuals) including partners of high risk groups account for approximately 39%, while individuals engaging in multiple partnerships (high-risk heterosexuals) account for approximately 22% of new infections. Female sex workers, their clients and the partners of sex worker clients will also contribute significantly with approximately 10% of

new infections. Injection drug use, blood transfusion and occupational exposure risk groups were not included in the model as these modes of transmission do not contribute significantly to the Jamaican HIV epidemic.

Conclusions: Data generated from the model identifies several populations that are most at risk including men who have sex with men and heterosexuals with multiple concurrent sexual partnerships. Even though vulnerable populations are accounting for a large percentage of new HIV infections, a significant number is still expected to occur among those with low self-perceived risk. In order to maintain the gains achieved, interventions for vulnerable populations must be coupled with a continuation of those targeting the general population. Improved surveillance systems can provide the biological and behavioural data to populate future MOT models and allow for greater understanding and improved estimates of HIV incidence in key risk populations.

1 Introduction

The current HIV epidemic in Jamaica has become increasingly concentrated among high risk groups. Through routine surveillance it is evident that the epidemic continues to also affect the general population. This MOT modeling project is the first effort of its kind to synthesize risk group data in a consistent mathematical framework in order to evaluate the distribution of new infections. The model allows policy makers to better understand the short term risk of new HIV infections faced by various risk groups, the potential for the epidemic to establish itself in the general population, and to assess the adequacy of the response against HIV. The main output of the model is an assessment of whether the current prevention resource allocation is commensurate with the distribution of new infections and risk within the population of Jamaica.

1.1 Epidemiologic profile

The early 1980s heralded the beginning of the HIV epidemic in Jamaica, when an index case of uncertain origin came to the island (Figueroa, 1995). The first diagnosed case of HIV in Jamaica was registered shortly afterwards in 1982. Subsequently, the epidemic has grown considerably, concentrated within high risk groups such as MSM, FSW and their clients. There is naturally a concern about the extent to which the epidemic continues to spread between high risk individuals and their partners and the magnitude of risk faced by the general population.

The Government of Jamaica established a National HIV/STI programme within the Ministry of Health in 1986 to coordinate and implement a national response. The programme incorporated HIV into existing STI control programmes, and established a monitoring system, through case reports, donor blood screening, routine antenatal clinic (ANC) surveillance and sero-surveys. A number of key governmental ministries are integral to its efforts, including labor, tourism, education and national security departments. Non-health non-governmental entities are also involved in the programme through the National AIDS Committee (NAC), which was established in 1988 (NSP, 2008).

ANC data show a steady increase in HIV prevalence until 1996, when reports indicate a rate of 19.6 per 1,000 pregnant women were found to be HIV positive (Duncan et al). Subsequently there has been a significant decline and since 2009 ANC rate have declined to below 1% (Figure 1)

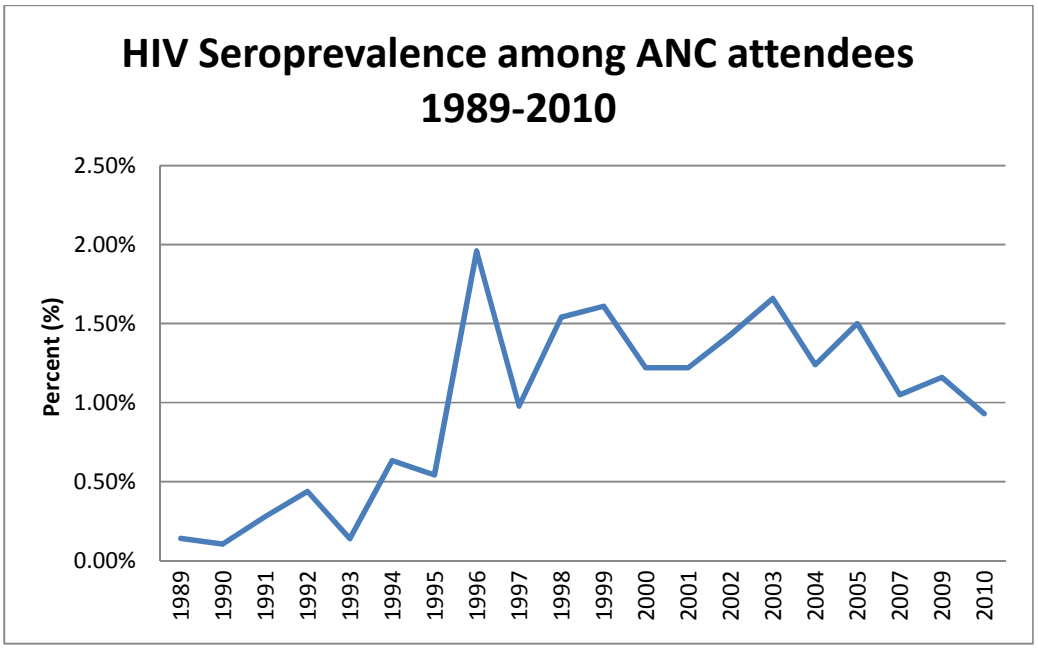

Figure 1: Seroprevalence ANC data

Presently, the epidemic stands at an estimated prevalence of 1.7% (UNAIDS 2010) in the general population, which translates into approximately 32,000 people currently living with HIV.

The number of reported AIDS cases has also varied over time, reaching peak levels in 2005 with approximately 1,400 persons being diagnosed. It has since declined to less than 1,000 in 2010. Mortality rates have followed a similar pattern, peaking in 2002 with 692 registered AIDS deaths followed by a decline to 320 deaths in 2007. Since 2007, there has been an overall decline in these rates, however, a fluctuation in total numbers have been recorded which is most likely a result of improvements in HIV diagnosis and case reporting mechanisms (NHP Facts and Figures 2010)

Reports on a number of high risk groups record HIV prevalence rates that are significantly higher than the general population. These include men who have sex with men (MSM), female sex workers (FSW) and the incarcerated population with prevalence rates of around 32%, 5% and 3% respectively. The youth, both in and out of school, are also identified as part of the most vulnerable populations. A number of prioritized intervention programmes have been established to prevent HIV transmission in vulnerable populations and to limit onward transmission. These include interventions involving FSW, encompassing women's empowerment, and MSM interventions, termed Men's Health workshops.

The HIV epidemic shows significant heterogeneity with respect to age, sex and geographic location. Young adults continue to be significantly affected by HIV. Of the reported AIDS cases up to 2010,

approximately 1.2% occurred in the 15-19 group and 18% in the 20-29 age group. Overall, 80% of all reported AIDS cases in Jamaica occur in the 20-49 year old age group, and 90% of reported cases aged between 20 and 60 years. Estimated HIV incidence among youth appears to be declining with 56 cases per 100,000 in both the 15-19 and 20-24 age range falling to 7.6 and 14.9 per 100,000 in 2010 respectively (NHP Facts and Figures 2010).

Total AIDS case rates among men continue to exceed AIDS case rates among women. However, surveillance data indicate that the sex disparity is narrowing. Women accounted for 37% of persons reported with AIDS prior to 1995 compared to 44% of persons reported with AIDS between 2004 and 2008 (Duncan et al, 2010). In 2010 women accounted for 47% of reported AIDS cases. It is unclear to what extent this apparent normalization points to a generalized epidemic. The growing number of reported HIV and AIDS cases among women may still be attributable to exposure through their MSM or other high risk male partners, as opposed to an epidemic now spreading independently in the general population.

All 14 parishes have been affected by HIV with a bias towards the most urbanized parishes. Between 1982 and 2010, St. James reported 1,956 HIV cases per 100,000 persons and Kingston & St. Andrew reported 1,494 HIV cases per 100,000 persons. The number of AIDS cases being reported from the most urbanized areas is however on the decline from 70% in 2008 to approximately 57% in 2010. The parishes with tourism-based economies have also been significantly affected with cumulative AIDS case rates ranging from 1,089 to 919 cases per 100,000 in St. Ann and Trelawny respectively. (NHP Facts and Figures, 2010)

1.2 Behavioural factors

There are several behavioural and socio cultural factors which appear to be driving the HIV epidemic in Jamaica. The National Strategic Plan 2012 - 2017 has identified multiple sexual partnerships, early sexual debut, high levels of transactional sex, commercial sex and inadequate condom use as key elements.

Based on self-reported data, there appears to be a significant difference in high risk behaviours between sexes. Data obtained from the National HIV/AIDS Knowledge, Attitudes and Behaviour Survey (KABP) conducted in 2008 indicated approximately 50% of men and 25% of women, representing 38.9% of all adults, have reported casual heterosexual activity. This was especially so for the younger men (age group of 15-24) of whom 76% reported multiple relationships compared to 53% of older men.

Multiple partnerships and transactional sexual relationships account for the majority of this casual behaviour. These have long been identified as a major risk factor for HIV acquisition in the Jamaican HIV epidemic. Between 1982 and 2007, approximately 80% of persons diagnosed with HIV indicated they had engaged in multiple partnerships. These risk behaviours were reported by a significantly larger proportion of men, who reported on average 5.68 partners, compared to women, who reported 2.91 partners. This is a likely consequence of social norms where sexual risk behaviour is more acceptable in men (see section 1.3). The differential societal acceptance of sexual behaviour may have also influenced under-reporting by women.

The 2008 national KABP survey also provides data on marriage/cohabiting rates: 31.5% of men and 37.7% of women reported being married or cohabiting for more than the last 9 years. These rates were considerably higher in the older age group of 25-49 years, reporting a marriage/cohabiting rate of 43.9%. While those aged 15-24, only 2.5% of respondents reported being married or cohabiting.

The early age of sexual debut in Jamaica is also a concern with respect to the HIV epidemic. Over 90% of men aged 15-19 have already engaged in sexual activity. This age also appears to be decreasing in women who report a median age of sexual debut at 16.9 years of age in 2008, compared to 17.2 years in 2004. (KABP 2008). An earlier survey concluded of those youth who had been sexually active the mean age of sexual debut for both sexes was 11.02 years (95% CI=10.76-11.29) (Jamaican Youth Risk and Resiliency Behaviour Survey 2005)

The utilization of barrier contraception, namely condom use, while much improved since the beginning of the epidemic still appears to be sub-optimal. The condom market in Jamaica has grown from 2.5 million per year in 1985 to 12 million in 2006 (Figueroa 2008). However, approximately 25% of men and 50% of women do not use a condom with a non-regular partner (KABP 2008). In addition, an assessment of condom use among persons who were engaged in multiple partnerships indicated that more than half of the non-users and a quarter of sometimes users were reportedly unlikely to use condoms at their next sexual exposure.

Sexually transmitted infections (STIs) also appear to be on the decline. STI surveillance data indicate a decline in genital ulcer disease (GUD) from 2,106 cases in 1997 to approximately 1,300 in 2003 to 2006, with further declines to 895 reported cases in 2010. Women appear to be disproportionately affected with 496 reported GUD cases in 2010 compared to 399 men.

1.3 Sociocultural norms

Social norms and cultural practices, including gender roles, have played a significant role in the HIV epidemic of Jamaica. Within the context of sexual relationships, social norms reinforce the

dominance of men in the relationship. Not actively redressing the practice of multiple partnerships has led to tacit encouragement of it. Female counterparts in particular seem to accept its open practice. Yet women often find it difficult to negotiate condom use in relationships where men play a dominant role.

Significant economic problems continue to impact the country including increasing national debt and unemployment. In January 2011, the overall unemployment rate for Jamaica was 12.9%, with more than 50% occurring in the under 24 age group (STATIN 2011). High levels of unemployment in both men and women have contributed to the development of transactional relationships. The 2008 KABP survey reported that of the sexually active participants, 52.7% of men and 21.0% of women were reportedly engaging in transactional sex. The need for economic security has also encouraged intergenerational sex. Sexual activity between younger women and older men occurs widely. The 2008 KABP survey also speaks to this trend, where approximately 20% of women aged 15-19 were in a cohabiting relationship with a male partner who was at least 10 years older.

The economic climate in Jamaica has also contributed to sex worker activity. An estimated 12,000 women are said to be operating as sex workers in Jamaica. However, HIV prevalence rates appear to be declining in this high risk group. Initially estimated at 21% in 1990, a 2008 survey conducted in three health regions across Jamaica indicated an HIV prevalence rate of 5%. STI rates, specifically syphilis and genital ulcer disease (GUD), have remained relatively constant between 6-9%. (SW Survey, 2008)

The homeless population in Jamaica is also vulnerable to HIV. A survey of 289 homeless persons, approximately 25% of the homeless population, in 2009 found an HIV prevalence rate of 34% and 9% among women and men respectively. Non-injecting substance abuse also occurs at high rates in this population being reported by 64% of women and 59% in men.

1.4 Modes of transmission

HIV case reporting surveillance data indicates that sexual transmission of HIV is the primary transmission route in Jamaica and that approximately 90% of persons diagnosed with HIV report heterosexual practice. Among men however, 40% of cases have an unknown designation. Of the 60% for which data is available, 86% indicate only having sexual interactions with women, while 14% report having male partners (NHP, Facts and Figures, 2010). The paucity of data for this risk behaviour may represent either under reporting of sexual practices by MSM, due to fears of stigma and discrimination, or inefficiencies within the surveillance system.

In 2002, a prevention of mother-to-child transmission of HIV (pMTCT) programme was developed in the Kingston and St. Andrew Health region. By 2007 the programme had been extended island wide and reported a rate of mother-to-child transmission of less than 5%. Currently the pMTCT rates have been reported at 4.6%.

Intra-venous drug use (IDU) has historically not been a major mode of HIV transmission in Jamaica as this is a very uncommon practice in the country. Less than 1% of the cumulative HIV cases have reported needle sharing while living in Jamaica.

Jamaica has been able to maintain 100% screening of all blood products (MOH annual report 2007) and therefore blood transfusion does not contribute to HIV transmission. Occupational exposures have been grossly under reported and quantification of risk by this mode of transmission is not currently available.

1.5 Prevention assessment

Prevention strategies have played a major role in the national response to HIV. The initial focus was to increase awareness of the general population to HIV. The National KABP surveys conducted between 1988 and 1994 showed marked improvements in the knowledge categories. However, they also identified significant discrepancies between knowledge and behaviours. A shift towards Behaviour Change Communication (BCC) subsequently became a priority for prevention planning. Initially, the interventions were broad and encompassed general messages to the entire population. These included the implementation of the Health and Family Life Education (HFLE) curriculum, the training of community peer educators, collaboration with local music artistes and multimedia prevention campaigns focusing on condom use, prevention of mother-to-child transmission and anti-stigma messaging (NSP 2008).

More recently there has been a shift towards targeted prevention specifically designed for vulnerable populations. This shift has been demonstrated in the increase in expenditure targeting key populations in recent years. Spending on prevention activities targeting MSMs increased from 15% to 20% of total prevention expenditures between 2009 and 2010 (NASA, 2012). This increase occurred amidst an overall decrease on spending for prevention activities in 2010. Spending for activities targeting female sex workers also increased by 2%.

Collaboration with civil society organizations has been instrumental in the roll out of MARP specific activities, assisting with access to these populations and their acceptance of the programmes. Priority areas that have been focused on include interventions promoting both treatment and

prevention with MSM and SW populations, educational activities with adolescents and testing and treatment interventions with the incarcerated population.

One of the major prevention successes in Jamaica is the pMTCT programme. As discussed earlier, pMTCT programme has reduced perinatal infections to less than 5% with the goal of complete elimination of vertical transmission by 2015 (NHP Stats 2010). The expansion of the treatment as prevention concept has yet to be applied to the adult population.

The prevention programme is primarily funded from external sources and the NASA reports Global Fund contributing an average of 70% of financial resources in this area for 2009 and 2010. This needs to be taken into account in discussions around meeting prevention targets and sustainability of key programmes (NASA 2012).

2 The MOT Model

2.1 Methodology

The Modes of Transmission Model was initially developed in 2002 by the UNAIDS Reference Group for Estimations, Models and Predictions. It generates estimates of the number of new or incident HIV infections in key identified populations over the coming year. The model utilizes data for key risk groups: the proportion of adults in each group, the current HIV prevalence, patterns of risk and levels of protection against HIV infection in each risk group.

The risk of HIV infection is characterised by a number of variables, including the number of sexual partners per year and the number of sexual acts per partner per year. These variables estimate the annual number of potential sexual encounters in each risk group. HIV prevalence in corresponding partner risk groups determines the likelihood that any contact will be with an HIV+ partner. The prevalence of other sexually transmitted infections (STIs) increases the risk of HIV transmission while condom use and male circumcision reduces the probability of transmission during a sexual act.

A standard MOT model uses a mathematical equation (a so-called Bernoulli equation) to calculate the probability of transmission in each identified risk group as one minus the probability of avoiding HIV transmission during each of the yearly sexual encounters. The result is an estimate for the distribution of new infection over identified risk groups.

These estimates are typically used to evaluate whether current or planned prevention resources are allocated in a manner which is broadly commensurate with the modelled distribution of new infections. This comparison may reinforce support for the current allocation strategy, but more often than not suggests HIV risk which is not adequately addressed.

Including all risk groups in a uniform framework sheds light on the HIV risk faced by each risk group, ranging from small, hidden, stigmatized, neglected or simply unnoticed. While case reports and routine surveillance provide insights to epidemic trends and guidance for response, it requires a model such as MOT to account for all these heterogeneities when accessing the adequacy of response.

2.2 The Jamaica MOT initiative

The application of the model commenced in October 2011 and was completed in February 2012. A brief outline of the process is presented.

The MOT process started with the formation of two teams: a technical working group (JMWG), comprising members of the National HIV/STI Programme, a technical staff member from the local UNAIDS office and a local consultant, and an expert team (JMEG) consisting of a wider range of local experts with extensive knowledge of the HIV epidemic and the key populations at risk in Jamaica. These teams conducted a comprehensive review of epidemiological and behavioural data for the HIV epidemic in Jamaica.

Following the formation of these groups, sensitization and information gathering activities were conducted with the JMEG, a local consultant, a national team of experts and an international technical group with experience in application of the model. The national team comprised members of several components of the National HIV/STI Programme and experts representing key populations of the HIV epidemic and supported by the local UNAIDS office. A one day web based training and sensitization session was conducted with these two groups and the international consultant in conjunction with UNAIDS experts.

2.3 Identification of risk groups

One of the challenges faced in the creation of the MOT model is deciding which risk groups to include. A number of factors are taken into account primarily risk quantification and availability of data. There is an allocation constraint from the model which requires individuals to be allocated to one risk group only. If they logically belong to more than one risk group then they are allocated to the group where they face highest risk of HIV infection. All individuals in a risk group have the `average' same risk. Heterogeneity within a risk group can be handled by adding sub risk groups, if the heterogeneity can be justified by context and availability of behavioral data.

The standard risk groups considered for entry into the model are:

Table 1: Definition of Risk Groups

Population	Operative Definition
MSM	Men who have sex with men
Female partners of MSM	Percentage of MSM who report having sex with a woman in the past 12 months
Female sex workers	Women who has exchanged sex for money in the past 12 months
Clients of female sex workers	Men aged 15-49 who reported having paid for sex in the last 12 months
Casual Heterosexual Sex	Men or women who have had more than 1 sexual partner in the past 12 months
Partners of High Risk Heterosexual	Percentage of high risk heterosexuals who report being married or cohabiting (Partners of: SW, clients of SW, MSM and CHS)
Low Risk Heterosexual	Men or women who reports only having 1 sexual partner in the last 12 months
Without Risk	Persons in the general population who report no sexual activity in the last 12 months
Medical Injections	Adults receiving at least one medical injection in the past year
Blood Transfusions	Adults receiving at least one blood transfusion in the past year
IDU	Adults who have used injected drugs in the last 6 months
Partners of IDU	Sexual partners of IDU

The JMEG considered risk groups for inclusion in the model from the list in **Error! Reference source not found.**. The team argued for the removal of the IDU, medical injection and blood transfusion `groups', based on the relatively rare occurrence of infection events and scarcity of data. These groups are highlighted in the bottom four rows of **Error! Reference source not found.**.

The team also argued for the inclusion of additional groups based on reported incidence within these groups and their acknowledged vulnerability.

- Adolescents
- Homeless
- A distinction to be made between high risk and low risk MSM populations
- The replacement of IDU with Non-injecting drug users

These additions were reviewed using the following criterion (see **Error! Reference source not found.**):

- Shared common behavior
- Availability of information on the particular population

Based on this review, it was the group's consensus not to include the additional groups due to lack group specific information. It was also argued that these groups share key risk factors for HIV infection with other groups in the model.

Table 2: Evaluation of risk groups for inclusion in MOT model

Population	Shared Risk Behaviour	Available sources to respond to indicators? Yes/No
MSM	Multiple sexual partners/acts without using a condom	Yes
Female sex workers	Multiple sexual partners/acts without using a condom	Yes
Clients of FSW	Multiple sexual partners/acts without using a condom	Yes, limited
Casual Heterosexual Sex	Multiple sexual partners/acts without using a condom	Yes
Low Risk Heterosexual	Acts without using a condom	Yes
Homeless	Multiple sexual partners? Acts without using a condom?	No
Adolescents	Multiple sexual partners/acts without using a condom	Yes, limited
Drug Users (non-injecting)	Multiple sexual partners/acts without using a condom	No

3 Model calibration

With key risk groups defined, members of the JMWG and JMEG were contacted to provide relevant data. Key documents and other data sources were identified and in cases where sub-analysis was required to provide the relevant data for the model, additional requests were made to the individual gate keepers. Additional consultations with the working group were conducted to facilitate this process.

3.1 Total population

The total mid-year population of Jamaica is estimated at 2,828,381 (Spectrum, based on UN Population Division data) of which 1,492,425 (52%) are adults aged 15-49.

3.2 Transmission probabilities

The transmission risk of HIV from women to men is assumed to be 0.11%. Female to male transmission probability is assumed to be 0.1%, accounting for the percentage of men who are circumcised, which is estimated to be 10% nationally (Figueroa 2010).

Estimates for MSM transmission probability varies widely. The default assumption of the MOT model is that it is 10 times higher than male to female transmission. We used a factor of 5, and included variation in this factor in the uncertainty analysis (see section 3.9)

3.3 Risk group sizes

The adult (15-49 years) population in Jamaica was divided into risk groups based on their highest risk factor for the acquisition of HIV.

The percentage of men who have sex with men (MSM) in the country was estimated as 4.0% of the male population. This estimate was derived from a review of regional estimates, available population studies conducted in Jamaica, and consultations with members of the JMEG.. All additional data requirements were derived from the MSM survey conducted in 2011.

The percentage of female sex workers was the upper limit from estimates that had been used in EPP (Duncan et al 2010). This was estimated at 2% (n=14,957) of the female population. For the parameters evaluated within this risk group, the data used was from the 2011 Sex Work Survey.

From the National KABP 2008 survey, the proportion of the population in the CHS group was estimated at 60% men and 16% women among those who were sexually active. The same survey

also reported that women identified as engaging in multiple partnerships had on average 2-3 partners, which suggests some under reporting. Therefore, the percentage of CHS women was adjusted up to 25%, to more accurately reflect this segment of the female population.

The not-at-risk group is defined to be those adults who had no sexual activity in the last 12 months or who were never sexually active. The data source for this information was derived from the 2004 and 2008 National KABP surveys with expert opinion indicating over reporting of no sexual activity by both sexes in these surveys and concluded the rates were closer to 5% of men and 15% of women which constituted this group.

The LRH was the exclusionary group and thereby was estimated as 26% men and 27.4% women.

3.4 Sexual partners of high risk groups

3.4.1 Female sexual partners of MSM:

The number of female partners of MSM was estimated from the percentage of MSM reporting a female partner in the past 12 months or 40% to the MSM population. This proportion represents 1.6% of the female population. The sample captured in this survey is not believed to be representative of the MSM population, and likely under-estimates the proportion of MSM which are married or cohabiting thereby underestimating the number of regular female partners of MSM.

3.4.2 Male clients of female sex workers:

The number of clients of FSW was estimated at 6% of the male population (Duncan et al., 2010). HIV and STI prevalence rates were estimated at 80% and 25% of the prevalence rate noted in the sex workers' group respectively. Unfortunately, there is very limited data on clients of sex workers that can be used to support the MOT model.

3.4.3 Sexual partners of clients of female sex workers:

The number of partners of clients of FSW was estimated to be 3.6% of the female population based on applying the marriage/cohabiting rate of 60% (KABP, 2008) to the clients of sex workers. Partners of clients of FSW were hitherto assumed to have been low risk, implying only one sexual partner.

3.4.4 Sexual partners of men engaging casual heterosexual sex:

The estimate used was generated from the EPP model and taken at 24% of the female population (KABP, 2008).

The proportion of men, comprising partners of CHS women, who were not already captured in the CHS male category, would not significantly contribute to the model and were therefore excluded.

Based on this data, the model was populated as reflected in Figure 2:

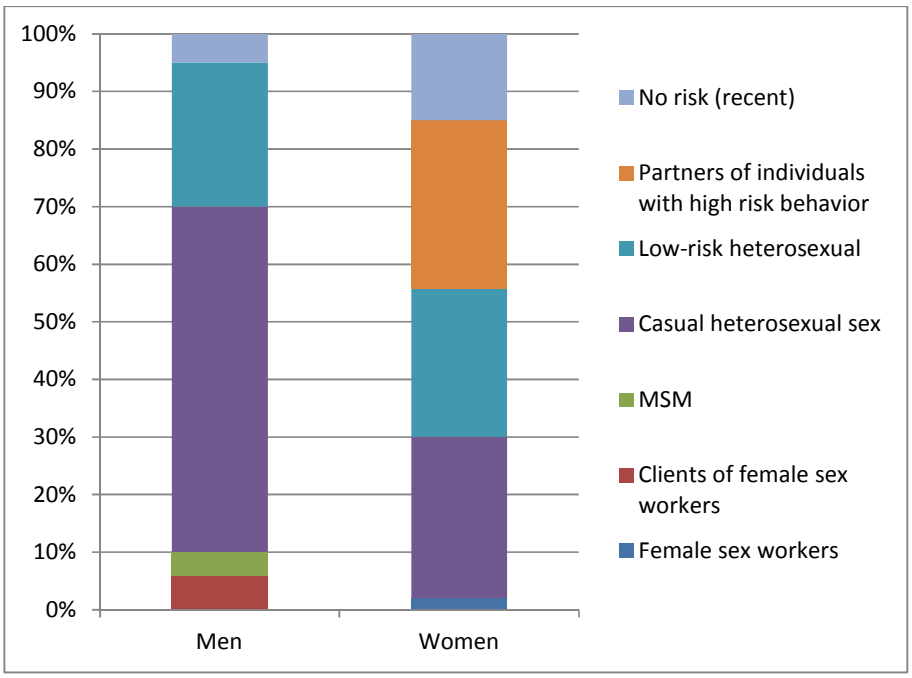

Figure 2: Distribution of adult population by risk factor for HIV Infection

3.5 HIV prevalence

The prevalence rate of HIV in the general population was based on National HIV data collated in 2010. The prevalence amongst the high risk groups was based on surveys conducted in 2011 for MSM and FSW as well as data derived from STI clinic attendees, which was used as a proxy for CHS. The HIV prevalence rates for MSM and CHS were both reduced from the initial survey estimates, 32% and 2.3% to 15% and 1.9% respectively, based on expert-panel opinion which suggests that the sample included in the surveys was biased towards a high risk population and did not reflect the general risk group. In the case of the CHS group, the STI clinic attendees represent a small and likely high risk sample of the CHS group. The estimate of 1.9% which was utilized in the model was derived from an average of the general population, specifically CHS, partners and low risk, and matches the EPP estimates. The HIV prevalence among clients of FSW were estimated at 80% of that for the risk

group, FSW, while partners of clients and partners of other risk groups were assumed to be the same as LRH.

3.6 Prevalence of other STIs

Prevalence rates of syphilis or genital ulcer disease (GUD) identified in the various surveys was used to represent STI prevalence rates in the model. STI prevalence rates for partners of risk groups were not included in the model as the model only assesses the first level of extra risk of HIV acquisition they face from their partners.

3.7 Number of sexual partners and acts per year

The estimates based on 2008 KABP survey of the number of sexual acts of those married or cohabiting was 95 acts of sexual intercourse per year. For the high risk groups, FSW and their clients, MSM and CHS, data for this parameter were derived from the sex worker, MSM and KABP surveys, respectively.

The number of sexual partners per year for each risk group was again derived from each of the corresponding surveys. Participants reporting no sexual activity in the last 12 months were presumed to have no risk and those reporting low risk sexual behaviours, including partners of high risk groups, were presumed to have only one sexual partner.

3.8 Percentage of acts protected

This parameter refers to the number of sex acts where a condom was utilized. This was determined from the percentage of persons reporting condom use at the last sexual act. These estimates were obtained from the KABP, MSM survey and Sex worker survey.

Sex workers reported very high levels of condom use at 90%. However the reported condom use by their clients was much lower at 68% (KABP). The percentage condom use in the CHS group was only 65% based on information contained in the KABP survey. Self-reported condom use has often been quoted as an overestimate of actual use.

The percentage of protected sexual acts of MSMs was estimated to be 50%, based on the percentage of MSM that used a condom at the last sexual exposure with a man in the Men's Health Survey. The estimate of condom use by the female partners of MSM was based on the assumption that their behaviour would be the same as that of the low risk group where condom use was of 17%.

Condom use among persons in the low risk group was presumed to be the same as the current use of condoms reported in the KABP 2008. This was estimated at 17% overall. In general, it has been noted that condom use is low among regular partners in Jamaica.

3.9 Uncertainty analysis

The MOT model requires detailed behavioural and other information on a number of risk groups. Data are seldom available from national surveys, and no Demographic and Health Survey (DHS) data is available for Jamaica. Behavioral data used in the Jamaica MOT model relies on a number of specific studies and surveys (Tables 7-15). These are often based on self-reporting, include biases, and are not entirely representative of the national epidemic. It is reasonable to expect uncertainty in the parameter values of the MOT model and therefore uncertainty in its output.

The standard MOT Model does not incorporate estimates of `uncertainty' or confidence intervals for its estimates. However, a recent elaboration of the model allows for a form of uncertainty analysis. The uncertainty is in principle based on the quality and availability of data with respect to statistical significance of studies used as well as their generalizability to national level. It is practically achieved by allowing each input parameter to vary between 0% and 100% (to be specified by user), reflecting the degree of uncertainty (or plausibility).

These plausibility ranges define the range of an assumed uniform distribution around which the uncertainty algorithm samples random input parameters. A range of 20% is typically used. An independent draw is then made for each parameter. The model is populated with a random parameter set and the output of the model is evaluated. The algorithm continues until a 1000 random results sets fall within the 95% confidence interval for the estimate of the new infections (see Table 3 and **Error! Reference source not found.**). A 95% plausibility range is derived for key output parameters.

3.10 R0: Identifying epidemic drivers

The standard MOT model is based on risk to HIV infection over the coming year. However, 'risk' is just one lens through which to view the epidemic. Comparing risk groups with respect to onward or secondary transmissions also sheds light on HIV control. Though not usually done in MOT analysis, we also used the model to obtain a distribution of onward transmission from each risk group.

The idea is to mimic a widely used measure of onward transmission, the so called R0 of the HIV epidemic. This measure is defined as the number of secondary infections that result from an HIV case during an entire infectious period when the index case is introduced into an entirely susceptible

population. Mathematically it is a measure of the ability of an epidemic to `invade' a population. When R0 is greater than one, it does, as each infective case `replaces' more than just himself/herself in the epidemic and an endemic equilibrium will be established. Practically, estimates of R0 guides interventions by evaluating if they can bring R0 below one, which eventually should lead to eradication of the epidemic.

We used the MOT model to do a simple R0-type analysis by estimating the number of secondary cases that could result from an HIV case in key risk groups. This is achieved by multiplying the number infections caused by each HIV case by a crude estimate for a typical infectious period. The precise value of R0 is not as interesting as the relative distribution of the R0 estimates of different risk groups.

This approach has a number of limitations. It does not account for the transitions of an infective case through different risk groups, and it does not account for periods of increased or reduced infectiousness. These limitations also apply to the standard risk-based MOT model.

4 Results

The model estimated a total number of 27,500 people with HIV in Jamaica resulting in an HIV prevalence rate of 1.84% for the total population. This agrees with the estimate from EPP of 1.86% (**Error! Reference source not found.**). The model predicted approximately 2,590 new infections will occur over the next year in Jamaica. This estimate was higher than the estimate of 2,500 produced by the 2010 Spectrum analysis. However, Spectrum estimates are based on all available survey data as opposed to the population based data used for this model. Differences in estimates could also be related to uncertainty in the risk profile of clients of female sex workers and partner groups (partners of MSM, clients of SW and CHS).

Table 3: MOT Comparison With 95% Confidence Intervals from Spectrum AIM and EPP

	MOT	Spectrum/AIM and EPP		
		Low	Median	High
Prevalence	1.84%	1.43%	1.86%	2.35%
New Infections	2,590	1,600.00	2,500.00	3,600.00

Table 4: Distribution of percentage of new infections by risk group

	Low	Median	High
Injecting Drug Use (IDU)	n/a	n/a	n/a
Partners IDU	n/a	n/a	n/a
Sex workers	0.20	1.34	3.42
Clients	3.20	5.23	8.42
Partners of Clients	2.16	3.73	6.32
MSM	24.61	31.75	40.13
Female partners of MSM	4.95	7.16	9.79
Casual heterosexual sex	15.35	21.98	29.61
Partners CHS	9.19	13.93	20.05
Low-risk heterosexual	7.51	13.49	20.47
No risk (recent)	n/a	n/a	n/a
Medical injections	n/a	n/a	n/a
Blood transfusions	n/a	n/a	n/a

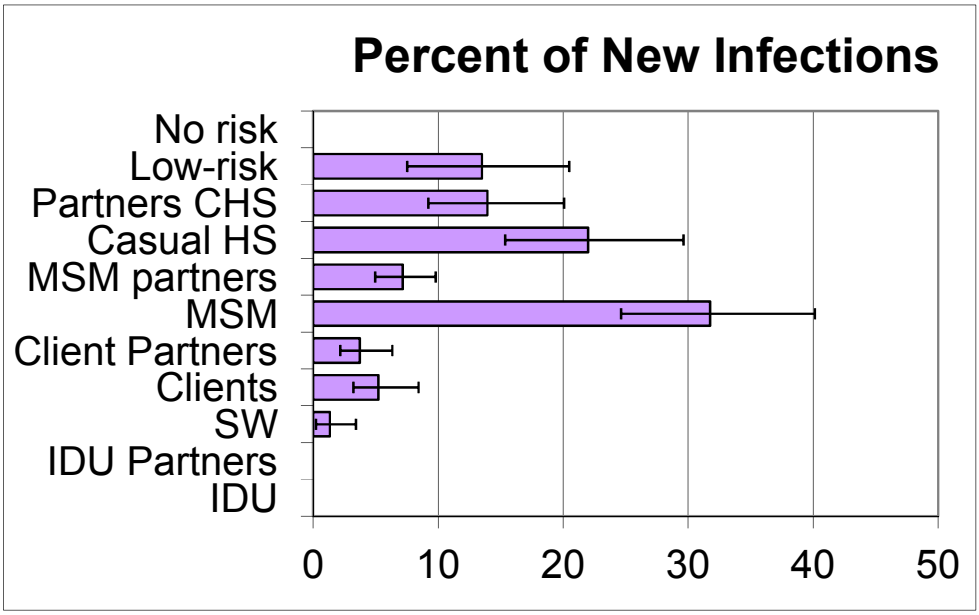

Figure 3: Uncertainty in distribution of new infection occurring in different risk groups

Error! Reference source not found. shows the low bound (2.5% percentile), median (50% percentile) and high bound (97.5% percentile) for incident infections in each risk group. The median value is considered the final result from this model. Figure 3 shows the same incident infections in a bar chart and highlights the 95% confidence intervals.

The model predicts that 32% of new HIV infections will occur among MSM and 7.2% among their female partners. The CHS risk group, their partners and LRH, account for approximately 50% of new infections. A relatively low contribution of around 10% result from sex work practices, which may simply reflect high condom use by sex workers and their clients (see **Error! Reference source not found.** and **Error! Reference source not found.**) and the relatively low prevalence of HIV in these groups.

Figure 3 shows that the 95% confidence intervals of the heterosexual risk groups overlap with the exception of transmission in female partners to MSM. Note that incidence rate among female partners of MSM is significantly higher than incidence in other heterosexual groups given the high number of infections occurring in this relatively small group. Based on the model, there is no strong evidence to distinguish the risk of HIV infections faced by the overlapping groups. Moreover, there is good evidence to suggest that a substantial portion of new infections, more than two thirds, occur outside of the MSM group.

Further, modelling work indicates that there is clearly a need to evaluate prevention strategies for the general population. Firstly, a Goals model was prepared for the Jamaica HIV epidemic, based on roughly the same risk group structure adopted for the MOT model (http://www.futuresinstitute.org/download/goals/Goals.pdf). It shows that even if infections in MSM population are completely stopped in 2012, HIV will still spread at roughly 50% of current levels come 2030, confirming the need to expand all prevention services.

We also used the MOT model to gain more insight into `drivers' of the HIV epidemic in Jamaica, using the method described in section **Error! Reference source not found.**. The method is laid out in **Error! Reference source not found.**. From the results of the MOT model we use estimated numbers of HIV cases in each risk group and the number of infections that occur in the risk group they `partner' with, to estimate the average number of infections caused by one infective case in one year. We assumed that all risk groups will have an infectious period of 10 years.

The estimates are crude, but a number of observations from **Error! Reference source not found.** are noteworthy. In the MSM risk group, the potential for new infections value is 2.2 indicating that every current infection in an MSM individual will lead to approximately 2.2 new infections. The value is greater than one, the `R0' threshold described in section **Error! Reference source not found.**. An independent HIV epidemic is well established in the MSM risk group, as a R0 value greater than one predicts. Further prevention action is needed in order to control the epidemic in this group, where prevalence levels have been reported as high as 32.9% in key subpopulations.

`R0' for FSW is around 2.2 and is directly related to the average duration of sex work. If it is less than 10 years, then 'R0' for sex workers will be significantly lower than 2.2. Of course former sex workers can continue to infect partners once they are no longer involved with sex work, but in that case their contribution should not be attributed the sex worker category.

The most interesting feature of **Error! Reference source not found.** lies in a comparison of the `R0' values for FSW and their clients (around 2.2 and 0.7 respectively) and Low Risk individuals (around 0.9). It appears that the Low Risk individuals may be as significant `drivers' of the epidemic as clients of FSW (and sex work related infections generally, if sex work duration is significantly shorter than 10 years), which can again be related to condom use in these groups (high use for sex work and significantly lower use among Low Risk individuals — see **Error! Reference source not found.** and **Error! Reference source not found.**). Another warning from **Error! Reference source not found.** is that men engaging in casual heterosexual sex and low risk heterosexual sex have values that are below but close to 1. These R0 values suggest that rapid epidemic growth within these groups is not

likely in the near future, but that eventual control within these groups using current strategies should not be assumed with certainty either.

Table 5: New infections resulting from different types of index case

Risk Groups	Number causing infection	Number of infections caused	Infections per person risk	Duration of infectious period	Max potential for new infections
Sex workers	658	143	0.22	10	2.2
Clients of sex workers	1,571	141	0.09	10	0.9
MSM	4,487	995	0.22	10	2.2
Female Casual heterosexual sex	3,979	186	0.05	10	0.5
Male casual heterosexual sex	8,526	766	0.09	10	0.9
Female Low Risk	2,122	181	0.09	10	0.9
Male Low Risk	2,057	175	0.09	10	0.9

5 Discussion

The MOT model has a number of limitations which have to be taken into consideration when analysing and interpreting the results. These limitations can be attributed to the model itself, but many of them are related to data availability. They include:

1. No consideration for the heterogeneity of behaviors within risk groups, although subgroups can be defined.
2. The model does not allow for cumulative risk due to individuals engaging in more than one risk behaviour.
3. The model does not account for the changing probability of transmission along the life course of HIV infection, for example, due to the use of ART.
4. Gaps in available data to represent the various risk groups.

The results of the model indicate that high risk groups, namely MSM and CHS groups continue to be the major contributors to HIV incidence in Jamaica. However, it also indicates that persons identified as low risk and partners of high risk groups, self-identified low risk groups, are also contributing a significant proportion to the pool of new HIV infection. Conversely, the model also shows that the traditional high risk group of FSW and their clients collectively contribute less to HIV incidence than was previously thought.

When we examine the estimate of the expected number of cases caused by each risk group over the lifetime of each case's potential infective period, we note that MSM have the highest HIV transmission capacity at 2.2 infections per case. This provides further evidence for the need to

strengthen the prevention services directed towards the MSM group as present efforts are not controlling this epidemic. However, low risk groups, both men and women, also contribute significantly to the number of new infections at 0.9 infections per case annually. These R0 values point to ongoing challenges in controlling HIV within these groups. FSWs and their clients contribute 2.2 and 0.7 infections per case respectively, highlighting the need for prevention in both the FSW groups as well as their clients.

The results of this exercise should be viewed with the knowledge that a number of assumptions were made with regard to the risk profile of partners of high risk groups. Very few studies have been undertaken to understand the dynamics of the HIV epidemic among these groups worldwide, and none have been undertaken in Jamaica. The lack of data in some areas and the need to rely on estimates could also lead to a bias of the results obtained. The data included in this model were garnered from the most recent surveys for MSM and FSW conducted in 2011. For the parameters required for the majority of the heterosexual population, data was obtained from the 2008 national KABP survey.

Determining the size of the risk populations was challenging. Although some information existed to determine the distribution of the population, limited population-based data was available to categorically substantiate the proportions allocated to each risk group. This was especially the case when determining the size of the partner populations of the risk groups.

6 Recommendations

The findings from the exercise are significant and raise a number of key questions.

6.1 Which intervention will make the most impact?

- The high level of HIV transmission that occurs within the high risk groups is disconcerting. Approximately 64% of all new infections may be attributed collectively to MSM, SW and CHS groups. Continued attention needs to be focused on these groups to include scale up of testing as well treatment and care of STI and HIV. Improved coverage and increased involvement of these groups in our interventions is recommended.

- FSWs, FSW clients and partners of clients contribute approximately 10% of the annual new infections. Targeted interventions for these groups could have a considerable effect in slowing the epidemic. Unfortunately, we have very limited knowledge of the dynamics of infection transmission among clients of sex workers and the partners of these clients. Interventions for this high risk group should include not only the female sex workers themselves, but also specific interventions targeting the clients of FSW. Data collection on FSW clients and their non-paying sex partners would provide valuable information to design suitable interventions for these groups.

- A major finding in this study indicates approximately 40% of incident infections will occur among persons who are considered to be engaging in low risk sex.

    - Further expansion of HIV Counselling and Testing services will allow for the identification of these individuals who likely do not self-identify as being at risk of HIV infection.

    - Condom use and HIV testing should be socially marketed as the norm in any relationship in which the HIV status of the partner is not certain, rather than only during risky sex. Efforts must be made to get couples to undergo joint or couple counselling and testing.

- Further strengthen VCT among all groups and improve the accessibility and availability of testing through routine Provider Initiated Testing and Counselling (PITC) in our health facilities.

- Improved data on risk groups and risk behaviours to inform the MOT model will assist in further delineation of the HIV epidemic within the Jamaican context.

- The MOT analysis should be repeated periodically to assess the progress of interventions and strategies implemented over time.

6.2 Implications for resource allocation

- Additional resources should be focused on prevention strategies that will yield the greatest reduction in HIV transmission. In the light of these findings, it is obvious that a delicate balance must be struck to yield the best results. There is a need to maintain the national programme focus on low risk groups even as the efforts to target MARPS are intensified.

- There is a need to expand universal access to HIV counselling and testing. This should include routine HIV screening for all hospital admissions and labour room HIV testing of mothers with no antenatal care.

- Investment in techniques to overcome all barriers to condom usage including:

    - Socio-cultural
    - Availability
    - Cost effectiveness

- Additional methods of prevention including biomedical prevention and treatment as prevention techniques should be investigated and implemented as appropriate.

- Ensure on going technical assistance and financial sustainability of targeted interventions for vulnerable populations

- Strengthen of the prevention component for general population, including targeted interventions for groups with low risk perception and partners of high risk groups.

6.3 Implications for data analysis, surveillance and incidence monitoring

- General population surveys which include biological surveillance can provide important information on the effects of high risk sexual behaviour on HIV prevalence and incidence.

- Generate studies that contribute to a better understanding of key populations (MSM, SW) and sub populations such as High Risk MSM, Low Risk MSM, Male SW, female partners of MSM, clients of FSW, partners of clients of FSW, Non- injecting drug users and their partners, adolescents and the homeless.

- Novel techniques should be developed and implemented to ascertain rates of condom use that more accurately reflect true rates.

- The model should be repeated periodically with an effort to sub-classify the risk groups and include other vulnerable populations in this model to attain greater detail of the HIV epidemic in Jamaica.

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8 Appendix: Data Sources

8.1 National epidemic estimates

Table 6: National epidemic estimates

Description	Estimate	Year of Estimation	Data Source	Comments
Total Number of adults (15-49)	1,462,535	2010	Statistical Institute of Jamaica	Mid-year population
HIV prevalence in adults	1.86%	2010	National HIV data	Spectrum estimate (15-49 yrs)
New HIV infections among adults	2,500	2010	National HIV data	Spectrum estimate (15-49 yrs)

8.2 MSM

Table 7: Data for risk group: MSM

Data for MSM	Estimation	Year of Estimation	Data Source	Comments
Total MSM in the population	4.0%	2012	Expert Opinion	
HIV prevalence	15%	2011	MSM survey	Adjusted based on biased sampling in the survey
STI prevalence	9%	2011	MSM survey	Syphilis
Average number of sexual partners per year	4	2011	MSM survey	Survey data was adjusted to reflect what was done for the prevalence rate
Average number of sexual acts by partner per year	16	2011	MSM survey	Survey data was adjusted to reflect what was done for the prevalence rate
Percentage of MSM who used a condom during sex	50%	2011	MSM survey	Condom use at last anal sex Accounts for last sex rather than total

8.3 Female partners of MSM

Table 8: Data for risk group: Female partners of MSM

Data for Female Partners of MSM	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of Female partners of	12,000/1.4%	2012	Expert Opinion	Estimated by applying marriage rate to MSM

MSM in the population				(1.4% of the total female population are partners of MSM)
HIV prevalence in this population	1.4		Expert Opinion	Thought to be higher than that of low risk group
STI prevalence in this population	N/A			N/A as their risk of HIV infection is due to their partner
Average number of sexual partners per year	1			By definition
Average number of sexual acts by partner per year	95	2008	KAP survey	Same as number of sex acts in low risk heterosexual
Percentage of condom use during sex	17%		Expert Opinion	Same as condom use in low risk (Main female partner)

8.4 Female Sex Workers

Table 9: Data for risk group: Female Sex Workers

Data for Female Sex Workers	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of Female Sex Workers in the population	14,957/2%		Upper limit of EPP estimate	
HIV prevalence in this population	4.4%	2011	Sex work survey	
STI prevalence in this population	40%	2011	Sex work survey	Syphilis
Average number of sexual partners per year	114	2011	Sex work survey	Mean
Average number of sexual acts by partner per year	2.2	2011	Sex work survey	
Percentage of condom use during sex	90%	2011	Sex work survey	Consistent condom use in the last act

8.5 Clients of Female Sex Workers

Table 10: Data for risk group: Clients of Female Sex Workers

Data for Clients of Female Sex Workers	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of Clients of Female Sex Workers in the	44,872/6% of male population		Estimate from EPP	

population				
HIV prevalence in this population	3.5 %		Expert Opinion	Estimate 80% of SW
STI prevalence in this population	10%		Expert Opinion	Estimate 25% of SW

8.6 Partners of clients of Female Sex Workers

Table 11: Data for risk group: Partners of clients of Female Sex Workers

Data for Partners of SW clients	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of Partners of Clients of FSW	3.6%		Expert Opinion	Based on 60% co-habiting rate Clients of FSW
HIV prevalence in this population	1.1%			As with Low Risk Heterosexuals
STI prevalence in this population	NA			
Average number of sexual partners per year	1			By Definition
Average number of sexual acts by partner per year	95			As with Low Risk Heterosexuals
Percentage of condom use during sex	17%	2008	KAP	As with Low Risk Heterosexuals

8.7 High Risk Heterosexual

Table 12: Data for risk group: High Risk Heterosexual

Data for High risk heterosexual	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of High Risk Heterosexuals in the population	(M) 60% (F) 16% adjusted upward to 25%	2008	National KAP (N=1800)	Female figure adjusted up due to under reporting, based on 2-3 partners being reported in KABP survey 2008.
HIV prevalence in this population	1.9%		Expert Opinion	STI clinic (high risk)
STI prevalence in this population	10%		Expert Opinion	Estimate based on clients of sex workers
Average number of sexual partners per year	5.5	2008	KABP	Calculation weighted
Average number of sexual acts by partner per year	17		Expert Opinion	

Percentage of condom use during sex	65%	2008	KABP	Represents condom use at last sex

8.8 Partners of High Risk Heterosexual

Table 13: Data for risk group: Partners of High Risk Heterosexual

Data for Partners of CHS	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of High Risk Heterosexuals in the population	179,487/24%		Estimate from EPP	
HIV prevalence in this population	1.1%			As with Low Risk Heterosexuals
Average number of sexual partners per year	1			By Definition
Average number of sexual acts by partner per year	95			As with Low Risk Heterosexuals
Percentage of condom use during sex	17%			As with Low Risk Heterosexuals

8.9 Low Risk Heterosexual

Table 14: Data for risk group: Low Risk Heterosexual

Data for Low risk Heterosexual	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of Low Risk Heterosexuals in the population	M: 25% F:25.8%		Expert Opinion	
HIV prevalence in this population	1.1%			Low risk from EPP (ANC)
STI prevalence in this population	2.3%	2011	Outreach team	GUD in past 12 months
Average number of sexual partners per year	1			By definition
Average number of sexual acts per partner per year	95	2008	KAP survey	Annual coital frequency among married couples (3 times per week)
Percentage of condom use during sex	27% - adjusted to 17%	2008	KAP survey	Weighted average between genders reflecting condom use at last sex with main partner

8.10 Without Risk

Table 15: Data for risk group: Without Risk

Data for Without Risk	Estimation	Year of Estimation	Data Source	Comments
Number/percentage of those Without Risk in the population	M: 5% F: 15%	2008	National KAP	Those not sexually active in last 12 months or never active
HIV prevalence in this population	1.1%			Same as Low Risk Heterosexual
STI prevalence in this population	2.3%			Same as Low Risk Heterosexual